Digital Self-Tracking Technologies, Disordered Eating Behaviours, and Athlete Populations:

Exploratory Research to Inform the Design of Future Technologies

Michael Peel

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Abstract

Background: Clinically diagnosed eating disorders, subclinical disordered eating, and their associated disordered eating behaviours can lead to serious and potentially life-threatening consequences (American Psychiatric Association [APA], 2022; Deloitte Access Economics [DAE], 2020). Some athletes are especially susceptible to disordered eating behaviours due to a variety of complex and interconnected risk factors, including specific body composition and athletic performance expectations (Mountjoy et al., 2023; Wells et al., 2020). These athletes may utilize digital self-tracking technologies (e.g., Apple Watch, Fitbit, MyFitnessPal, Strava) to collect and analyze their personal health, fitness, and nutrition data (Boldi & Rapp, 2022; Rapp & Tirabeni, 2020). For some individuals, these technologies are associated with positive health and athletic performance outcomes (Boldi & Rapp, 2022; Feng et al., 2021), while for other individuals, these technologies are associated with unintended negative health and athletic performance outcomes, including initiating and intensifying disordered eating behaviours (Moody et al., 2023; Scheid & Lupien, 2021). Simultaneously, there is growing interest and evidence supporting the successful incorporation of digital self-tracking technologies within treatment and advanced research settings, including their potential to predict, detect, interrupt, and treat disordered eating behaviours within both general and athlete populations (Presseller et al., 2022; Taylor et al., 2021).

Design Problem and Research Aim: This foundation of research reveals that, in relation to disordered eating behaviours, digital self-tracking technologies are linked with both positive and negative health outcomes and possess the potential to improve or degrade the mental and physical health of some users. The conflicting potential and unintended negative consequences that are associated with these evolving technologies present several distinct challenges for designers that justify the need for additional research and understanding, specifically within vulnerable athlete populations. Therefore, the purpose of this Master of Design research project was to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations to inform the design and development of safe and ethical future technologies.

Research Approach: The research approach consisted of a social constructivism philosophical paradigm, an interpretative theoretical lens, a semi-structured qualitative study (SSQS) research design, and the use of semi-structured interviews as the primary research

method. A total of 10 academic, professional, and lifestyle experts from the fields of product design and development, clinical psychology and counselling, and health sciences and kinesiology were interviewed. The interview participants were selected based on their education, expertise, and experience related to the topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. The interview sessions were recorded and transcribed, and the participant-approved interview transcripts were analyzed using an adapted form of thematic analysis.

Findings: Eight primary themes were established from the analysis of the interview transcript data. These themes included: (1) observed associations, unintended negative consequences, and potential risk factors; (2) addressing the complexity, presentation, and contextualization of health and performance data; (3) recognizing control, obsession, and addiction in health and performance data; (4) the conflicting potential of social media, social networking, and data-sharing features; (5) understanding the impact of self-tracking technologies on personal intuition and internal sensory awareness; (6) enhanced user customization and intelligent personalization features for improved safety; (7) future self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours; and (8) exploring increased ethical responsibility requirements for designers and future technologies.

Conclusions: The findings from this research project enhance our understanding of the complex relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations. These findings serve to educate the design community about this complex and emerging design problem, provide a foundation for further research, and inform the design and development of safe and ethical future technologies that seek to mitigate disordered eating behaviours in both athlete and general populations.

Keywords: digital self-tracking technologies; fitness trackers; diet apps; smartwatches; disordered eating behaviours; eating disorders; athlete populations; product design and development; user experience design; qualitative research.

Preface

This thesis is an original work by Michael Peel. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board 1, Project Name "Design research to inform future wearable health tracking devices which address body dissatisfaction and disordered eating behaviours in fitness athlete populations," No. Pro00125375, March 8, 2023.

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1.0 Introduction

1.1 Background

The following subsections will incrementally explore some of the known relationships between disordered eating behaviours and athlete populations, between athlete populations and digital self-tracking technologies, and between digital self-tracking technologies and disordered eating behaviours. This section will conclude with a summary that integrates this critical background information before establishing the design problem and rationale.

1.1.1 Disordered Eating Behaviours and Athlete Populations

Eating disorders are serious psychiatric illnesses that are characterized by persistent disturbances in eating behaviours that significantly impair an individual's mental and physical health (American Psychiatric Association [APA], 2022). According to worldwide prevalence estimates, the most common clinically recognized and diagnosed eating disorders are anorexia nervosa (AN), bulimia nervosa (BN), binge-eating disorder (BED), and other specified feeding or eating disorder (OSFED) (APA, 2022; Silén & Keski-Rahkonen, 2022). These disorders can affect any individual, regardless of demographic factors, and evidence suggests that within the current United States population, an estimated 28.8 million people will develop an eating disorder within their lifetime (Deloitte Access Economics [DAE], 2020). Eating disorders have one of the highest premature mortality rates of any psychiatric illness and were associated with approximately 10,200 deaths within the United States between 2018 and 2019 (APA, 2022; DAE, 2020). Furthermore, the prevalence of eating disorders is rapidly rising, especially among youth worldwide, with substantial increases observed since the start of the COVID-19 pandemic (Agostino et al., 2021; DAE, 2020; Silén & Keski-Rahkonen, 2022). Despite this evidence, the true impact of eating disorders is likely unrecognized, as many individuals will experience significant but subclinical symptoms, avoid seeking treatment, or face challenges with secrecy, denial, and misdiagnosis (Ghazzawi et al., 2024; Joy et al., 2016; Silén & Keski-Rahkonen, 2022).

In a 2020 consensus statement, Wells et al. noted that within athlete populations, these clinically recognized and diagnosed eating disorders are situated at the extreme end of a continuous spectrum of eating behaviours. As illustrated in Figure 1.1, this spectrum spans from optimized nutrition that supports overall health and athletic performance to clinically diagnosed eating disorders that severely degrade these attributes (Wells et al., 2020).

Between these poles lies a continuum of eating pathology known as disordered eating (Chaves et al., 2023; Wells et al., 2020). Generally speaking, disordered eating represents a range of dysfunctional eating behaviour patterns that progressively escalate in symptom severity and negative health and athletic performance outcomes but do not meet the strict criteria required for clinically diagnosed eating disorders (Chaves et al., 2023; Ghazzawi et al., 2024; Wells et al., 2020). Subsequently, the term disordered eating behaviours encompasses the specific dysfunctional eating behaviour patterns that are typically associated with both subclinical disordered eating and clinically diagnosed eating disorders (Chaves et al., 2023; Mountjoy et al., 2023).

Figure 1.1: Spectrum of eating behaviours (Chaves et al., 2023; Wells et al., 2020)

Due to a variety of well-established biological, psychological, and sociocultural risk factors, disordered eating and clinically diagnosed eating disorders are more prevalent within athlete populations compared to non-athlete populations (Wells et al., 2020). For athletes, these risk factors include sport-specific pressures, societal pressures, social media influence, internalization of appearance ideals, pervasive body dissatisfaction, genetic predispositions, trait perfectionism, and other complex and interconnected variables (Petrie & Greenleaf, 2012; Šmahel et al., 2018; Stoyel et al., 2020; Wells et al., 2020). While these athletes are more likely to experience disordered eating than clinically diagnosed eating disorders, the frequency and severity of the shared disordered eating behaviours can increase and result in several adverse mental and physical health consequences (Chaves et al., 2023; Mancine et al., 2020; Mountjoy et al., 2023; Wells et al., 2020).

Evidence has revealed that any athlete may experience disordered eating, regardless of their age, gender, ethnicity, cultural background, socioeconomic status, athletic skill level, or specific sport discipline (Wells et al., 2020). Additionally, disordered eating can occur at any time, regardless of prior history, as athletes can move within the spectrum of adaptive and maladaptive eating behaviours during individual training phases and

throughout their career (Wells et al., 2020). For example, a recent systematic review, meta-analysis, and meta-regression by Ghazzawi et al. (2024) investigated the prevalence of self-reported disordered eating behaviours among athletes worldwide. From 177 eligible studies, the population included a total of 70,957 athletes from 27 countries, and the findings indicate that approximately one in five athletes (19.23%) reported disordered eating behaviours, including, but not limited to, dietary restraint, binge eating, and compensatory purging behaviours (Ghazzawi et al., 2024).

While any athlete in any sport may be susceptible, additional evidence indicates that disordered eating behaviours are more prevalent and present a higher risk within lean sport categories (Ghazzawi et al., 2024; Mancine et al., 2020). According to Mancine et al. (2020), lean sports refer to athletic activities where physical attributes such as low body weight, minimal body fat, and a high strength-to-weight ratio are emphasized and considered performance advantages. Lean sports typically include aesthetically judged (e.g., bodybuilding, diving, figure skating, gymnastics), weight class (e.g., boxing, judo, karate, wrestling), and endurance categories (e.g., cross-country skiing, cycling, running, swimming). These lean sport categories are strongly associated with disordered eating behaviours as methods to control body weight and subsequently influence aesthetics and athletic performance. Furthermore, athletes within the aesthetically judged subgroup currently present the greatest risk (Mancine et al., 2020), with gymnastic sports reporting the highest rate of prevalence, with 41.5% of athletes endorsing disordered eating behaviours (Ghazzawi et al., 2024).

For athletes, these disordered eating behaviours commonly include body dissatisfaction, dietary restraint, binge eating, excessive exercise, compensatory purging behaviours, and muscularity-oriented disordered eating behaviours (Ghazzawi et al., 2024; Joy et al., 2016; Messer et al., 2021; Mountjoy et al., 2023; Petrie & Greenleaf, 2012; Wells et al., 2020). To better understand each of these behaviours, detailed descriptions are provided below.

Body dissatisfaction refers to negative thoughts and feelings that an individual possesses about their own body and may include a perceived discrepancy between their current and idealized appearance, coupled with negative personal evaluations of their body weight, size, shape, and muscularity (Grogan, 2021). Body dissatisfaction is considered both a symptom of and a predominant risk factor for the development of disordered eating and clinically diagnosed eating disorders within athlete populations (Ghazzawi et al., 2024; Petrie & Greenleaf, 2012; Wells et al., 2020).

Dietary restraint is the conscious and purposeful intention to restrict food intake and may involve calorie counting, strict dieting, meal skipping, fasting, and other behaviours that could become maladaptive and contribute to disordered eating, depending upon the individual and their circumstances (Schaumberg et al., 2016).

Binge eating is characterized by recurrent episodes of rapidly consuming large amounts of food, accompanied by a sense of loss of control, and typically resulting in physical discomfort, psychological distress, and dysphoria (APA, 2022).

Excessive exercise refers to dysfunctional patterns of physical activity performed at a level of intensity, frequency, or duration that significantly interferes with important social and professional responsibilities or continues despite the presence of physical injury or illness (APA, 2022; Mond & Gorrell, 2021). Excessive exercise is an evolving term and is commonly associated with a range of interrelated maladaptive and dysfunctional exercise behaviours, including compulsive exercise, obligatory exercise, exercise dependence, exercise addiction, and overtraining (Alcaraz-Ibáñez et al., 2020; Colledge et al., 2020; Mond & Gorrell, 2021).

Compensatory purging behaviours include self-induced vomiting, the misuse of laxatives and diuretics, and engagement in excessive exercise as reactionary measures to prevent weight gain or counteract the effects of binge eating (APA, 2022).

Muscularity-oriented disordered eating behaviours are commonly associated with athlete populations and involve the use of maladaptive dietary strategies such as the overconsumption of protein, the elimination of fats or carbohydrates, the misuse of approved supplements, or the illicit use of performance-enhancing substances to attain a socially idealized muscular physique (Messer et al., 2021; Murray et al., 2017; Nagata et al., 2019).

In isolation, each of these disordered eating behaviours can negatively impact overall health and athletic performance (Mancine et al., 2020; Wells et al., 2020). However, research suggests that approximately one in three athletes will experience multiple behaviours, which can increase the severity of the resultant mental and physical health consequences (Joy et al., 2016). For these athletes, disordered eating can produce states of low energy availability (LEA), which can suppress numerous physiological and psychological processes and lead to a syndrome termed Relative Energy Deficiency in Sport (REDs) (Mountjoy et al., 2023; Wells et al., 2020). This syndrome is caused by severe or prolonged states of caloric deficiency and can result in several detrimental health outcomes, including impairment of metabolic, cardiovascular, musculature, gastrointestinal, cognitive, immune, and reproductive functions. The impairment of these vital functions can degrade athletic performance by reducing concentration, coordination, endurance, power, strength, recovery, and other critical attributes, as well as increasing an athlete's risk for injury and illness (Mountjoy et al., 2023; Wells et al., 2020). The mental health consequences of disordered eating behaviours can include increased irritability, anxiety, stress, depression, substance abuse, addiction, social withdrawal, self-harm, and suicidal ideation (Joy et al., 2016; Mountjoy et al., 2023; Wells et al., 2020). Furthermore, the presentation of subclinical disordered eating has the potential to escalate into clinically diagnosed eating disorders, which have life-threatening repercussions (Mancine et al., 2020; Petrie & Greenleaf, 2012). Therefore, the collective consequences of these disordered eating behaviours pose significant harm to an athlete's overall health, well-being, and sport performance (Mountjoy et al., 2023; Wells et al., 2020).

1.1.2 Athlete Populations and Digital Self-Tracking Technologies

As previously noted, the increased prevalence of disordered eating behaviours within athlete populations is partially attributed to rising internal and external pressures to achieve and continuously maintain ideal body composition and optimal athletic performance (Cotton, 2024; Mancine et al., 2020; Mountjoy et al., 2023; Wells et al., 2020). To meet these demands, athletes may employ various self-tracking strategies to support self-regulation, assess physical condition, boost motivation, and enhance overall performance (Rapp & Tirabeni, 2020). Within this context, self-tracking is considered the purposeful practice of systematic data collection and analysis to gain increased knowledge and understanding about oneself (Boldi & Rapp, 2022; Feng et al., 2021). The information gained through the practice of self-tracking can empower athletes, enable informed decision-making, and facilitate progress towards personal goals and envisioned optimal selves (Boldi & Rapp, 2022).

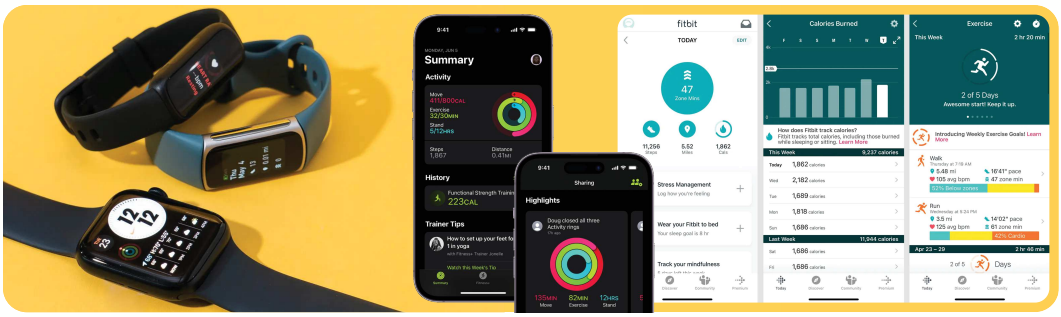

Figure 1.2: Examples of digital self-tracking technologies (Apple, n.d.; Berkman, 2024; Williams, 2024)

Digital self-tracking technologies (see Figure 1.2) have become increasingly accessible and ubiquitous, granting any individual the ability to continuously track physiological, behavioural, and performance measures related to personal health, fitness, and nutrition with greater ease, accuracy, and precision (Boldi & Rapp, 2022). These technologies include wearable fitness tracking devices (e.g., Apple Watch, Fitbit, Garmin, Oura Ring, Samsung Galaxy, Whoop) that use embedded sensors to automatically collect a range of physical activity indicators (e.g., steps taken, stairs climbed, distance travelled) and physiological measures (e.g., heart rate variability, electrodermal activity, skin temperature) to calculate metrics such as caloric expenditure, stress level, sleep quality, and recovery (Branin, 2022; Feng et al., 2021; Scheid & Lupien, 2021). These wearable devices are often paired with proprietary and third-party smartphone applications (e.g., Apple Fitness, Apple Health, Fitbit App) that allow users to easily view and interact with their collected data while providing additional features such as detailed progress visualizations and social networking capabilities. These smartphone applications also include dedicated nutrition tracking apps (e.g., MyFitnessPal, Noom) to log caloric intake, macronutrient ratios, and body weight data, as well as dedicated fitness tracking apps (e.g., Strava, Strong) to record routes, exercises, and workouts (Branin, 2022; Scheid & Lupien, 2021).

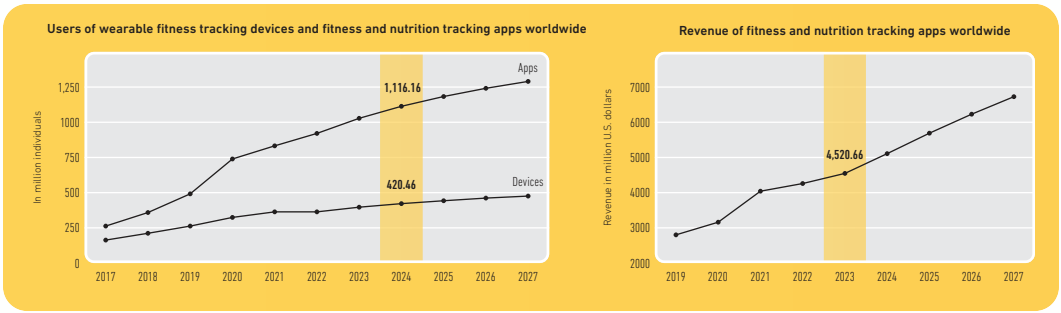

Figure 1.3: Digital self-tracking technology market growth (Statista Research Department, 2023a, 2024)

As illustrated in Figure 1.3, the global popularity of these digital self-tracking technologies continues to increase. According to the Statista Research Department (SRD, 2024), there are currently 420.46 million users of wearable fitness tracking devices and 1.11 billion users of fitness and nutrition tracking apps worldwide. In 2023, approximately 33.78 million wearable fitness tracking devices and 165.23 million smartwatches were shipped globally (Laricchia, 2024c). These devices generated a combined revenue of 63.67 billion USD in 2023 and are projected to generate an additional 70.72 billion USD in 2024 (SRD, 2023b). Since displacing Fitbit in 2017, the Apple Watch has continuously dominated this market segment and currently accounts for 31% of devices shipped worldwide (Laricchia, 2024a, 2024b). Furthermore, in 2023, fitness and nutrition tracking apps generated 4.52 billion USD in global revenue (SRD, 2023a). As of January 2024, the five most profitable fitness and nutrition tracking apps were MyFitnessPal, Strava, Peloton, Lose It!, and Fitbit, which generated a combined global revenue of approximately 35.8 million USD within the month alone (Ceci, 2024). These values indicate the current scale of this rapidly expanding industry, and future projections suggest the total number of users, devices shipped, apps downloaded, and global revenue generated will continue to rise into 2028 (Laricchia, 2024c; SRD, 2023a, 2023b, 2024).

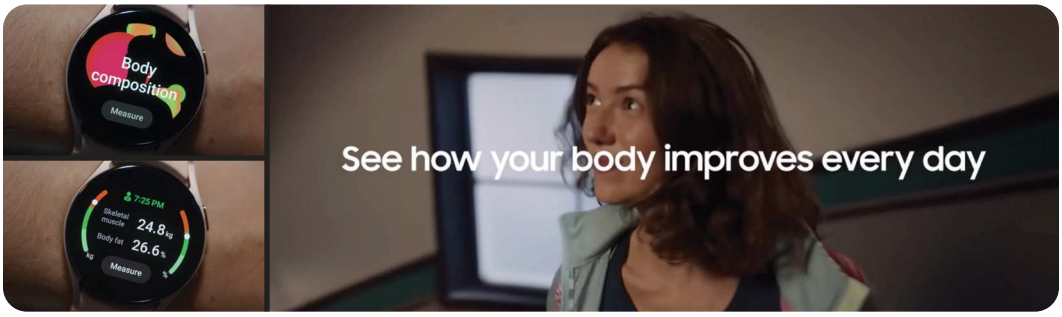

Figure 1.4: Digital self-tracking technology marketing material (Samsung, 2022)

Collectively, these self-tracking technologies often incorporate empirically validated behavioural change techniques, such as self-monitoring, self-quantification, goal setting, social support, social comparison, and gamification design features, to promote adherence, self-awareness, self-efficacy, and self-regulation, which are foundations for lasting health behaviour change (Branin, 2022; Feng et al., 2021; Scheid & Lupien, 2021; Šmahel et al., 2018). Therefore, these self-tracking technologies have the potential to empower individuals

and help them achieve their personal health, fitness, and nutrition goals (Branin, 2022; Scheid & Lupien, 2021). Additionally, these technologies can improve athletic performance, as self-tracking can help athletes develop a sensitive awareness of internal body processes (e.g., heart rate), which can lead to a greater understanding of their current physical capabilities and inform future training and recovery protocols (Boldi & Rapp, 2022; Rapp & Tirabeni, 2020). As depicted in Figure 1.4, the positive potential of self-tracking is commonly emphasized within marketing material, where these technologies are explicitly presented as tools to improve health, athletic performance, and alter body composition (Samsung, 2022).

1.1.3 Digital Self-Tracking Technologies and Disordered Eating Behaviours

However, these technologies are not without risks (De Moya et al., 2021), and empirical research studies indicate that they have the potential to degrade athletic performance (Boldi & Rapp, 2022) and influence disordered eating behaviours for some users (Scheid & Lupien, 2021). Beginning in 2017, several researchers have specifically investigated the relationships between digital self-tracking technologies and disordered eating behaviours in both general and clinical populations (Moody et al., 2023). A series of cross-sectional observational studies have revealed consistent evidence linking the use of fitness and nutrition tracking technologies to disordered eating behaviours, including body dissatisfaction, dietary restraint, binge eating, excessive exercise, compensatory purging behaviours, and muscularity-oriented disordered eating behaviours (Blackstone & Herrmann, 2020; Guo et al., 2022; Hahn, Sonneville, et al., 2021; Messer et al., 2021; Moody et al., 2023; Plateau et al., 2018; Simpson & Mazzeo, 2017). Additional qualitative and mixed methods research studies have deepened our understanding of these complex relationships, revealing dynamic user engagement practices, unintended negative consequences, problematic design features, and potential causation mechanisms associated with these self-tracking technologies (Eikey, 2021; Eikey & Reddy, 2017; Honary et al., 2019; McCaig et al., 2020). However, despite this growing body of empirical evidence, these observed relationships and associations have not been consistently replicated within experimental research studies (Berry et al., 2024; Gittus et al., 2020; Hahn, Kaciroti, et al., 2021; Moody et al., 2023; Wons et al., 2022). Furthermore, there is growing interest and evidence supporting the successful incorporation of these technologies within treatment and advanced research settings, including their potential to predict, detect, interrupt, and treat disordered eating behaviours (Presseller et al., 2022; Taylor et al., 2021). Collectively, these research studies reveal the complex and conflicting potential of these evolving technologies and indicate the need for increased research and understanding.

1.1.4 Summary of Background Information

In summary, clinically diagnosed eating disorders, subclinical disordered eating, and their associated disordered eating behaviours can lead to serious and potentially life-threatening consequences (APA, 2022; DAE, 2020). Some athletes are especially susceptible to disordered eating behaviours due to a variety of complex and interconnected risk factors, including specific body composition and athletic performance expectations (Mountjoy et al., 2023; Wells et al., 2020). These athletes may utilize digital self-tracking technologies (e.g., Apple Watch, Fitbit, MyFitnessPal, Strava) to collect and analyze their personal health, fitness, and nutrition data (Boldi & Rapp, 2022; Rapp & Tirabeni, 2020). For some individuals, these technologies are associated with positive health and athletic performance outcomes (Boldi & Rapp, 2022; Feng et al., 2021). Conversely, for some individuals, these technologies are associated with unintended negative health and athletic performance outcomes, including initiating and intensifying disordered eating behaviours (Moody et al., 2023; Scheid & Lupien, 2021). Simultaneously, several researchers are currently exploring how digital self-tracking technologies could be utilized for intervention, treatment, and advanced research applications for disordered eating behaviours within both general and athlete populations (Presseller et al., 2022; Taylor et al., 2021).

1.2 Design Problem and Rationale

This foundation of research reveals that, in relation to disordered eating behaviours, digital self-tracking technologies are linked with both positive and negative health outcomes. As currently designed, these technologies possess the potential to improve or degrade the mental and physical health of some users. The conflicting potential and unintended negative consequences that are associated with these evolving technologies present several distinct challenges for designers. These challenges justify the need for additional research and understanding, specifically within vulnerable athlete populations. This research is crucial due to the potentially life-threatening consequences correlated with disordered eating behaviours.

1.3 Research Aim, Questions, and Objective

Based on this design problem and rationale, the purpose of this Master of Design research project was to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations. With this overarching research aim, the following research questions were developed.

1. What are the unique risk factors that may influence disordered eating behaviours within athlete populations, including the predominant physiological, psychological, societal, environmental, and technological risk factors?

2. How do existing digital self-tracking technologies influence disordered eating behaviours within athlete populations, including their potential roles in causation, aggravation, prevention, and treatment?

3. What design criteria could future digital self-tracking technologies incorporate to improve safety, reduce unintended negative consequences, and effectively mitigate disordered eating behaviours within athlete populations?

Finally, the objective of this thesis document is to serve as a comprehensive design brief to educate the design community about this complex and emerging problem and to use the findings from these exploratory research questions to inform the design and development of safe and ethical future digital self-tracking technologies that seek to mitigate disordered eating behaviours in both athlete and general populations.

The following section will describe the product design and development process used to address this design problem, research aim, questions, and objective.

1.4 Product Design and Development Process

Digital self-tracking technologies from companies such as Apple, Fitbit, Garmin, Google, Oura, Samsung, and Whoop are considered complex consumer products that are embedded within immense interrelated technological ecosystems and are typically developed through incremental and iterative progression that builds upon existing platform products and innovative technologies (Ulrich et al., 2020). The complexity of these physical and digital products necessitates intensive interdisciplinary product design and development processes that involve global collaboration from many disciplines, including but not limited to, research, design, programming, engineering, manufacturing, and marketing (Cross, 2021; Ulrich et al., 2020). These product design and development processes are defined by Ulrich et al. (2020) as the sequence of steps and activities used to conceptualize, design, and commercialize a product. There are many different product

design and development processes established by different individuals and groups, utilized for different applications and specializations, and featuring varying degrees of structure and definition (Bobble et al., 2016; Cross, 2021; Ulrich et al., 2020).

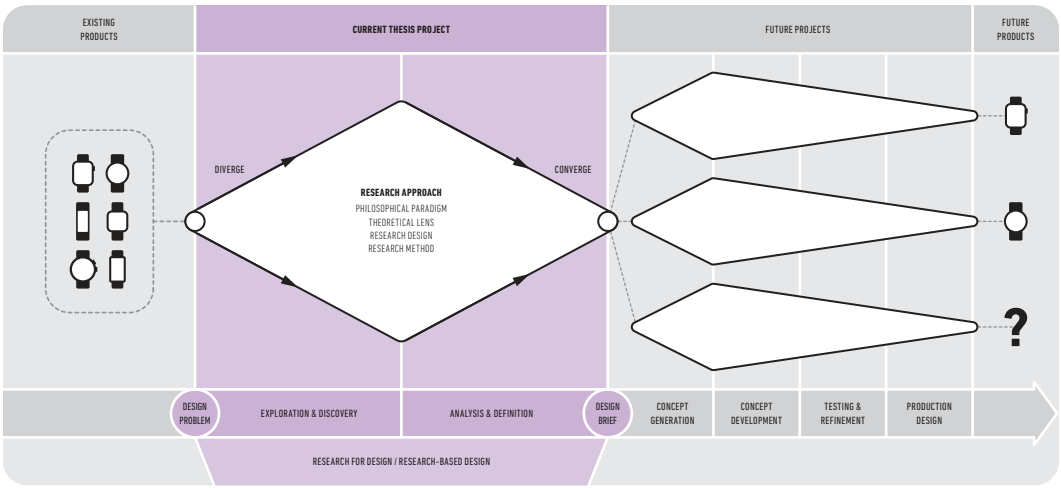

Figure 1.5: Product design and development process

Figure 1.5 illustrates the product design and development process that was assembled for this research project based on the specific design problem, research aim, questions, and objective. This process was inspired by compatible models from the British Design Council, Frog Design, Google, IDEO, and Ulrich et al. (Bobble et al., 2016; Google, n.d.; Ulrich et al., 2020). Common among these contemporary product design and development processes are the initial phases of divergent exploration and discovery, followed by convergent analysis and definition (Bobble et al., 2016; Cross, 2021; Ulrich et al., 2020). These initial phases typically involve research activities to investigate the design problem and discover pertinent knowledge, culminating in the creation of a comprehensive design brief, which specifies user requirements, technical criteria, project constraints, and additional information to inform the design of future solutions (Cross, 2021; Milton & Rodgers, 2013; Ulrich et al., 2020). This design brief serves as the initial input for the following concept generation phase and continues to guide subsequent phases (Ulrich et al., 2020). Within our discipline, this approach is commonly defined as research for design (Frayling, 1993; Galdon & Hall, 2022) or research-based design (Simonsen et al., 2010). As indicated in Figure 1.5, these initial exploration, discovery, analysis, and definition phases represent the total scope of this research project, with further product design and development phases identified as future projects.

The following section will describe the significance of research-based product design and development processes and provide an overview of the research approach used for the initial exploration, discovery, analysis, and definition phases of this research project.

1.5 Overview of Research Approach

The design and development of future technologies is intrinsically characterized by risk, uncertainty, and unpredictability (Simonsen et al., 2010). Human history has revealed that our design decisions have tremendous intentional and unintentional consequences, as the resulting artifacts have the power to improve or degrade conditions across multiple domains (Eikey, 2021; Fry, 2009; Norman, 2023; Simonsen et al., 2010). Renowned design researcher and cognitive scientist Donald Norman believes that designers can no longer ignore this reality, stating that "design must change from being unintentionally destructive to being intentionally constructive: repairing what's gone wrong, collaborating with marginalized voices, and sustaining the earth's limited resources" (Norman, 2023).

While it is impossible to predict all future consequences, many believe that rigorous research-based product design and development processes that prioritize empathy, understanding, and ethics could potentially mitigate some of the unintended negative consequences of our design decisions and lead to improved outcomes (Martin & Hanington, 2019; Muratovski et al., 2022; Simonsen et al., 2010). It is crucial to note that, for this research to be effective, it must be conducted in a rigorous manner, uphold ethical practices, and be reported in detail to assess its validity (Muratovski et al., 2022). Furthermore, this research should not be confined to the initial phases but should be continuously performed and critically integrated throughout the entire product design and development process (Simonsen et al., 2010).

To effectively address these increasingly complex contemporary design problems, designers are often required to develop a deep understanding of human interactions, which forces them to look beyond their profession to other disciplines for suitable research approaches and methods (Muratovski et al., 2022). Therefore, it is now common for designers to integrate approaches and methods from well-established research traditions, such as those from the social and cognitive sciences (Blandford, 2014; Sanders & Stappers, 2012). For example, the field of psychology involves studying people's thoughts, feelings, and behaviours and has developed tools and methods to identify influences, explore perspectives, understand

language representation, and determine the greater consequences and meaning of these elements (Sullivan, 2018). These objectives are in alignment with human-centred and research-based product design and development processes that seek to understand how people think, feel, and act (Muratovski et al., 2022; Sanders & Stappers, 2012). These objectives are also in alignment with the fundamental aim of this research project, which seeks to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations.

These interdisciplinary perspectives and urgent calls for rigorous and ethical research-based product design and development processes significantly shaped this research project. As a result, the following research approach was selected as the most appropriate means to address the research aim, questions, and objective. Within this context, a research approach is a framework utilized within the social and cognitive sciences that provides a detailed overarching plan for the multiple stages of a research project (Creswell & Creswell, 2018). According to Creswell (2016) a research approach consists of four primary components that are interrelated and hierarchical. These primary components are the philosophical paradigm, the theoretical lens, the research design, and the research method (Creswell, 2016; Creswell & Plano Clark, 2018).

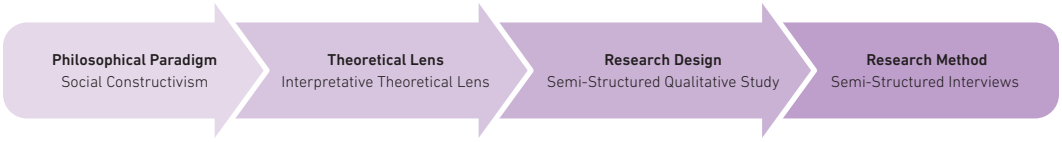

Figure 1.6: Primary components of the research approach

As illustrated in Figure 1.6, the research approach assembled for this project consisted of a social constructivism philosophical paradigm, an interpretative theoretical lens, a semi-structured qualitative study (SSQS) research design, and the use of semi-structured interviews as the primary research method. A total of 10 academic, professional, and lifestyle experts from the fields of product design and development, clinical psychology and counselling, and health sciences and kinesiology were interviewed for this research project. The interview participants were selected based on their education, expertise, and experience related to the topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. The interview sessions were recorded and

transcribed, and the participant-approved interview transcripts were analyzed using an adapted form of thematic analysis (Braun et al., 2015), which incorporated recently published reflexive considerations from Braun and Clarke (2023). Ultimately, eight primary themes were established from the analysis of the interview transcript data.

This research approach was assembled with compatible components to address the specific needs of this research project. It was derived through an inductive discovery process that included understanding the design problem, discovering gaps within the existing research literature, developing critical research questions, and assessing the landscape of available research methods (Blandford, 2014; Creswell & Creswell, 2018). This approach is reflexive and aligns with my current philosophical assumptions and personal experiences as a designer and researcher. Additionally, this approach is interdisciplinary, which corresponds with the complex nature of this design problem and the intended audiences for this thesis document. Finally, this approach is pragmatic and acknowledges the available resources and tangible constraints that were associated with this research project (Blandford, 2014; Creswell & Creswell, 2018; Pabel et al., 2021).

1.6 Overview of Thesis Document

This thesis document consists of six chapters followed by references and appendices. This first chapter, the **Introduction**, outlined the background information required to establish the design problem and rationale; the research aim, questions, and objective; the product design and development process; and the initial overview of the research approach. Building upon this introduction, the following **Literature Review** chapter will discuss the existing research literature that has investigated the links between digital self-tracking technologies and disordered eating behaviours within general, clinical, and athlete populations. This literature review will provide a foundation of knowledge for the subsequent **Research Approach** chapter, which will detail the framework, components, and procedures utilized to address this design problem. The **Findings** chapter will deliver a detailed account of the eight primary themes generated through the implementation of this research approach. The **Discussion** chapter will summarize these findings, interpret their meaning, acknowledge known limitations, propose recommendations for further research, and describe the implications and contributions of these findings. The main body of this thesis document will close with the **Conclusion** chapter, which will present a succinct overview of this research project.

2.0 Literature Review

2.1 Chapter Introduction

This literature review explores the documented relationships between digital self-tracking technologies and disordered eating behaviours within general, clinical, and athlete populations. The purpose of this review is to provide the background information that is required to understand and contextualize this design problem, as well as to construct a foundation for my primary research approach (Creswell & Creswell, 2018; Ridley, 2012).

This is a conventional narrative literature review that describes and evaluates the significant contemporary research literature that has incrementally shaped our current understanding of this design problem (Creswell & Creswell, 2018; Sutton et al., 2019). This research literature includes peer-reviewed articles, systematic reviews, meta-analyses, and overview articles. Additionally, due to the evolving nature of this research area, emerging information from pre-print articles and study protocols was evaluated and incorporated. This literature review is organized into four primary sections, which are quantitative research, experimental research, mixed methods and qualitative research, and finally intervention, treatment, and advanced research studies.

As will be discussed in the following chapter, my research approach incorporated a semi-structured qualitative study (SSQS) research design. An advantage of this adaptable, inductive, and exploratory research design was that it facilitated an ongoing dialogue with the literature throughout the multiple phases of this research project (Blandford, 2014; Creswell & Creswell, 2018; Holloway & Brown, 2012). Therefore, this literature review evolved concurrently with the progression of my research project and through continuous engagement with emerging research literature. This strategy served to confirm research gaps, refine research questions, inform my research approach, develop beneficial interview questions, identify expert interview participants, and assist interview analysis and interpretation, among other functions.

2.2 Quantitative Research

Simpson and Mazzeo (2017) performed the first cross-sectional observational study that examined the relationship between digital self-tracking technologies and disordered eating behaviours. This foundational study recruited 493 undergraduate students (mean age = 20.52) from the United States and assessed their use of fitness and nutrition tracking technologies (e.g., Fitbit, MyFitnessPal) in relation to eating disorder symptomatology and body image concerns. The results revealed that nutrition tracking technologies were associated with greater eating concern and dietary restraint, while fitness tracking technologies were uniquely associated with greater disordered eating behaviours. However, despite these associations, neither fitness nor nutrition tracking technologies were linked to body dissatisfaction within this sample. While this study was the first to reveal these associations, the results could not determine whether these technologies triggered disordered eating behaviours in individuals without a prior history or whether individuals with a prior history of disordered eating behaviours were more likely to use these technologies (Simpson & Mazzeo, 2017).

A subsequent study by Plateau et al. (2018) attempted to extend this research by exploring the use of fitness and nutrition tracking technologies in relation to disordered eating behaviours, with a specific emphasis on eating psychopathology, compulsive exercise, and psychological wellbeing. This cross-sectional observational study assessed the perspectives of 353 undergraduate students (mean age = 21.90) from the United Kingdom, and the results demonstrated strong associations between the use of these technologies and increased body dissatisfaction, eating concern, dietary restraint, compulsive exercise, and compensatory purging through excessive exercise. Additionally, these associations were heightened for participants who reported using these technologies primarily for body weight and shape management compared to those using them to improve overall health and fitness. However, despite these significant and concerning associations, there were no reported differences in psychological wellbeing between users and nonusers or between stated reasons for use. This was an unexpected finding, and the researchers suggested the potential negative effects of self-tracking may be offset by the participant's perceptions of increased physical wellness or progress towards goal attainment. However, additional longitudinal and experimental research studies would be required to understand the nuanced psychological impacts of fitness and nutrition tracking technologies (Plateau et al., 2018).

Levinson et al. (2017) conducted one of the few cross-sectional observational studies that examined the relationship between nutrition tracking apps and individuals with clinically diagnosed eating disorders, including anorexia nervosa, bulimia nervosa, and OSFED. In a sample of 105 individuals (mean age = 25.58) recruited from an eating disorder clinic in the United States, approximately 75% of the participants used MyFitnessPal to track calories, and of these users, 73% perceived the app as contributing to their eating disorder. Further analysis revealed that these perceptions correlated with significantly higher eating disorder symptoms, including body dissatisfaction and dietary restraint (Levinson et al., 2017).

These findings were expanded upon by Linardon and Messer (2019), who examined MyFitnessPal users without clinically diagnosed eating disorders recruited from fitness-oriented online communities. In a sample of 122 individuals (mean age = 28.41), the researchers found that MyFitnessPal users reported significantly higher levels of disordered eating symptoms, body dissatisfaction, dietary restraint, binge eating, and psychosocial impairment compared to non-users (Linardon & Messer, 2019). While causal relationships could not be determined as these studies relied on self-reported and retrospective data, the results suggest that nutrition tracking apps are commonly used within eating disorder and fitness populations, and their use is linked to eating disorder pathology and increased eating disorder symptoms (Levinson et al., 2017; Linardon & Messer, 2019).

Research by Blackstone and Herrmann (2020) specifically investigated the relationships between wearable fitness tracking devices and exercise dependance, compulsive exercise, and compensatory purging behaviours typically associated with eating disorders. These behaviours are commonly employed by some individuals to counteract the perceived mental and physical consequences of not meeting their physical activity or caloric expenditure goals (e.g., to alleviate guilt and avoid weight gain). The sample included 337 undergraduate students (mean age = 19.31) from the United States, and the results indicated that the use of wearable fitness tracking devices is strongly associated with increased exercise dependance and compulsive exercise. Additionally, users were significantly more likely to utilize dietary restraint and increased vigorous exercise to meet physical activity and caloric expenditure goals (Blackstone & Herrmann, 2020).

These findings were supported and expanded upon by Hahn, Sonneville, et al. (2021), who determined that using multiple forms of fitness and nutrition tracking technologies is

associated with an increased likelihood of engaging in disordered eating behaviours. In a sample of 647 undergraduate students from the United States (age range = 18–22), individuals who utilized multiple forms of fitness and nutrition tracking technologies, including wearable devices (e.g., Fitbit, Garmin) and digital apps (e.g., MyFitnessPal, CalorieKing), were significantly more likely to engage in disordered eating behaviours compared to individuals who used minimal self-tracking technologies. These behaviours included dietary fasting, skipping meals, appetite suppression, compensatory purging behaviours, and excessive exercise (Hahn, Sonneville, et al., 2021). While prior research by Simpson and Mazzeo (2017) identified that fitness and nutrition tracking technologies are often used together, these findings by Hahn, Sonneville, et al. (2021) revealed that the combined use of these technologies may increase the potential for, and even predict, disordered eating behaviours. Therefore, the authors suggest that researchers must examine the combined use of fitness and nutrition tracking technologies to understand their true impact on the general population (Hahn, Sonneville, et al., 2021).

Further cross-sectional observational studies consistently measured increased disordered eating behaviours for users of fitness and nutrition tracking technologies compared to non-users (Guo et al., 2022; Messer et al., 2021). For example, a study of 1357 adults (mean age = 30.28) from global online communities by Messer et al. (2021) found that participants who had used nutrition tracking apps (e.g., MyFitnessPal, Lose It!, Noom) at any point in their lives reported significantly higher scores for disordered eating symptomatology compared to non-users, and long-term use was correlated with higher symptom severity. Additionally, individuals who used the apps primarily for body weight and shape management exhibited higher disordered eating symptom severity compared to individuals who used the apps for health and disease prevention purposes. Finally, this study revealed that these relationships were also correlated with increased muscularity-oriented disordered eating behaviours, which are typically associated with athletic populations. These findings were significant and extended prior research, but due to the cross-sectional research design, any potential explanations for these associations could not be definitively concluded (Messer et al., 2021).

However, Guo et al. (2022) sought to better understand the mechanisms through which fitness tracking technologies influenced disordered eating behaviours. In a sample of 495 undergraduate students (mean age = 19.19) from mainland China, the researchers determined that the use of fitness tracking apps for calorie calculation, diet regulation, exercise regulation,

and weight loss tracking evoked significant disordered eating cognition, and these thoughts induced subsequent disordered eating behaviours. The induced behaviours included increased body dissatisfaction, dietary restraint, binge eating, and excessive exercise. Additionally, the study determined that disordered eating cognition was also evoked through passive and active exposure to online media content related to health, fitness, and appearance, which also induced subsequent disordered eating behaviours (Guo et al., 2022).

A longitudinal study by Hahn et al. (2022) investigated the long-term impact of these technologies, collecting initial data from a culturally and economically diverse sample of 1446 youth (mean age = 14.40) from the United States, followed by subsequent data collection eight years later as the sample entered early adulthood (mean age = 22.00). The results suggest there is a strong association between the use of fitness tracking technologies (e.g., Fitbit, MyFitnessPal) during adolescence and greater disordered eating behaviours in early adulthood. This included increased prevalence for both disordered weight-control behaviours (e.g., fasting, purging), and disordered muscle-building behaviours (e.g., steroid use). Furthermore, this association was not explained by preexisting levels of disordered eating in adolescence and suggests the use of fitness tracking technologies may in fact be a risk factor for disordered eating rather than a symptom (Hahn et al., 2022).

2.3 Experimental Research

While the above-mentioned cross-sectional observational studies revealed strong associations between digital self-tracking technologies and disordered eating behaviours, replicating these findings through experimental research has yielded inconsistent results (Moody et al., 2023). For example, a short, 10-day, randomized controlled trial by Gittus et al. (2020) examined the psychological effects of a wearable fitness tracking device (i.e., Fitbit) in relation to disordered eating behaviours and body dissatisfaction. In a sample of 262 undergraduate students (mean age = 22.86) from Australia, Fitbit users were less likely to report instances of dietary restraint and binge eating compared to individuals from the control group. Additionally, there were no significant differences in levels of body satisfaction between the groups. These findings were unexpected and contradicted prior observational research by Simpson and Mazzeo (2017). However, the researchers noted their 10-day trail duration as a significant limitation, suggesting the potential negative consequences associated with wearable fitness tracking devices may emerge through

extended use (e.g., months or years), revealing the need for future experimental research with increased trial durations (Gittus et al., 2020).

Therefore, a subsequent randomized controlled trial by Wons et al. (2022) investigated the perceived influence of a wearable fitness tracking device (i.e., Mi Smart Band) on eating disorder symptoms and physical activity engagement during a 12-week cognitive behavioural therapy (CBT) treatment program. The sample included 30 individuals (mean age = 37.10) from the United States with clinically significant binge eating and restrictive eating pathologies who engaged in either maladaptive exercise (i.e., compensatory or driven) or adaptive exercise (i.e., neither compensatory nor driven) prior to treatment. The results of the study were mixed, as some participants perceived that the wearable fitness tracking device influenced their eating disorder symptoms and instances of maladaptive exercise, while others perceived that the device reduced instances of binge eating, dietary restraint, and maladaptive exercise. Additionally, the results demonstrated that the perceived influence of the device varied between treatment sessions and decreased throughout the treatment program. However, these results may highlight the efficacy of the CBT treatment program rather than establishing definitive conclusions regarding the relationships between the device, disordered eating behaviours, and maladaptive exercise. With this said, these results are promising and indicate that the use of a wearable fitness tracking device may not inhibit eating disorder treatment within a clinically controlled program, illuminating the potential for novel treatment possibilities. Finally, it is worth noting that a significant limitation of this study was that participants were instructed not to look at or engage with the wearable device's corresponding digital app during the trial. This presents a non-typical use-case scenario and prohibits the generalizability of these findings for typical consumer use (Wons et al., 2022).

Two additional noteworthy experimental studies aimed to validate prior observational findings by Levinson et al. (2017), Plateau et al. (2018), Simpson and Mazzeo (2017), and others by evaluating the relationships between fitness and nutrition tracking through MyFitnessPal and disordered eating behaviours. The first study was a one-month randomized controlled trial by Hahn, Kaciroti, et al. (2021), which tested the impact of MyFitnessPal on a sample of 192 undergraduate students (mean age = 20.20) from the United States. The inclusion criteria required that the participants had not engaged in dietary tracking within the last year and possessed a low baseline risk for developing an

eating disorder. Contrary to the researcher's hypotheses, the results revealed no difference in levels of disordered eating behaviours, including dietary restraint, binge eating, compulsive exercise, and body satisfaction, between MyFitnessPal users and individuals from the control group after one month. These findings demonstrate that initial use of nutrition tracking technologies is not shown to cause disordered eating behaviours within low-risk populations. However, the researchers expressed caution and suggested the use of nutrition tracking technologies may be associated with, or a predictor of, disordered eating cognitions and behaviours within high-risk populations, such as those observed by Levinson et al. in 2017 (Hahn, Kaciroti, et al., 2021).

The second noteworthy study was an eight-week longitudinal experiment by Berry et al. (2024), which tested the fitness and nutrition tracking functions of MyFitnessPal on a sample of 68 undergraduate students (mean age = 19.78) from the United States. The results revealed a relationship between tracking frequency and higher levels of trait body dissatisfaction, suggesting that individuals who possess preexisting body image concerns or preoccupations with body weight and shape management may track with greater frequency. However, similar to previous experimental studies (Gittus et al., 2020; Hahn, Kaciroti, et al., 2021; Wons et al., 2022), the quantitative results produced insufficient evidence to support a relationship between fitness and nutrition tracking and increased instances of disordered eating behaviours, including dietary restraint and compulsive exercise. While these findings conflict with prior observational research studies, the experiment also collected qualitative comments, which revealed discrepancies with the quantitative data. These comments state that some individuals deliberately avoided tracking, intentionally manipulated data, and increased food intake as adaptive coping strategies to regulate negative emotions such as guilt, anxiety, and shame that arose when they exceeded their caloric limit or received negative feedback from the app (Berry et al., 2024). These qualitative findings provided important insights and revealed the potential limitations of quantitative research designs.

2.4 Mixed Methods and Qualitative Research

A robust 12-month mixed methods research study by Honary et al. (2019) sought to develop a holistic understanding of the potential risks associated with fitness and nutrition tracking apps and their relation to disordered eating behaviours in young people. The researchers conducted four quantitative and qualitative research activities, including a broad user survey

(*n* = 95) and two focused workshops (*n* = 8) with young people (age range = 18–25), followed by semi-structured interviews with eating disorder and body image experts (*n* = 3), and concluding with a systematic content analysis of the most downloaded fitness and nutrition tracking apps (*n* = 100) from the Google Play Store. Collectively, these research activities investigated several apps, including MyFitnessPal, Fitbit, Strava, Samsung Health, Google Fit, Garmin Connect, Nike+, and others (Honary et al., 2019).

The research approach utilized by Honary et al. (2019) obtained detailed participant insights, and the results revealed strong associations between app use and disordered eating, body dissatisfaction, maladaptive exercise, and compulsive behaviour formation. For example, the findings indicate that the goal-setting and gamification design features integrated within these apps can promote obsessive tracking of physical activity and dietary intake. Failure to meet these health goals can provoke feelings of guilt, anxiety, and depression, which can lead to dietary restraint, excessive exercise, and compensatory purging behaviours. Additionally, while many apps integrate social networking and data sharing features, the findings suggest that some individuals experience negative emotional consequences due to unhealthy social comparison and competition. Furthermore, some individuals experience increased social isolation due to strict adherence to rigid training and eating routines associated with their personal fitness and nutrition goals. Together, these negative associations caused many individuals to feel controlled by the apps, resulting in approximately one-third of the survey participants discontinuing use. Overall, this mixed methods approach achieved valuable in-depth user perspectives and identified specific design features that may instigate and aggravate disordered eating behaviours in young people. Finally, the study provided explicit responsibility guidelines for future technology researchers, designers, and developers that could mitigate the detrimental consequences associated with these technologies and vulnerable populations (Honary et al., 2019).

Building upon these findings, Eikey noted that fitness and nutrition tracking apps generally emphasize dieting and weight loss as proxies for optimal physical health, which can normalize, encourage, and support disordered eating behaviours for some individuals (Eikey, 2021). Based on this perspective, Eikey performed a mixed methods research study that illuminated the unintended negative consequences associated with these apps (e.g., MyFitnessPal) as experienced by 24 undergraduate students (mean age = 20.63) from the United States with preexisting disordered eating behaviours. Through surveys, think-aloud exercises, and semi-

structured interviews, the participants identified design features that would initiate and intensify their disordered eating behaviours, including features that emphasize quantification, promote overuse, and provide positive and negative feedback (Eikey, 2021).

For example, Eikey reported that participants developed a fixation on the numeric data collected and presented by the apps, including an acute awareness of their caloric intake and energy expenditure that altered their relationship with food and physical activity. This often led to the development of strict and rigid diets, including eating the same foods every day or only eating foods that could be easily logged within the apps. Participants reported becoming obsessed with self-tracking, which progressed into obsessive thoughts regarding food and physical activity that interfered with their school, work, and social relationships. App dependency would often emerge, where participants would feel a sense of safety and control when using the app but would feel anxious and fearful when not. Participants noted that they felt a strong sense of accomplishment from positive feedback indicators, such as green progress visualizations, for losing body weight, eating under their caloric targets, or when logging compensatory purging behaviours. However, negative feedback indicators, such as red progress visualizations for gaining body weight, eating over their caloric targets, or not performing enough physical activity, would result in extreme negative emotions, such as guilt, embarrassment, and shame. Especially concerning, some participants reported feeling a sense of motivation from messages and visual cues that were intended to deter harmful use but inadvertently reinforced their disordered eating behaviours, such as inadequate calorie consumption and low body weight warnings. Finally, due to the gamification design features, participants viewed calorie consumption, energy expenditure, and weight loss as a game, promoting excessive and unhealthy internal competition as the participants aimed to outperform the app or themselves through dietary restraint and compensatory purging behaviours (Eikey, 2021).

Eikey's findings indicate that fitness and nutrition tracking apps caused significant unintended negative consequences that adversely impacted the participant's quality of life, worsened their disordered eating behaviours, and interfered with their treatment and recovery (Eikey, 2021). After critically examining these apps and their intricate user engagement relationships, Eikey provided suggestions for designers to improve these technologies, advocating for a fundamental shift towards a more holistic and personalized approach that prioritizes mental health. To help achieve this, they recommended

participatory design initiatives where experts and people with disordered eating behaviours are meaningfully involved in all phases of the product design and development process. Eikey believes that implementing these principles would benefit all users, not just those who are at risk for disordered eating behaviours. Finally, Eikey noted that the qualitative research methods utilized (i.e., think-aloud exercises and semi-structured interviews) uncovered detailed participant perspectives and emergent themes that would not have been discovered if only quantitative methods were used (Eikey, 2021).

A qualitative research study by McCaig et al. (2020) furthered our understanding of the complex user engagement relationships associated with these technologies and disordered eating behaviours. The researchers noted that prior cross-sectional observational studies (Levinson et al., 2017; Linardon & Messer, 2019; Plateau et al., 2018; Simpson & Mazzeo, 2017) assessed a limited conceptualization of user engagement (i.e., use dichotomy or use frequency), which does not accommodate for the true range of nuanced user interactions. Therefore, important pathological aspects of user engagement likely remained undetected (McCaig et al., 2020). Based on this perspective, McCaig et al. attempted to provide comprehensive insight into fitness and nutrition tracking technology engagement practices through the inductive thematic analysis of online comments (n = 1695) from unique contributors (n = 920) posted on eating disorder-related Reddit forums (n = 3) that specifically mentioned MyFitnessPal usage (McCaig et al., 2020).

Analysis of these comments extended prior research (Levinson et al., 2017; Linardon & Messer, 2019) and observed links between MyFitnessPal use and disordered eating behaviours, including dietary restraint, binge eating, and compensatory purging behaviours (McCaig et al., 2020). The analysis also revealed alarming user engagement strategies to successfully circumvent interventions implemented by MyFitnessPal to recognize and prevent pathological use. These strategies included self-deception and intentional data manipulation primarily to facilitate weight loss by overestimating caloric intake, underestimating energy expenditure, ignoring purge behaviours, altering sex and height data to enable lower weight loss goals, and using different devices, applications, or accounts to bypass interventions. Additionally, while some users deliberately ignored or disabled intervention notifications, other users expressed satisfaction when MyFitnessPal issued low caloric intake warnings, viewing them as progress towards their goals. Several users reported feeling addicted to MyFitnessPal and that it contributed to obsessive thoughts,

unproductive rumination, and eating disorder relapse. As a result, some users would delete the app to aid their treatment and recovery. Finally, as observed in other studies (Berry et al., 2024; Eikey, 2021; Honary et al., 2019), some users would discontinue use to avoid negative emotions such as guilt, anxiety, and stress which were associated with MyFitnessPal, self-tracking, or failing to meet personal goals (McCaig et al., 2020).

Many of the aforementioned research studies (Eikey, 2021; Honary et al., 2019; McCaig et al., 2020) build upon pivotal findings by Eikey and Reddy (2017) from the field of human-computer interaction. In their mixed methods study, the researchers interviewed 16 participants (mean age = 20.88) from the United States, all with a history of disordered eating behaviours and experience using fitness and nutrition tracking apps (e.g., MyFitnessPal). The participant interviews revealed that the use patterns and subsequent impact of these technologies can change and evolve throughout each user's personal health journey. For example, the participants described in detail how the apps had the potential to initiate and intensify their disordered eating behaviours or aid their treatment and recovery, depending on their attitudes and motivations at different stages of their lives. These findings challenged conventional binary classifications of these technologies as solely positive or negative, demonstrating that technology use is dynamic in nature and influenced by many contextual factors. Furthermore, the researchers emphasized that understanding this dynamic nature and the associated contextual factors will be imperative when designing for future health-focused technologies (Eikey & Reddy, 2017).

2.5 Intervention, Treatment, and Advanced Research

The previously discussed findings by Eikey and Reddy (2017) revealed that while fitness and nutrition tracking technologies can encourage and exacerbate disordered eating behaviours, they can also support treatment and recovery for some individuals. Therefore, based on this positive potential, several researchers have explored how these technologies could be better designed and safely incorporated into intervention, treatment, and advanced research applications for disordered eating behaviours (Presseller et al., 2022; Taylor et al., 2021).

For example, an overview article by Taylor et al. (2021) assessed the current state of scientific evidence evaluating the efficacy of technology-based interventions for the treatment of disordered eating behaviours. These interventions included a range of self-

guided, professionally guided, and blended mental health programs, incorporating online and in-person treatment methods, delivered through digital devices such as phones, tablets, or computers. The researcher's analysis of existing systematic reviews and meta-analyses determined that technology-based interventions (e.g., online cognitive behavioural therapy) were generally effective treatment methods that successfully reduced eating disorder symptoms across the studied populations (Taylor et al., 2021).

An earlier article by Flatt and Taylor (2018) recognized the potential of these technology-based interventions and proposed the integration of digital mental health programs specifically adapted to detect, prevent, and treat eating disorders in athlete populations. Building upon established evidence-based examples, the researchers developed a customized model that accounts for the unique risk factors and treatment barriers that athletes encounter. In this model, athletes would complete an online assessment to screen for eating disorder risk and symptomatology. Based on these results, an algorithm would triage each athlete, deliver personalized feedback, and match them with a tailored online program contextualized for their sport-specific risk factors. For example, the researchers noted that athletes who participate in sports that prioritize aesthetics, leanness, or body weight class (e.g., gymnastics, endurance running, wrestling) often experience greater levels of body dissatisfaction. Therefore, these athletes may benefit from custom programs specifically designed to improve body image by addressing the paradoxical relationship between perfectionism, which can lead to success in sports but negatively impact body image. The researchers believed that this model could provide personalized, private, accessible, and affordable evidence-based mental health care to athletes in real-time (Flatt & Taylor, 2018). However, while this model demonstrated significant promise, its implementation and efficacy remain unclear, warranting further research.

It is important to note that while technology-based interventions were considered effective treatment methods for eating disorders, they were observed to be less effective than comparable interventions for the treatment of anxiety and depression (Taylor et al., 2021). This further illustrates the complexities of eating disorder treatment, revealing the need for continued research and development for future technology-based interventions that seek to address related comorbidities, improve patient engagement, extend treatment duration, and reduce dropout rates (Taylor et al., 2021). Furthermore, while smartphone apps for the

treatment of eating disorders exist, analysis revealed that many were not backed by scientific evidence, and their utility within clinical treatment remains inconclusive (Taylor et al., 2021).

Several researchers have observed these limitations, and a review article by Graham et al. (2023) suggests the cause may be that many technology-based interventions are developed in research environments that lack sufficient input from users, disregard true use settings, and overlook the dynamic nature of technology use previously identified by Eikey and Reddy (2017). From this perspective, Graham et al. reviewed several research projects that utilized elements of human-centred design, user-centred design, and design thinking methodologies to develop technology-based interventions for eating disorders. Their review extends prior recommendations by Eikey (2021), as Graham et al. advocate for the use of participatory design initiatives that account for specific implementation settings and involve real users through all phases of the design process, including individuals from marginalized groups and those with intersectional identities who are typically underrepresented within the research literature. Additionally, they recommend continuous assessment and iterative development of the intervention to optimize performance over time and adapt to evolving user needs. The authors believe that integration of these recommendations may enhance accessibility, engagement, functionality, and user satisfaction of future interventions, potentially leading to improved clinical impact and effectiveness (Graham et al., 2023). While this review generally focused on the development of new technology-based interventions, I believe these recommendations could also be applied to the incremental improvement of existing consumer fitness and nutrition tracking technologies to address disordered eating behaviours.

A systematic review by Presseller et al. (2022) highlights the exciting potential and rapidly expanding use of emerging wearable sensor technologies within eating disorder research. Wearable sensor technologies, such as those integrated within modern consumer fitness tracking devices (e.g., Apple Watch, Fitbit), have allowed researchers to objectively measure cognitive, behavioural, and affective factors linked to eating disorder symptomatology in a noninvasive, passive, and continuous manner. These objective measurements can complement traditional data collection methods and mitigate some of the validity concerns that may be associated with self-reports, clinical interviews, and direct observations. Within eating disorder research, wearable sensor technologies have been used to collect data related to physiological measures (e.g., heart rate, heart rate variability, respiration rate,

electrodermal activity, skin temperature, sleep quality), behavioural patterns (e.g., physical activity, eating patterns, smartphone usage), and environmental information (e.g., location, ambient temperature), providing revolutionary new insights into the causation and maintenance of these complex health conditions (Presseller et al., 2022).

Furthermore, some of the most promising advancements in eating disorder research are currently underway and are leveraging these emerging wearable sensor technologies. For example, an observational study protocol by Kilshaw et al. (2022) has used passive sensor data from Apple Watches (i.e., heart rate and step count) in combination with self-reported data from the Recovery Record iPhone app (i.e., emotions and eating behaviours) to characterize states of increased risk for binge eating and compensatory purging behaviours. This study is part of the larger longitudinal Binge Eating Genetics Initiative (BEGIN) by Bulik et al. (2020) and utilized data captured from 1019 participants (mean age = 29.60) from the United States with clinically diagnosed binge eating disorder or bulimia nervosa (Kilshaw et al., 2022). By analyzing the passive and active data that proceeds and follows binge and purge episodes, the researchers can identify dynamic patterns that indicate when an individual is at risk for engagement with these behaviours. The future application of this research is to develop novel wearable technologies that can recognize states of increased risk, disrupt in-progress behaviours, and provide personalized therapeutic interventions in the moment. Data analysis for this study began in the spring of 2022, and the final results have not yet been reported (Bulik et al., 2020; Kilshaw et al., 2022).

An additional observational study protocol by Presseller et al. (2023) will use a Fitbit Sense 2 wearable fitness tracking device to passively collect continuous measures of nervous system arousal (i.e., heart rate, heart rate variability, and electrodermal activity) that coincide with states of negative affect in a sample of 30 individuals who are experiencing recurrent binge eating behaviours. This study aims to determine whether wearable sensors can differentiate between states of positive and negative affect in this sample and whether this sensor data, in combination with ecological momentary assessment surveys and machine learning algorithms, can predict binge eating behaviours in response to negative affect with greater accuracy. What is exceptional about this study is that the researchers specifically acknowledge the underrepresentation of many racial, ethnic, and gender identities within eating disorder research and are purposefully seeking equal

enrolment from these demographics. This study is also in progress, with data collection stated for completion by May 2024 (Presseller et al., 2023).

Finally, extremely compelling data has emerged from a pilot study completed by Ralph-Nearman et al. (2024). In this study, the researchers used an Empatica E4 wearable sensor to passively collect physiological data (i.e., heart rate, electrodermal activity, and skin temperature) and then employed idiographic machine learning models to accurately detect the onset of disordered eating behaviours in real-world contexts. In a small sample of six participants (mean age = 29.50) from the United States with diagnosed eating disorders, the researchers collected this physiological data while the participants logged instances of disordered eating behaviours, including dietary restraint, binge eating, excessive exercise, self-induced vomiting, and the use of laxatives or diuretics. The results of this 30-day trial were fascinating, revealing that the machine learning models could predict the occurrence of disordered eating behaviours 20 minutes before onset with 91% accuracy. Furthermore, the models demonstrated a remarkable ability to identify the specific behaviour experienced by the participant (e.g., dietary restraint vs. self-induced vomiting) with 92% accuracy, despite variation in eating disorder diagnosis (e.g., anorexia nervosa vs. bulimia nervosa) amongst the participants (Ralph-Nearman et al., 2024).

Collectively, these studies suggest the exciting viability of thoughtfully designed future fitness and nutrition tracking technologies to predict, detect, interrupt, and treat disordered eating behaviours in real time (Flatt & Taylor, 2018; Kilshaw et al., 2022; Presseller et al., 2023; Ralph-Nearman et al., 2024). While these findings are extremely promising, it is important to note that the consumer technologies (e.g., Apple Watch, Fitbit) employed within these advanced research studies were often modified and used in controlled and supervised environments (Bulik et al., 2020; Kilshaw et al., 2022; Presseller et al., 2023). Alternatively, some wearable sensors, such as the Empatica E4 device used by Ralph-Nearman et al. (2024), are designed for clinical research applications and are not currently available for general consumer use. Therefore, it is important to distinguish these positive findings from the negative associations that users have reported with existing consumer products in typical use-case scenarios, as identified in the previously mentioned quantitative, qualitative, and mixed methods research studies. Despite this important clarification, these advanced research studies illustrate the immense potential of wearable sensor technologies to better understand the true complexities of disordered eating behaviours.

2.6 Chapter Summary

This literature review first described several quantitative research studies that established consistent evidence linking the use of digital self-tracking technologies with increased instances of disordered eating behaviours across multiple populations. The observed behaviours primarily included body dissatisfaction, dietary restraint, binge eating, excessive exercise, compensatory purging behaviours, and muscularity-oriented disordered eating behaviours (Blackstone & Herrmann, 2020; Guo et al., 2022; Hahn, Sonneville, et al., 2021; Messer et al., 2021; Moody et al., 2023; Plateau et al., 2018; Simpson & Mazzeo, 2017). Additional qualitative and mixed methods research studies obtained detailed user perspectives, which reinforced this quantitative evidence and enhanced our understanding of the complex relationships, dynamic user engagement practices, unintended negative consequences, problematic design features, and potential causation mechanisms that are associated with these technologies (Eikey, 2021; Eikey & Reddy, 2017; Honary et al., 2019; McCaig et al., 2020). However, due to a variety of methodological factors, these findings and associations have not been consistently replicated through experimental research studies (Berry et al., 2024; Gittus et al., 2020; Hahn, Kaciroti, et al., 2021; Moody et al., 2023; Wons et al., 2022). Finally, compelling evidence has highlighted the successful integration of these technologies within intervention, treatment, and advanced research applications for disordered eating behaviours (Presseller et al., 2022; Taylor et al., 2021).

This literature review highlights the conflicting potential and unintended negative consequences that are associated with digital self-tracking technologies and disordered eating behaviours within general, clinical, and athlete populations. As previously stated in the Introduction chapter, this conflicting potential presents several distinct challenges for the designers of future digital self-tracking technologies. To address these challenges, some of these researchers advocate for increased interdisciplinary and qualitative research approaches, human-centred and participatory design initiatives, and meaningful collaboration with underrepresented and vulnerable identities, including those from athlete populations (Eikey, 2021; Flatt & Taylor, 2018; Graham et al., 2023; Levinson et al., 2017). These perspectives strongly influenced the development of the primary research approach utilized for this project, which will be discussed in detail in the following chapter.

3.0 Research Approach

3.1 Chapter Introduction

As first described in the Introduction chapter, a research approach is a framework utilized within the social and cognitive sciences that provides a detailed overarching plan for the multiple stages of a research project (Creswell & Creswell, 2018). According to Creswell (2016) a research approach consists of four primary components that are interrelated and hierarchical. These primary components are the philosophical paradigm, the theoretical lens, the research design, and the research method (Creswell, 2016; Creswell & Plano Clark, 2018). As illustrated in Figure 3.1, the research approach assembled for this project consisted of a social constructivism philosophical paradigm, an interpretative theoretical lens, a semi-structured qualitative study (SSQS) research design, and the use of semi-structured interviews as the primary research method. The following sections will detail the individual components of this research approach, which will allow readers to better understand the research journey, assess overall quality, rigour, and validity, and build upon the findings in an educated manner (American Psychological Association [APA], 2020; Blandford, 2014).

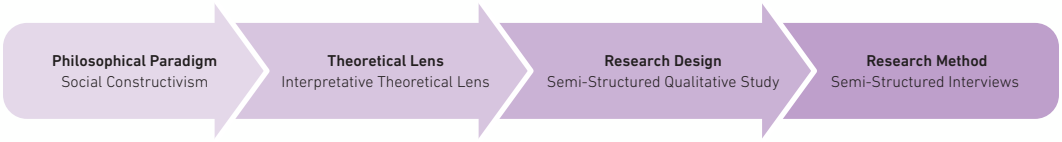

Figure 3.1: Primary components of the research approach

3.2 Philosophical Paradigm

The first component of the research approach is the philosophical paradigm. All researchers possess unique philosophical assumptions, orientations, and beliefs that will inform and influence all elements of their research approach in either a conscious or unconscious manner (Creswell, 2016; Creswell & Poth, 2018). These philosophical assumptions may be deeply ingrained within the researcher, but they can evolve over time and are typically instilled through educational training, professional experience, and engagement with scholarly communities and research literature. The philosophical assumptions held by the researcher will generally align with the principles and characteristics of established interpretive frameworks, which are called philosophical paradigms (Creswell, 2016; Creswell & Poth, 2018).

A philosophical paradigm represents the foundational metaphysical beliefs and basic ways of thinking that are shared within a research community and guide the practice of research (Creswell & Poth, 2018; Denzin & Lincoln, 2018; Pabel et al., 2021). Established philosophical paradigms include positivism, postpositivism, constructivism, critical theory, and participatory action frameworks (Denzin & Lincoln, 2018). Each of these philosophical paradigms has developed specific ideologies regarding the four primary philosophical assumptions of ontology (the nature of reality), epistemology (the nature of knowledge), axiology (the role of ethics and values), and methodology (the process of research) (Creswell & Poth, 2018; Denzin & Lincoln, 2018). Therefore, a philosophical paradigm not only defines a general philosophical worldview but also provides a set of accepted practices and criteria for all stages of research inquiry (Denzin & Lincoln, 2018; Pabel et al., 2021). Based on this context and significance, contemporary scholars believe that researchers must explicitly identify their philosophical paradigm and ensure alignment with their research aim, questions, objectives, and the subsequent components of their research approach as a fundamental prerequisite for rigorous research practices (Creswell & Creswell, 2018; Teherani et al., 2015).

3.2.1 Social Constructivism

Through personal research and reflection, I concluded that the social constructivism philosophical paradigm best aligned with my current philosophical assumptions and the practical needs of this design problem and research project. Within social constructivism, the primary aim of research is to understand and interpret the socially constructed and subjective realities that people develop through their interactions with others, objects, and their environments (Creswell, 2016; Creswell & Poth, 2018). Within this paradigm, researchers seek to develop, rather than discover, meaning and understanding about a design problem through inductive research approaches that prioritize the unique viewpoints of each participant. Therefore, researchers will purposefully seek to capture, interpret, understand, and report the complexities and contradictions of these multiple viewpoints, rather than narrowing their meaning into general ideas, universal principles, or fundamental truths that claim to have validity for all people in all contexts (Creswell, 2016; Creswell & Poth, 2018; Denzin & Lincoln, 2018; Thomas & Hodges, 2010). Social constructivism can be further defined by its philosophical assumptions regarding ontology, epistemology, axiology, and methodology.

Ontology refers to the nature and characteristics of reality in terms of what an individual perceives as real or existing (Creswell, 2016; Creswell & Poth, 2018). Social constructivism possesses a relativist ontology in which individuals are continuously constructing their own personal realities, informed by their unique lived experiences and social interactions. Therefore, social constructivism acknowledges the existence of multiple socially constructed and subjective personal realities. Based on this ontological assumption, researchers within social constructivism will naturally become active participants within the research process and co-construct knowledge, meaning, and understanding through their interaction and collaboration with the research participants (Creswell, 2016; Creswell & Poth, 2018; Denzin & Lincoln, 2018; Lincoln et al., 2018).

Epistemology is concerned with the nature of knowledge, including what qualifies as knowledge, how knowledge is verified, and the relationship between the researcher and the researched (Creswell, 2016; Creswell & Poth, 2018). Social constructivism features a transactional and subjectivist epistemology where knowledge is co-constructed through the unique interaction between a specific researcher and a specific participant, informed by the distinct personal experiences of each individual. Therefore, the knowledge that is produced cannot be separated from the unique and unrepeatable conditions of the specific interaction (Creswell, 2016; Creswell & Poth, 2018; Denzin & Lincoln, 2018). Based on these epistemological assumptions, researchers within social constructivism will attempt to minimize the distance between themselves, the subject matter, and the research participants (Creswell & Poth, 2018).

Axiology addresses the role of personal ethics, values, and biases within research and among philosophical paradigms (Creswell, 2016; Denzin & Lincoln, 2018). Within social constructivism, participants are regarded as experts, and researchers strive to thoughtfully understand and accurately report their unique perspectives in a trustworthy and authentic manner. Furthermore, due to the ontological and epistemological assumptions regarding the active and participatory role of the researcher within social constructivism, researchers believe it is essential to acknowledge the influence of their personal values and biases by explicitly identifying their positionality within the context of the research project (Creswell, 2016; Creswell & Poth, 2018; Denzin & Lincoln, 2018). This topic will be explored in greater detail in the upcoming Reflexivity and Positionality and Researcher Description sections.

Methodology refers to the process of research and inquiry and includes the principles that govern how researchers seek out new knowledge (Creswell, 2016; Lincoln et al., 2018). Social constructivism generally aligns with research designs that feature a qualitative research methodology and utilize naturalistic and interpretive research methods, such as interviews, observations, and text analysis (Creswell, 2016; Creswell & Poth, 2018; Lincoln et al., 2018). When interviews are selected within social constructivism, they will typically feature a semi-structured format and include a series of open-ended questions to facilitate a deep and meaningful dialogue between the researcher and the participants. Therefore, within this context, knowledge, meaning, and understanding are collaboratively constructed through inductive and exploratory approaches that prioritize the perspectives of participants (Creswell, 2016; Creswell & Poth, 2018; Lincoln et al., 2018).

3.3 Theoretical Lens

The second component of the research approach is the theoretical lens. Contemporary scholars suggest that all research, including inductive and exploratory approaches, is influenced by underlying theory, regardless of whether this theory is consciously recognized or integrated (Blandford, 2014; Collins & Stockton, 2018; Creswell & Creswell, 2018). When theory is explicitly recognized and integrated within qualitative research, it can serve one of three primary roles: first, theory can be used in a deductive manner to explain elements of the design problem; second, theory can be generated in an inductive manner through the process of research itself; or third, theory can serve as an interpretive lens through which the research project is viewed (Creswell, 2016; Creswell & Creswell, 2018). This final role, that of an interpretive theoretical lens, was selected for this design problem, and this lens informed all elements of this research project (Blandford, 2014; Collins & Stockton, 2018; Creswell & Creswell, 2018). The following section describes the theories, concepts, and perspectives that construct this interpretive theoretical lens.

3.3.1 Interpretive Theoretical Lens

The contemporary philosopher, Byung-Chul Han, theorizes that modern society is no longer a disciplinary society based on external obedience and institutional control as identified by Michel Foucault but has transformed into an achievement society based on internal motivation and self-exploitation (Foucault, 1975/2012; Han, 2015; Smus, 2023). Han argues that within our modern achievement society, the power of prohibitions, commandments, and the law has been

replaced by the power of projects, initiatives, and motivation. Our achievement society has recognized that the positive affirmation of "can" is fundamentally more effective than the negative command of "should" for attaining the productivity goals once central to disciplinary society. Therefore, Han argues that our achievement society will promote the belief that everything is attainable and nothing is impossible, which can cause individuals to set unrealistic and unsustainable personal expectations, leading to self-exploitation, excessive work, disappointment, depression, and burnout (Han, 2015; Smus, 2023).

Building upon this theory, several contemporary scholars have identified problematic socio-technological beliefs that are deeply embedded within and perpetuated by our achievement society. Design researchers such as Manuel Lima and Donald Norman describe the concept of technological optimism, which is the tendency of our society to emphasize the perceived benefits of technological progress while ignoring or minimizing the potential problems and unintended negative consequences (Lima, 2023; Norman, 2023). Technological optimism assumes that technological progress is inherently positive, fundamentally improves the lives of all people, and will inevitably resolve all societal and environmental issues (Lima, 2023). However, Lima, Norman, and design anthropologist Dori Tunstall challenge the concept of technological optimism, arguing that it functions as propaganda to sustain the problematic ideologies of colonialism, industrialization, and modernism, within which technological advancements have historically prioritized privileged populations while exploiting, marginalizing, and oppressing others and the environment (Lima, 2023; Norman, 2023; Tunstall, 2023).

Lima and Norman argue that technological optimism has instilled the false belief that all human behaviours can be objectively measured, quantified, and optimized, which has further increased our trust and dependance upon technology and data (Lima, 2023; Norman, 2023). Simultaneously, the proliferation of technology and the abundance of abstract quantitative data are linked to increased levels of stress and anxiety, as well as impaired intuition and decision-making abilities (Lima, 2023). This situation has fostered an automation bias where individuals increasingly trust algorithms, automated systems, and artificial intelligence models over their own knowledge, judgment, and intuition, as they view these technologies to be objective tools to evaluate and manage their personal health and wellbeing (Lima, 2023; Norman, 2023). However, Lima notes that truly objective algorithms, automated systems, and artificial intelligence models do not exist, as these

technologies are embedded with the subjective ideologies, interests, and biases of their creators and privileged stakeholders (Lima, 2023). These embedded biases can further perpetuate the forms of systemic exploitation, marginalization, and oppression previously identified (Lima, 2023; Norman, 2023; Tunstall, 2023).

Within the context of our achievement society, which believes in technological optimism and possesses an automation bias, Lima and Norman note that design approaches and scientific knowledge originally intended to promote positive societal and behavioural change have been insidiously repurposed for profit generation and exploitation (Lima, 2023; Norman, 2023). These researchers have observed that human-centred design approaches, paired with critical knowledge from the fields of human psychology and cognitive science, are increasingly utilized to create intentionally addictive technologies that deliberately exploit, control, and capitalize upon the vulnerabilities, biases, and behaviours of people (Lima, 2023; Norman, 2023). Lima argues that these practices and the resultant technologies are fundamentally unethical, arguing that this "cycle of exploitation must stop" and "designers must think deeply about the impact and repercussions of their work" (Lima, 2023, p. 85). As a result, Lima, Norman, and Tunstall advocate for reforms within design education, professional practice, and technology development, emphasizing the need for increased awareness of unintended negative consequences and increased ethical responsibility requirements (Lima, 2023; Norman, 2023; Tunstall, 2023). The following quotation from Lima provides critical insight into these perspectives and calls to action.

> To advocate for technology without understanding its downsides and eminent threat to the fabric of society is to be naive at best. To conceal its harm behind simple and addictive interfaces is malicious. We cannot use the ethos of good design to continue misleading people and covertly sneaking addictive and discriminatory technology onto people's laps, pockets, and wrists. We cannot allow design to continue to be a slave to technology. It is simply too dangerous. The role of design is not to make new technology easier to use and adopt, to make it more appealing and engaging, or to sell more of it. The role of designers is to question and propose better solutions, even if that means a different technology, less of it, or none of it. Technology is a means to an end, not an end in itself. We must continue to dream the future and adapt technology to our needs, not let it take over us. (Lima, 2023, p. 127)

The growing popularity of digital self-tracking technologies, the increased prevalence of disordered eating behaviours within athlete populations, and the documented associations between these phenomena align with and provide evidence for the theory of an achievement society, the concepts of technological optimism and automation bias, and the need for increased ethical responsibly requirements. These contemporary theories, concepts, and perspectives construct the interpretive theoretical lens that informed the selection, creation, and execution of all elements of this research project, including data collection, analysis, and interpretation (Blandford, 2014; Collins & Stockton, 2018; Creswell & Creswell, 2018).

3.4 Research Design

The third component of the research approach is the research design. A research design is an established strategy for inquiry that provides guidance and specific procedural direction for all stages of a research project—from the initial research questions through to data collection, analysis, interpretation, and reporting (Creswell & Creswell, 2018; Creswell & Poth, 2018). The purpose of a research design is to enhance overall rigour, provide guidance for the researcher, and aid understanding for the audience (Creswell, 2016). Common qualitative research designs within the social and health sciences include narrative, phenomenology, ethnography, case study, and grounded theory (Creswell & Creswell, 2018).

3.4.1 Semi-Structured Qualitative Study (SSQS)

This research approach borrows the semi-structured qualitative study (SSQS) research design used within the neighbouring discipline of human-computer interaction. As the descriptive name implies, an SSQS features a semi-structured and adaptable nature and utilizes a qualitative research methodology and associated research methods (Blandford, 2014). Human-computer interaction researchers typically utilize an SSQS research design to develop understanding in an exploratory way. Therefore, this research design is particularly effective for addressing open-ended research questions regarding user needs and behaviours in relation to technology use, often with the goal of informing possibilities for improved and future solutions (Blandford, 2014). This purpose is in direct alignment with the aim of this research project, which seeks to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations and to use these insights to inform the development of future technologies that mitigate these behaviours.

A defining characteristic of an SSQS research design is that it can adapt and respond to the evolving circumstances of an inductive and exploratory research project (Blandford, 2014). To facilitate this, the SSQS research design provides general guidelines and considerations for planning and conducting all stages of a research project. These include important questions and recommendations related to purpose, resources and constraints, researcher attributes and roles, advocacy, participant recruitment, location and intervention, the role of theory, ethical considerations, data collection techniques, interleaving considerations, data analysis, and reporting (Blandford, 2014). These SSQS research design guidelines and considerations have informed the planning, execution, and reporting of this research project.

As previously mentioned, an SSQS research design utilizes a qualitative research methodology. Generally speaking, qualitative research is a research type that aims to understand complex human behaviour and social phenomena by collecting and analyzing non-numeric data such as words, artifacts, and observations (APA, 2020; Blandford, 2014; Creswell & Creswell, 2018; Muratovski et al., 2022). Qualitative research is typically used to examine how individuals perceive, experience, and interpret real-world situations. It acknowledges the complexity of these situations and strives to understand their multiple layers rather than generalizing their meaning into universal principles or fundamental truths (Creswell, 2016; Creswell & Creswell, 2018; Muratovski et al., 2022). To achieve this, qualitative research emphasizes the participant's personal perspectives and seeks to uncover multiple subjective and potentially contrasting viewpoints to construct a holistic account of the design problem (Creswell, 2016).

Additionally, qualitative research possesses several distinct advantages that are relevant to this research project. For example, qualitative research is a valuable tool for designers to develop comprehensive and meaningful understandings of new, unfamiliar, and complex design problems that may feature limited or inadequate preexisting information (Creswell, 2016; Muratovski et al., 2022). This is advantageous for the emerging and evolving associations between digital self-tracking technologies, disordered eating behaviours, and athlete populations (Moody et al., 2023; Wells et al., 2020). Qualitative research is especially effective for studying sensitive and emotionally charged topics (Creswell, 2016), which includes disordered eating behaviours (APA, 2022). Furthermore, since qualitative research prioritizes the individual, it can provide a voice for understudied populations (Creswell, 2016), which have historically included athletes experiencing disordered eating behaviours (Flatt &

Taylor, 2018). Finally, qualitative researchers will report their personal biases, identify their positionality, and reflect on how these elements may influence the research project (Creswell, 2016), which aligns with the axiological assumptions of social constructivism previously discussed (Creswell & Poth, 2018; Denzin & Lincoln, 2018). Based on these strengths and characteristics, the SSQS research design was selected for this research approach.

3.5 Research Method

The fourth component of the research approach is the research method. The research method is the specific technique used to gather information to address the research aim, questions, and objective (Creswell, 2016). The research method involves considerations, plans, and procedures related to ethics, sampling, recruitment, participants, data collection, data recording, data analysis, and other pertinent topics (Creswell & Creswell, 2018). Research methods are not neutral or interchangeable, as each method has distinct characteristics to serve different applications, and these characteristics will inevitably influence the type of data that can be collected and the quality of insights that can be achieved (Knott et al., 2022; Sullivan & Forrester, 2018). Consequently, there is a critical relationship between the research aim, questions, and objective, the established components of the research approach, and the selection of the appropriate research method (Creswell, 2016). Therefore, while many different research methods are available, interviews, participant observations, and text analysis are common research methods that align with the social constructivism philosophical paradigm and the semi-structured qualitative study (SSQS) research design (Blandford, 2014; Creswell & Poth, 2018).

3.5.1 Semi-Structured Interviews

This research project utilized semi-structured interviews as the primary research method. This interview format is a specific type of qualitative research method, and it was selected as the most appropriate means to address the research aim, questions, and objective. This method also aligns with the tangible constraints of this research project and the coexisting components of the research approach, including the philosophical paradigm, theoretical lens, and research design (Blandford, 2014; Creswell & Poth, 2018; Lima, 2023). The primary features, strengths, limitations, and epistemological assumptions of this research method are described in the following section.

3.5.1.1 Features, Strengths, Limitations, and Epistemological Assumptions

As a qualitative research method, an interview represents a familiar form of conversational interaction in which a researcher will ask a participant questions about their lived experience in relation to the research topic with the hope that they will share their personal perspectives (Knott et al., 2022). The goal of this interview interaction is for the researcher to thoroughly understand the unique perspectives of each participant and to accurately interpret their meaning in relation to the research aim, questions, and objective (Brinkmann & Kvale, 2018). There are several different interview formats to facilitate this goal, and selection is dependent upon several factors, including the research topic, the purpose of the interview, the proposed interview participants, and the researcher's epistemological assumptions (Brinkmann & Kvale, 2018). Depending upon these factors, interview formats can range from entirely unstructured, free-flowing conversations to highly structured, survey-like conversations (Knott et al., 2022).

The semi-structured interview format used for this research project includes a structured interview protocol with predetermined questions but is simultaneously free to adapt and respond to the unique circumstances and conditions of each interview interaction (Brinkmann & Kvale, 2018). This flexible nature facilitates extended and organic conversations, allowing participants to construct nuanced and descriptive accounts in their own words (Brinkmann & Kvale, 2018; Knott et al., 2022). The one-on-one interview format is also advantageous for encouraging detailed personal responses that would not typically be shared in a group setting (Creswell, 2016). Furthermore, this interview format provides time for participants to contemplate and reflect upon the interview questions, potentially discovering new themes or evolving their descriptions throughout the interview session (Brinkmann & Kvale, 2018).

This semi-structured interview format is typically used within the design disciplines for exploratory research purposes and is considered a fundamental method for understanding the unique perspectives, experiences, and emotions that people have regarding their products, systems, and services (Blandford, 2014; Martin & Hanington, 2019; Milton & Rodgers, 2013; Muratovski et al., 2022). This interview format is considered a versatile tool for all stages of the product design and development process and is especially useful for the exploration, discovery, analysis, and definition phases to identify user needs and to formulate a comprehensive design brief (Milton & Rodgers, 2013). These features and strengths directly align with the aim and objective of this research project.

However, these features and strengths also present corresponding challenges and limitations. For example, because the semi-structured interview format prioritizes depth of insight over breadth, the research process can be time-consuming, and due to practical constraints, it is typically not possible to achieve a large, statistically representative sample (Knott et al., 2022). The familiarity of conversational interaction can also present challenges, as participants may have preconceived notions about the type of information that is desired by the researcher, providing responses they believe are socially acceptable rather than reflecting their true thoughts and behaviours (Knott et al., 2022; Muratovski et al., 2022). The interview conversation itself may present ambiguous or contradictory statements that the researcher must first recognize and then clarify to determine whether these statements represent the participant's genuine perspectives or whether they are the result of miscommunication (Brinkmann & Kvale, 2018). Additionally, some scholars argue that all interview formats represent artificial data collection methods that remove people from their daily lives and are only capable of capturing what people say but not what they actually do (Knott et al., 2022).

Furthermore, the flexible nature of the semi-structured interview format, in combination with the epistemological assumptions of interview-produced knowledge, means that it is impossible to precisely replicate an interview interaction and the resultant research data (Brinkmann & Kvale, 2018; Knott et al., 2022). Brinkmann and Kvale (2018) have investigated these epistemological assumptions and identified important questions regarding the objectivity and validity of interview-produced knowledge. These researchers recognize that within the social constructivism philosophical paradigm, an interview interaction is considered an event where knowledge is co-constructed in-situation through the mutual interaction and reciprocal influence of two unique individuals (Brinkmann & Kvale, 2018). Therefore, the knowledge that is produced is based upon the specific social interaction itself, and different conditions would inevitably produce different knowledge. These epistemological assumptions acknowledge the complexity of human interaction and recognize that interview-produced knowledge is not universal, context-independent facts but rather situated, socially constructed perspectives. Understanding these epistemological assumptions forces the researcher to progress from philosophical questions regarding the objectivity and validity of interview-produced knowledge to pragmatic questions regarding the quality and value of interview-produced knowledge. As a result, the researcher must ethically consider whether the

interview-produced knowledge is useful and insightful, and if so, for what purpose and for whom (Brinkmann & Kvale, 2018). These epistemological assumptions and questions align with the ethical responsibly requirements described in the interpretive theoretical lens (Lima, 2023; Norman, 2023; Tunstall, 2023).

Considering these features, strengths, limitations, and epistemological assumptions, the semi-structured interview format was determined to be the most suitable method to address the needs of this research project. It is important to note that both the potential strengths and limitations of this research method are directly influenced by the overall quality of the research approach and the rigour of its execution (Brinkmann & Kvale, 2018; Knott et al., 2022). This quality and rigour can be assessed through the transparent documentation of the researcher's methodological decisions and subsequent procedures, which are detailed within the following sections (Blandford, 2014; Knott et al., 2022).

3.5.1.2 Reflexivity and Positionality

In accordance with the social constructivism philosophical paradigm and the semi-structured qualitative study (SSQS) research design, the researcher will typically plan and implement all elements of their research approach and is therefore considered the primary instrument for data collection, analysis, and interpretation (Blandford, 2014; Creswell & Creswell, 2018; Teherani et al., 2015). As a result, the researcher themselves will have a significant influence on the conduct and outcome of the research project, including the types of data they are sensitive and responsive to (Blandford, 2014).

This perspective is especially true for the semi-structured interview format, which facilitates a unique dialogue between the researcher and the participant that will inevitably uncover the subjective realities, perspectives, and interests of both parties (Blandford, 2014; Brinkmann & Kvale, 2018; Creswell & Poth, 2018; Teherani et al., 2015). Consequently, the researcher becomes an indispensable component of the interview interaction rather than a neutral and independent entity, and the quality of knowledge that is produced will depend upon their skill, sensitivity, subject matter knowledge, and other personal attributes (Blandford, 2014; Brinkmann & Kvale, 2018).

Therefore, in alignment with the axiological assumptions of social constructivism, it is customary for qualitative researchers to consciously reflect upon their identity, values,

beliefs, and biases and acknowledge how these elements may influence the research project and the knowledge that is collaboratively constructed (Creswell & Poth, 2018). This personal introspection is typically referred to as "reflexivity" and is an iterative process that will span the entire research project (Creswell & Creswell, 2018).

One of the visible results of this reflexive process is the definition of the researcher's "positionality," which is how the researcher theoretically positions or situates themselves in relation to the research project (Creswell & Poth, 2018). This is accomplished by the researcher describing personal information relevant to the context of the research project, including elements of their identity, education, and professional background as well as their personal experiences and perspectives regarding the research topics (APA, 2020; Blandford, 2014; Creswell & Poth, 2018). Qualitative researchers will actively disclose this information, identifying their positionality and challenging the traditional omniscient and distanced approach of quantitative researchers (Creswell, 2016). Based on these perspectives, a description of my positionality and relevant personal information is included within the following section.

3.5.1.3 Researcher Description

I, Michael Peel, served as the principal investigator for this research project. I am a master of design graduate student in industrial design within the Department of Art & Design at the University of Alberta. I identify as a white, Canadian male living without visible disability, and I recognize the embedded societal privileges that are associated with this identity. Professionally, I am an interdisciplinary designer and researcher with a foundation of complementary education and professional experience. My educational background consists of a bachelor's degree in industrial design from the University of Alberta, which included an academic exchange to the FH Münster University of Applied Sciences in Germany. Additionally, I hold a diploma in mechanical design technology and a red seal journeyman machinist certification from the Southern Alberta Institute of Technology (SAIT). My professional experience has included the roles of product design manager, industrial designer, mechanical designer, and journeyman machinist across the consumer furniture and aerospace industries. Over the course of this research project, I have also held the roles of graduate teaching assistant, principal instructor, and graduate research assistant within the Department of Art & Design at the University of Alberta.

My intention for this research project was to build upon this foundation by exploring the interrelated topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations through the lens of design. I am passionate about athletic training, and I have personally utilized a range of commercially available and custom-designed self-tracking technologies to collect and analyze health and performance data. While I recognize the significant benefits of athletic training and self-tracking technologies, I also understand the associated mental and physical health risks, including the potential for disordered eating behaviours, which I have personally encountered and have observed in fellow athletes. Therefore, I am interested in interdisciplinary research to inform the design and development of future self-tracking technologies that seek to mitigate disordered eating behaviours in both athlete and general populations. I am particularly interested in rigorous research-based product design and development processes, understanding unintended negative consequences, and the development of safe and ethical technologies.

Through reflexive introspection, I acknowledge that my identity, positionality, experiences, and perspectives have informed my research approach and the execution of this research project in both conscious and unconscious ways. Therefore, throughout this process, I have critically examined these factors to recognize and address the potential influence of my inherent values, beliefs, and biases to ensure the ethical responsibly and methodological integrity of this research project.

3.5.1.4 Sampling and Recruitment

Inclusion Criteria: To address the research aim, questions, and objective, this project conducted semi-structured interviews with academic, professional, and lifestyle experts from the fields of product design and development, clinical psychology and counselling, and health sciences and kinesiology. The inclusion criteria required that potential participants have education, expertise, and experience related to the topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. Potential participants could be located in any geographic location but required English language proficiency for effective communication and comprehension. Potential participants who met the inclusion criteria were considered eligible for this research project.

Sampling Techniques: Before contacting any potential participants, this project received research ethics approval from the University of Alberta Research Ethics Board on March 8, 2023. The approved Research Ethics Application is included within Appendix A. Potential participants were identified through a combination of purposeful and snowball sampling techniques. In this context, purposeful sampling is the deliberate selection of interview participants based on their education, expertise, and experience with the research topics (Creswell & Creswell, 2018; Knott et al., 2022). Snowball sampling is a supplemental recruitment technique where the researcher asks existing participants to help identify additional individuals who also meet the inclusion criteria (Knott et al., 2022). These sampling techniques are typically combined and are commonly used for SSQS research designs and semi-structured interviews (Blandford, 2014; Creswell & Creswell, 2018; Knott et al., 2022).

Participant Recruitment: Participant recruitment occurred between July and October 2023. In total, 50 potential participants from North America and Europe were identified as meeting the inclusion criteria. These potential participants were discovered through a variety of means, including university directories, company directories, research publications, in-person workshops, professional networks, and personal referrals. The expertise of each potential participant was inferred through the evaluation of their educational background, professional experience, and research publications in relation to the research topics.

A Letter of Initial Contact (see Appendix B) was personalized for each potential participant, and contact was initiated through their publicly available contact methods, including email and social media direct messaging. A Participant Consent Form (see Appendix C) was included during initial contact, which conveyed all of the relevant details regarding the research project. Potential participants were informed that participation in the research project was voluntary, that there were no consequences to declining, and that they may withdraw from the research project at anytime without consequence. No incentives or compensation were provided, and all correspondence with the potential participants has remained private.

Responses were not received from all of the contacted individuals, and of those who did respond, some were either ineligible or unavailable to participate. As the research project progressed, ongoing participant recruitment was concurrent with scheduled interviews, allowing time to reflect on the type of information previously obtained and adjust the sample and recruitment strategy to ensure an equal distribution of perspectives across areas of expertise.

Sample Size: Ultimately, 10 individuals were selected and interviewed for this research project. This sample size is in alignment with the SSQS research design and recommendations for semi-structured interviews that seek rich and detailed personal perspectives (Blandford, 2014; Brinkmann & Kvale, 2018; Knott et al., 2022). This sample size was also influenced by the tangible resources and constraints associated with this research project. In practice, this sample size achieved a comprehensive range of in-depth participant viewpoints that effectively addressed the research aim, questions, and objective, eliminating the need to revise the sample size.

3.5.1.5 Interview Participants

The interview participants included the following academic, professional, and lifestyle experts. These interview participants represent a diverse interdisciplinary sample from across North America with specialized knowledge within the fields of product design and development, clinical psychology and counselling, and health sciences and kinesiology. These interview participants were selected because their education, expertise, and experience met the inclusion criteria, and it was believed that their unique perspectives could help to address the research aim, questions, and objective. The following interview participant biographies are presented in chronological order and describe the expertise of each participant in relation to the research topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. The relative position of each interview participant in relation to these research topics is illustrated in Figure 3.2. For increased transparency, any relevant pre-existing relationships or interactions between the participants and myself have also been documented (APA, 2020; Blandford, 2014).

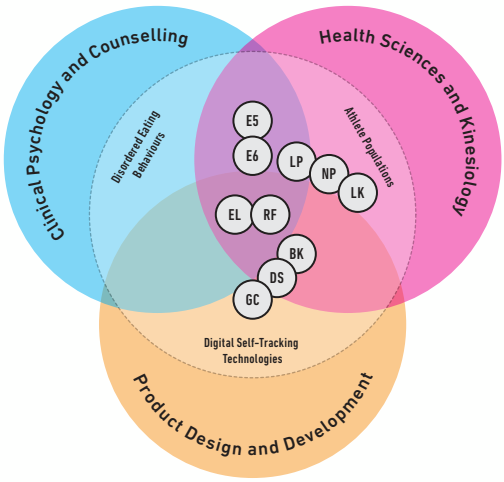

Figure 3.2: Relative position of interview participants in relation to research topics

Lacey Paulsen (LP) is a certified therapeutic recreation specialist (CTRS) for Alberta Health Services within the Eating Disorder Program at the University of Alberta Hospital. Lacy has a bachelor's degree in sport and recreation studies with a major in therapeutic recreation from the University of Regina. Lacey is also a certified personal training specialist (PTS) and group exercise instructor. Lacey has experience with a wide range of athletic sports and promotes intuitive movement and body neutrality. Additionally, she is a passionate educator for eating disorders and dysfunctional exercise awareness. Lacey was a presenter at the Eating Disorders: Awareness and Risk Mitigation in the Fitness Industry workshop hosted by the Eating Disorder Support Network of Alberta (EDSNA) on May 6–7, 2023. I met Lacey at this workshop. However, there was no pre-existing relationship or interaction prior to this workshop or research project. Lacey was located in Edmonton, Alberta, Canada, and was interviewed on July 26, 2023.

Naissa Preston (NP) is a fitness manager and personal trainer at the Royal Glenora Club and a national figure skating dry land coach. Additionally, Naissa is the former program coordinator of group exercise within Campus & Community Recreation at the University of Alberta. Naissa has a bachelor's degree in nutrition and food science with a minor in physical education and a postgraduate certificate in Indigenous sport and recreation from the University of Alberta. Additionally, Naissa has a diploma in personal fitness training from the Northern Alberta Institute of Technology (NAIT) and is a certified fitness trainer (CFT). Naissa has experience with many forms of athletic training and is passionate about teaching intelligent and purposeful movement. Naissa was also a presenter at the Eating Disorders: Awareness and Risk Mitigation in the Fitness Industry Workshop hosted by the Eating Disorder Support Network of Alberta (EDSNA) on May 6–7, 2023. I met Nassia at this workshop. However, there was no pre-existing relationship or interaction prior to this workshop or research project. Naissa was located in Edmonton, Alberta, Canada, and was interviewed on August 4, 2023.

Leo King (LK) is the owner of Kings Fitness and the president of the World Natural Bodybuilding Federation (WNBF) of Canada. Leo is also an internationally competitive athlete, a WNBF professional natural bodybuilder, and a Canadian Powerlifting Union (CPU) national powerlifter. Leo has a bachelor's degree in kinesiology and exercise science from the University of Calgary and is a certified personal trainer (CPT) and a certified strength & conditioning specialist (CSCS). Leo coaches a variety of athletes and is an advocate for safe

and intelligent training approaches. Furthermore, Leo has personally experimented with a range of digital self-tracking technologies and has utilized some of these products with his personal training clients. I met Leo when I was a member of Kings Fitness from 2020–2021, and prior to this research project, we could be considered friendly professional acquaintances with infrequent interaction. Leo was located in Calgary, Alberta, Canada, and was interviewed on September 1, 2023.

Ben King (BK) is a product designer and researcher at True Angle Medical Technologies and a principal instructor within the Department of Art & Design at the University of Alberta. Additionally, Ben is a former industrial designer for the Institute for Reconstructive Sciences in Medicine (iRSM). Ben has a master's degree and a bachelor's degree in industrial design from the University of Alberta. Ben has experience developing wearable biofeedback devices and digital health technologies, including BRETH and Mobili-T for True Angle Medical Technologies. Furthermore, Ben is currently leading research and development efforts for new athletic recovery technologies. I met Ben when I was an undergraduate student at the University of Alberta from 2012–2016. However, I did not have Ben as an instructor, and prior to this research project, we could be considered friendly professional acquaintances with infrequent interaction. Leo King and Ben King are not related. Ben was located in Edmonton, Alberta, Canada, and was interviewed on September 20, 2023.

Expert 5 (E5) is a doctoral student (PhD) in clinical psychology. Expert 5 has a master's degree in clinical psychology, a master's degree in interdisciplinary studies between psychology and health sciences, a bachelor's degree in kinesiology, and is a certified personal trainer (CPT). Expert 5's research is at the intersection of health sciences and clinical psychology, with a specific focus on dysfunctional exercise, eating disorders, body image, perfectionism, and problematic internet use. This research has resulted in numerous peer-reviewed publications. Expert 5 has requested that their name be withheld for privacy purposes. There was no pre-existing relationship or interaction with this participant prior to this research project. Expert 5 was located in Canada and was interviewed on September 22, 2023.

Expert 6 (E6) is a licensed mental health counsellor. Expert 6 has a master's degree in mental health counselling, a bachelor's degree in psychology, and is a certified mental performance consultant (CMPC) with the Association of Applied Sports Psychology (AASP). Expert 6 has

expertise in the fields of sports psychology, eating disorders, and body image. They have experience working with all populations, including high-performance National Collegiate Athletic Association (NCAA) Division I athletes, to overcome challenges and optimize performance. Expert 6 has requested that their name be withheld for privacy purposes. There was no pre-existing relationship or interaction with this participant prior to this research project. Expert 6 was located in the USA and was interviewed on September 26, 2023.

Elizabeth Lampe (EL) is a doctoral candidate (PhD) in clinical psychology within the Center for Weight, Eating, and Lifestyle Science (WELL Center) at Drexel University. Elizabeth also has a master's degree and a bachelor's degree in psychology from Drexel University. Elizabeth's background in ballet dancing partially informs her research, which focuses on the development of novel treatments for eating disorders, with a particular emphasis on athletes and adolescents. This research has resulted in numerous peer-reviewed publications, and some of these publications have influenced the early stages of this research project. These publications included investigations into the impact of wearable fitness tracking devices on eating disorder symptoms, understanding the complexities of adaptive and maladaptive exercise within the context of eating disorders, and the use of wearable sensor technologies to predict binge eating. However, there was no pre-existing relationship or interaction with this participant prior to this research project. Elizabeth was located in Philadelphia, Pennsylvania, USA, and was interviewed on October 2, 2023.

Dylan Scott (DS) is the chief technical officer at True Angle Medical Technologies, a biomedical engineer at the University of Alberta, and a former biomedical engineer for the Institute for Reconstructive Sciences in Medicine (iRSM). Dylan has a master's degree and a bachelor's degree in mechanical engineering from Dalhousie University and the University of Alberta, respectively. Dylan specializes in the design and development of small electromechanical systems to measure and monitor human activities and body signals. Dylan has experience developing wearable biofeedback devices and digital health technologies, including BRETH and Mobili-T for True Angle Medical Technologies. Furthermore, Dylan has personally experimented with a range of digital self-tracking technologies and is considered a long-term user of these products. Dylan was recommended and introduced to me by Ben King. However, there was no pre-existing

relationship or interaction with this participant prior to this research project. Dylan was located in Edmonton, Alberta, Canada, and was interviewed on October 4, 2023.

Gabriela Constantinescu (GC) is the manager of post-secondary research and innovation strategy within the Ministry of Advanced Education for the Government of Alberta. Gabriela is a former co-founder and the chief experience officer (CXO) at True Angle Medical Technologies. Additionally, Gabriela is a former co-lead, program coordinator, and speech-language pathologist at the Institute for Reconstructive Sciences in Medicine (iRSM). Gabriela has a doctoral degree (PhD) in rehabilitation science and a master's degree in speech-language pathology from the University of Alberta. Gabriela has experience developing wearable biofeedback devices and digital health technologies, including Mobili-T for True Angle Medical Technologies. Gabriela was recommended and introduced to me by Ben King. However, there was no pre-existing relationship or interaction with this participant prior to this research project. Gabriela was located in Edmonton, Alberta, Canada, and was interviewed on October 6, 2023.

Rachael Flatt (RF) is a doctoral candidate (PhD) in clinical psychology within the Center of Excellence for Eating Disorders at the University of North Carolina at Chapel Hill. Additionally, Rachael is a current member of the US Olympic and Paralympic Committee's (USOPC) Mental Health Taskforce and a retired US Olympic figure skater. Rachael has a Master's degree in clinical psychology from the University of North Carolina at Chapel Hill and a bachelor's degree in biology with a minor in psychology from Stanford University. Rachael's background as an Olympic athlete partially informs her research, which focuses on digital mental health tools, eating disorders, and athlete populations. Rachael's research has resulted in numerous peer-reviewed publications, and some of these publications have influenced the early stages of this research project. These publications included investigations into the use of digital mental health tools to deliver real-time disordered eating behaviour treatment for athletes, as well as the use of wearable sensor technologies to predict binge eating and compulsive exercise. However, there was no pre-existing relationship or interaction with this participant prior to this research project. Rachael was located in Chapel Hill, North Carolina, USA, and was interviewed on October 10, 2023.

3.5.1.6 Interview Procedure

The semi-structured interview sessions occurred between July and October 2023. Participant consent was obtained prior to each interview session through a signed Participant Consent From (see Appendix D). Each participant was interviewed once, for a total of 10 unique interview sessions. All of the interview sessions were one-on-one between the participant and myself. The duration of the interview sessions ranged from 48 minutes to 88 minutes, with an average duration of 71 minutes.

This research project was based at the University of Alberta in Edmonton, Alberta, Canada, which is situated on Treaty 6 territory, the traditional lands of First Nations and Métis people. All of the interview sessions were conducted virtually with Google Meet (n = 9) and Zoom (n = 1) video conferencing software applications. Historically, in-person interviews were preferred to online interviews for their increased ability to identify non-linguistic information such as facial expressions and body gestures (Brinkmann & Kvale, 2018; Knott et al., 2022). However, since the COVID-19 global pandemic, these video conferencing software applications have become ubiquitous tools, and online interviews are now familiar research methods, offering increased flexibility, privacy, and facilitating geographically remote participation, which were primary requirements for this research project (Knott et al., 2022).

The goal for each semi-structured interview session was to facilitate an in-depth and organic conversation focused on the participant's perspectives regarding the research topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. To assist with this goal, a detailed interview protocol was created in advance. This interview protocol provided a structural outline to consistently guide each interview session while permitting flexibility to adapt and respond to the unique circumstances presented in each conversation (Brinkmann & Kvale, 2018; Creswell, 2016; Knott et al., 2022). This interview protocol was comprised of several components, including relevant participant information, internal procedural information, introductory statements, research project information, interview questions, closing statements, and mental health resources (Creswell, 2016).

Before commencing the interview session, the research project information and Participant Consent Form were reviewed with the participant, and all questions were addressed. The participant was reminded that the interview session would include potentially sensitive questions related to disordered eating behaviours. The participant was notified that they

would not have to answer any questions they were not comfortable answering, that they could withdraw from the interview session at any time without consequence, that anything they shared could be removed from the interview transcript, and that mental health resources could be provided if needed. The participant was also notified that the semi-structured interview format would be guided by an interview protocol that included a selection of open-ended interview questions. However, the participant was free to deviate from the interview protocol and encouraged to explore topics as they desired. Finally, I stated that my role was to guide the interview session, ask questions, and participate in the conversation while attempting to remain as neutral as possible.

3.5.1.7 Interview Questions

Informed by an initial exploratory literature review, a selection of primary interview questions were developed and subsequently approved by the University of Alberta Research Ethics Board (see Appendix E). These primary interview questions were designed to be direct, open-ended, and neutral in nature and were utilized to initiate discussion, prompt contemplation, and elicit detailed responses from the interview participants. To aid the flow of conversation and encourage deep responses, a large selection of follow-up, probing, and supplemental questions were also prepared and included in the interview protocol or were generated spontaneously within context (Brinkmann & Kvale, 2018; Knott et al., 2022). These secondary questions were also used to clarify participant statements, remove ambiguity, and improve understanding within the interview session to aid future data analysis (Brinkmann & Kvale, 2018).

The selection and ordering of the primary and secondary interview questions was tailored for each interview participant based on their specific area of expertise. The personalization of the interview protocol was informed by significant preparatory research for each interview participant, including a detailed review of their publicly available professional information, research publications, and prior interviews. The purpose of this preparation and personalization was to develop a foundation of relevant knowledge, create a balanced interview dynamic, and effectively utilize the limited time with each expert (Brinkmann & Kvale, 2018). Due to this personalization, there was planned variation regarding which interview questions were asked and in what order among the interview participants. Additionally, spontaneous variation occurred among the interview sessions due to the organic nature and unique time constraints of each conversation. Therefore, the 10 interview sessions were not identical. However, this variation is both permissible and

commonplace for semi-structured interviews within the social constructivism philosophical paradigm (Brinkmann & Kvale, 2018; Knott et al., 2022).

Additionally, detailed reflexive notes were generated after each interview session, indicating what elements were successful and what elements could be improved (Brinkmann & Kvale, 2018; Knott et al., 2022). As the research project progressed, the interview protocol and the interview questions were refined to reduce procedural issues, decrease personal bias, anticipate participant fatigue, and aid future data analysis. Despite these refinements, the overall structure of the interview protocol and the essence of the interview questions were not significantly altered. This reflexive investigation and the resultant incremental improvements align with the principles of the semi-structured interview format, the SSQS research design, and the social constructivism philosophical paradigm and are documented with the final interview transcripts (APA, 2020; Blandford, 2014; Brinkmann & Kvale, 2018; Creswell & Poth, 2018).

3.5.1.8 Data Recording and Transcription Process

To assist data collection and future data analysis, interview sessions are typically recorded, and the verbal conversations are transformed into written texts through an interpretive transcription process (Brinkmann & Kvale, 2018; Knott et al., 2022). Regardless of the transcription approach, the translation of oral language into written language will decontextualize and abstract a conversation, presenting several important practical and philosophical questions for the researcher. These questions include who will transcribe, what verbal and non-verbal information will be included, whether the transcription accurately represents the participant's original statements, and how these decisions will impact future data analysis (Brinkmann & Kvale, 2018; Knott et al., 2022). Based on this contextual information, this section will explicitly describe the data recording and transcription process used for this research project.

With the consent of each participant, both the interview audio and video were simultaneously recorded through the Google Meet (n = 9) and Zoom (n = 1) video conferencing software applications. These audio and video recordings captured the interview conversations verbatim, allowing me to concentrate on the discussion rather than taking detailed notes during each interview session (Knott et al., 2022). These applications also featured integrated voice recognition technologies that automatically

generated initial written transcripts. However, these automatically generated transcripts contained significant errors and required detailed review and revision.

I developed a systematic editing procedure and personally compared and carefully corrected all of the automatically generated transcripts to accurately correspond with the original audio and video recordings. I utilized the semi-verbatim transcription format, where the original meaning, intent, and accuracy of each statement were preserved, but some elements such as false starts, repeated words, and mispronunciations were omitted to improve readability and understanding (Brinkmann & Kvale, 2018; Knott et al., 2022).

The corrected interview transcripts were personally reviewed multiple times, and any areas of ambiguity were discussed with the interview participants and revised to accurately reflect their intended meaning. The corrected interview transcripts were then emailed to the interview participants for review and approval. During this stage, the interview participants were permitted to make any final revisions or redactions to further clarify their original statements or remove sensitive information from the public record. These final revisions were applied to the interview transcripts, and a concluding review was performed to refine grammar and punctuation. The completed participant-approved interview transcripts (see Appendix F) were now ready for data analysis.

The transcription process occurred between July and December 2023, commencing immediately after the first interview session and continuing concurrently through the remaining interviews and beyond. The entire process required approximately 193.5 hours to transcribe 710 total minutes of audio and video data, resulting in over 76,000 total words of interview transcript data. While this rigorous process was time-consuming, I believed it was necessary to ensure the accuracy and integrity of the interview data. Additionally, personal involvement in the transcription process increased my familiarity and understanding of the interview data, facilitated personal reflection and continuous improvement of the interview protocol, and revealed the appropriate data analysis method (Brinkmann & Kvale, 2018).

3.5.1.9 Data Analysis Method

The completed participant-approved interview transcripts were analyzed using an adapted form of thematic analysis (Braun et al., 2015), which incorporates recently published reflexive considerations from Braun and Clarke (2023). Within this context, thematic

analysis is a qualitative data analysis method that utilizes close reading and iterative coding to systematically identify patterns, construct meaning, and generate themes from a dataset (Braun et al., 2015; Knott et al., 2022). Various forms of thematic analysis are commonly used within the fields of design, human-computer interaction, and the social sciences to interpret and progressively develop understanding from interview transcript data (Blandford, 2014; Braun et al., 2015). This flexible analysis method is in alignment with the existing components of the research approach and emerged as the most suitable means to address the research aim, questions, and objective (Blandford, 2014; Braun & Clarke, 2023; Creswell, 2016; Knott et al., 2022). This section describes the iterative phases and individual operations that comprise this adapted thematic analysis method.

Phase 1: Data Immersion and Familiarization

- Review the original research aim, questions, and objective.
- Read all of the interview transcripts several times.
- Generate initial notes.

Phase 2: Iterative Coding of Data

- Reexamine all of the interview transcripts and identify the important elements that are relevant to the research aim, questions, and objective.
- Using an organic, inductive, and data-driven approach, generate initial codes to identify and label these important elements.
- Systematically code the entire dataset in this manner.
- Perform a series of iterative reviews to progressively refine these initial codes, verify their accuracy, and ensure consistent application across the entire dataset.

Phase 3: Data Interpretation and Initial Theme Generation

- Group each code with its corresponding interview transcript data.
- Organize and examine this collection of data, searching for significant patterns.
- Generate initial themes to capture and identify these broad patterns.

Phase 4: Theme Review and Refinement

- Review and verify that each of the initial themes:
    - Is relevant to the research aim, questions, and objective.
    - Captures thematically distinct patterns of information.

    - Accurately represents the perspectives of the interview participants.
    - Possess sufficient supporting evidence from multiple interview participants.
    - Accommodates any disconfirming evidence from the interview participants.
    - Effectively relates to the other themes and the overall analysis structure.
- Utilizing this verification criteria, perform a series of iterative reviews to progressively refine, regenerate, or discard themes.

Phase 5: Theme Definition

- Group each theme with its corresponding interview transcript data.
- Identify the significant quotations to use as supporting evidence for each theme.
- Finalize the overall analysis structure by sequentially ordering the themes.
- Finalize each theme by generating an informative title and internal description.

Phase 6: Report Findings

- Report the findings of this thematic analysis process using an evidence-based narrative format that describes the primary themes, interweaves a selection of supporting quotations, and contextualizes this combined data and analysis in relation to the overall research aim, questions, and objective.
- Perform a series of iterative reviews to progressively refine the reported findings, ensuring a cohesive and comprehensive account of the interview transcript data.

Data analysis occurred between June and August 2024. The analysis was performed manually using standard office software (i.e., Google Docs and Apple Numbers). The thematic analysis method described above was consistently applied to all of the interview transcripts to maintain methodological integrity (APA, 2020). Due to the limitations and constraints associated with this research project, the findings were not externally validated by another researcher or by the interview participants. However, internal validation strategies included researcher reflexivity, triangulation across multiple interview transcripts, and the purposeful investigation of disconfirming evidence (Blandford, 2014; Creswell, 2016; Knott et al., 2022). Furthermore, direct quotations from the participant-approved interview transcripts were included in the reported findings as evidence to ground my interpretations within the research data (APA, 2020; Knott et al., 2022). The outcomes from this data analysis process are presented in the following Findings chapter.

4.0 Findings

4.1 Chapter Introduction

Eight primary themes were established from the analysis of the interview transcript data. These themes included: (1) observed associations, unintended negative consequences, and potential risk factors; (2) addressing the complexity, presentation, and contextualization of health and performance data; (3) recognizing control, obsession, and addiction in health and performance data; (4) the conflicting potential of social media, social networking, and data-sharing features; (5) understanding the impact of self-tracking technologies on personal intuition and internal sensory awareness; (6) enhanced user customization and intelligent personalization features for improved safety; (7) future self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours; and (8) exploring increased ethical responsibility requirements for designers and future technologies. The following sections will describe each of these themes and their findings in detail.

4.2 Observed Associations, Unintended Negative Consequences, and Potential Risk Factors

All of the interview participants could identify some useful applications or had observed some positive benefits with current consumer digital self-tracking technologies for athlete populations. These useful applications and positive benefits included promoting awareness, observing habits, tracking goals, increasing motivation, providing accountability, and cultivating empowerment for the user. Recovery-oriented metrics such as heart rate variability, stress level, and sleep quality were of particular interest and utility to both the interview participants and many of their clients or patients. Furthermore, some of the participants indicated that specialized self-tracking technologies have been successfully utilized to promote adherence and improve sensory awareness during injury treatment and recovery journeys. The following quotations capture this range of applications and benefits for athlete populations.

> LP: For athletes, I can absolutely see how tracking your heart rate would be helpful. Training zones, rest time, sleep patterns, stress—I can totally understand how useful that would be for an athlete.

> LK: I did try the Oura Ring for some of those things, and I did play around with the heart rate stuff during prep for my last competition in 2021. And there was some fascinating stuff that I was finding out. It was more for my own personal knowledge—looking at heart rate, sleep duration, and things like that over the course of a prep.

However, many of the participants acknowledged that an athlete's relationship with digital self-tracking technologies can change over time. They noted that these technologies can be adaptive or maladaptive tools, depending on the unique and evolving circumstances of each user. These circumstances are shaped by a variety of complex and interconnected variables, which are not fully understood at this time and continue to develop alongside the progression and proliferation of these technologies.

> E5: There is also a side that might not be so useful for people. Where the relationship with those devices, with the apps, etc., can become detrimental to them and not as helpful. … The individual relationship that the athletes have with them is really their own, and it can also change over time. It's different from person-to-person and from month-to-month. It's pretty complex.

Consequently, nearly all of the participants had identified, observed, or personally experienced significant risks and unintended negative consequences associated with digital self-tracking technologies in relation to the development or perpetuation of disordered eating behaviours. Many of the participants from eating disorder research and treatment environments indicated that these associations are well documented within contemporary research literature. However, these risks are typically not acknowledged, discussed, or understood by technology developers or by the general public, revealing the necessity for increased awareness, education, and advocacy.

> RF: There's pretty strong evidence for the fact that these types of wearables, devices, and apps can increase the risk and eventual onset of body dissatisfaction, poor body image, disordered eating, and all of that stuff. The evidence is pretty clear about that.

When viewed collectively, the interview participants identified a range of common traits and observable risk factors that often accompany the maladaptive use of self-tracking technologies or could indicate an increased susceptibility to their unintended negative

consequences in relation to disordered eating behaviours. For example, individuals who possess genetic predispositions for the development of eating disorders or those with preexisting disordered eating behaviour pathologies are at a heightened risk for maladaptive use of these technologies. Co-morbid conditions such as anxiety, depression, low self-esteem, and low energy availability can also increase the risk profile for an individual. Those who have previously experienced emotional difficulties with their eating, body image, physical activity, and other forms of self-tracking are also at risk.

> EL: For people with eating disorders, body shape and body weight tend to be such a central part of their identity and their value as a person that it feels really bad when they don't meet those goals, and that body dissatisfaction can just be incredibly intense.

These risk factors are compounded by the presence of rigid, perfectionist, and obsessive-compulsive personality traits. Highly compliant and adherent characteristics were also identified as potential risk factors. Conversely, users with high impulsivity and low emotional regulation are also susceptible. Individuals who are data-driven, goal-oriented, achievement-focused, or rely on external validation may be especially vulnerable to the addictive qualities of self-tracking technologies. Other risk factors include an explicit desire to exert control over the body (e.g., gain muscle, lose weight) or an intense fear of naturally occurring and non-preventable outcomes (e.g., aging, disease).

> RF: The folks that we see who are on that end of the spectrum, where there's poor body image or disordered eating behaviours, oftentimes have a high rate of perfectionism, are very compliant and adherent, tend to be people-pleasers, and there tends to be a lot of rigidity. … And I think all of those types of characteristics can very much align with folks who would then use these types of tools in a harmful way that would support or maintain some of the poor body image or disorder eating behaviours.

Athlete-specific risk factors included participation in lean sport categories (e.g., aesthetically judged, weight class, and endurance) or other activities where disordered eating behaviours are commonplace and normalized. Additionally, any athlete or individual whose appearance or performance is considered a central part of their identity, brand image, or perceived value as a person may be at an increased risk. Finally, several of the interview participants acknowledged that many of the risk factors for the maladaptive use

of self-tracking technologies and disordered eating behaviours are also factors that could contribute to the success of an athlete within their sport category, further indicating the complexity of these interconnected variables.

4.3 Addressing the Complexity, Presentation, and Contextualization of Health and Performance Data

Nearly all of the interview participants acknowledged that access to personal health and performance data can be useful and empowering for athletes and members of the general public. Simultaneously, these participants also expressed concerns regarding how this health and performance data is currently collected, presented, and contextualized by contemporary self-tracking technologies. Many of the participants critically questioned what data should be presented to the user, as well as how this data could be presented in a safe and meaningful way that mitigates the risks for disordered eating behaviours while still preserving user freedom and personal autonomy. The following quotation from EL conveys this general concern.

> EL: Especially with commercial fitness trackers, people have access to so much data, but really no help integrating that, and no help contextualizing that to their specific lives. … I think we need to be careful about what kind of data we're showing and how we're showing it.

A core socio-technological issue that many of the participants identified was the overwhelming abundance and increasing pervasiveness of complex and decontextualized information that many individuals encounter through their daily interactions with various technologies. This contemporary situation may cause individuals to experience difficulty critically evaluating what information is factual and relevant for their unique circumstances and which assistive self-tracking technologies are necessary, if any. Participants stated that this situation can lead to feelings of fatigue and disillusionment and an increased susceptibility to disordered eating behaviours.

> BK: Navigating the complexity and availability of information is a real challenge for these people who are very focused and driven and want to research this, understand

their bodies, and understand what's best for them, but the enormity of that equation is horribly overwhelming.

GC: A decade ago, I was in love with wearable technology, and my brain went to, "Oh my God, you could collect so much data, and you could marry this data with this data, and you could get so much insight." And now, I guess this is more of a personal view, but I feel like there's just so much noise around us that I'm personally fatigued by wearables.

Contributing to the abundance and complexity of information, some of the participants noted that many of the sensors integrated into self-tracking technologies are relatively new and are advancing so rapidly that developers have not yet determined the optimal methods to present the collected data to users. The following quotation from DS provides additional detail into this situation.

DS: We're still figuring out how to display it in a meaningful, useful, engaging, and not overwhelming way. I don't think we're there yet—it's quite difficult. … There is a massive amount of complexity in a single data source, and now that's compounded by the number of data sources that we have via sensors, algorithms, and whatnot. And we don't have a great understanding of how to present that to users because it's really new. We don't have a good or unified understanding as to how to present that to users.

Additionally, participants expressed skepticism regarding the utility of increased data points and granular data presentation for most athletes, suggesting that some users could become fixated on irrelevant and inconsequential metrics that provide negligible or negative performance benefits. Furthermore, many of the participants urged designers to de-emphasize problematic metrics that have historically been used to indicate measures of health but are now known to be arbitrary, flawed, or potentially dangerous, such as 10,000 steps per day, body weight, and body mass index (BMI).

LP: BMI is very problematic when taken by itself without any other context, and everybody knows how problematic it is when it's used by itself. So, if the watches are using BMI as a marker of what a person's weight category is, that could be problematic in and of itself. Telling someone that they are overweight when, for their genetics and for their life situation, really they're not.

Other participants voiced an important criticism that these technologies are fundamentally developed for self-tracking and self-monitoring but often do not provide information or support regarding actionable steps that users can take to safely modify or improve their metrics. DS emphasized this point, stating that if the data point is not actionable in a safe manner, it becomes useless, confusing, demotivating, and potentially dangerous. Therefore, many of the participants advocated for the integration of education and support features to help users interpret and contextualize their data through long-term use. Participants stated that these education and support features could be integrated into the technologies, leverage artificial intelligence chatbots, or communicate with external mental and physical health teams.

> RF: I don't know if all of the types of data that are presented, or the visualizations for a lot of the applications that currently exist, are useful and, more importantly, are actionable. I think one of the things that is really lacking in a lot of these apps is that they're really just geared towards self-monitoring. So, it's getting the data, and then it's not actually telling you or giving you information as to "what you can change or improve upon so that you can get a better night's sleep" or "decrease your risk of engaging in XYZ behaviours."

Furthermore, nearly all of the interview participants suggested that designers need to purposefully reduce complexity for users and present information in a simple and understandable manner that relieves cognitive strain and the potential for emotional distress. This is an especially important consideration for designers who are developing treatment and intervention tools for disordered eating behaviours, as the concept of data itself can be triggering for some patients. Additionally, many patients are already overloaded with inputting, describing, and measuring various elements of their personal health data within clinical treatment settings. Designers need to be sensitive to these unique needs, and some of the technology developers suggested that data abstraction and intelligent personalization features could be potential strategies to reduce complexity for these users.

4.4 Recognizing Control, Obsession, and Addiction in Health and Performance Data

Several of the interview participants described how athletes often utilize self-tracking technologies to monitor and control their behaviours and physiology in an attempt to optimize their athletic performance and health. However, many participants believe that

the over-abundance of decontextualized data collected from these technologies, combined with an over-fixation and over-analysis of this data, can lead athletes to obsessive and compulsive behaviour formation and attempts to over-control their bodies and performance. Additionally, users may become addicted to positive reinforcement mechanisms, such as notifications and rewards for achieving their step, sleep, or caloric goals, regardless of whether these targets are healthy and sustainable for the athlete. The following quotation by EL provides excellent insight into this perspective.

> EL: But I think having access to so much of that data sometimes leads us to this place where we are trying to over-control what our bodies are doing and how our bodies are functioning. And I think that's the trap that I see a lot of athletes falling into with fitness trackers. They have access to so much specific information about their bodily functions—that may or may not be as accurate as they think it is—and they're like, "I know this thing, so I should be able to control this—I should be able to do this." And when they can't—when they can't restrict their eating without resorting to binge eating—then they're feeling frustrated, discouraged, and guilty, and it brings up this host of negative emotions, which then reinforces that whole cycle over again.

Many of the interview participants stated that athletes may link their self-worth to their goals and their data, and these athletes may experience severe psychological distress if they do not meet these often unrealistic and unattainable objectives. Failure to meet these objectives, combined with a strong negative emotional response, may cause athletes to utilize a variety of disordered eating behaviours as potential goal-attainment strategies or emotional coping mechanisms. However, these behaviours will further degrade the athlete's overall health and athletic performance and continue to perpetuate this harmful cycle. These elements can deprive the athlete of the enjoyment that is typically obtained from their sport, training activities, and personal life.

> LP: What I see most in my patients is feelings of "worthiness," "not being enough," or "not doing enough," coming with the wearable tracking devices.
>
> EL: The biggest one that I see are feelings of frustration with oneself when they're not able to stick to their step goal. I have had a lot of patients who really feel like they are

an "unworthy person" because they didn't get 10,000 steps that day. As you might imagine, that can lead to a whole host of downstream effects.

NP: It's pushing people to do more than maybe they should have or could have—for better or for worse. And I feel like it gives them this feeling of, "I failed. I didn't do enough. I didn't work hard enough." And I think that's damaging at some point.

RF: Athletes will use some of these step counters … And that has facilitated, for instance, an eating disorder where they get really stuck on getting a certain number of steps in a day or exercising a certain amount. And that has facilitated concerns with body image, compulsive exercise, and then drifting into a full-fledged eating disorder.

The interview participants noted that the wearable fitness tracking device itself is not neutral, and its physical presence can serve as a "tangible representation" and constant reminder of the user's goals. Therefore, if the user has a strong emotional connection to their goals and these goals are not being met, the presence of their device may cause mental distress and provoke disordered eating behaviours. EL describes this scenario by stating, "You're relentlessly pursuing this goal, and that fitness tracker becomes a reminder of the fact that your body doesn't look the way that you want it to look right now." Many of the interview participants expressed similar perspectives, with NP critically questioning whether users would actually "care as much about 'calories in, calories out' and all those metrics if they didn't have it sitting on their wrists?"

Furthermore, DS described how long-term users of self-tracking technologies will accumulate a substantial amount of health and performance data over time. However, many of these technologies do not account for contextual factors such as the aging process and evolving ability levels. Therefore, some products will compare the users' current goals and performance to the levels they achieved when they were younger and potentially more able. Despite these changes being natural and normal, this comparison can be demotivating and distressing for some users, indicating the need for enhanced user customization and intelligent personalization features, which will be discussed further in a separate theme. The following quotation by DS provides powerful and emotive insight into this perspective.

> DS: I've had (Strava) for countless years and all that data has been sitting there. So, when I was 20, I was significantly better at certain activities than I am now. But there's no contextual awareness within those platforms or within the device that says, "Hey, you don't have to be as good as you used to be." It is very demotivating to me, where I'm like, "Ah, I'm not as good as I used to be," or "I'm not as fast as I used to be," or "I'm not as strong as I used to be." And I think it's detrimental to the product itself—it makes me not want to use it as much. There have been points where I've taken it off because it's like, "I can't take this. I can't take another, 'You should train harder,' or 'You should do this.'"

In terms of additional design criteria, many of the interview participants viewed the self-quantification, goal-setting, and gamification design features as especially problematic for many users. These interview participants indirectly challenged designers to conceptualize safer self-tracking and user engagement techniques that are less invasive, less addictive, and less disciplinary for individuals. Additionally, some interview participants encouraged designers to thoughtfully incorporate improved safety and prevention measures that can identify and disrupt use patterns that are commonly associated with disordered eating behaviours. For example, the technologies could provide notifications and support resources when users log insufficient calories and engage in sustained periods of excessive exercise. Furthermore, the technologies could allow users to input qualitative comments and utilize machine learning algorithms to discern whether exercise patterns exhibit a compulsive or obligatory nature, as these are common indicators of disordered eating pathology.

4.5 The Conflicting Potential of Social Media, Social Networking, and Data-Sharing Features

Some of the interview participants noted that the social networking and data-sharing features integrated into digital self-tracking technologies can be beneficial for some users. Participants stated that these features can offer community support, foster healthy competition, and provide inspiration. This sense of community and competition can be a powerful motivator for some individuals. Furthermore, observing the techniques and accomplishments of other users may demonstrate what is achievable and potentially inspire individuals to surpass their preconceived or self-imposed limitations. The positive potential of these social features is summarized with the following quotation.

> BK: That, to me, encapsulates what these platforms and devices can be capable of. They can bring people together, they can encourage you to push yourself, and they can show you people who are incredibly inspirational.

Some participants also described how the visible presence of a wearable fitness tracking device could help some individuals fit in and gain acceptance within their sports and fitness communities. Additionally, self-tracking technologies may provide the user with a real or perceived sense of knowledge, expertise, and confidence, which can potentially shield them from anxiety, judgment, and negative comments.

Simultaneously, nearly all of the participants noted that the social networking and data-sharing features integrated into digital self-tracking technologies can also promote unhealthy comparison and excessive competition that can escalate and cause several negative consequences, including the development of disordered eating behaviours.

> E5: I think it can also play into some darker tendencies. And depending on who you are and how things have changed in your life, having that information can also facilitate comparison and competition. Especially when you can share your stats with other people. So, having that information—not only your own health data but other people's health data—can introduce some interesting paradigms that might not have been there.

This comparison and competition may cause an individual to increase their physical activity beyond their current capabilities, which can impair their recovery and increase their potential for physical injury. Additionally, due to the visibility and accessibility of information, individuals may emulate the training and nutrition practices of elite athletes, regardless of their current skill level or understanding of the potential risks involved. Depending on the individual, failure to meet unrealistic goals or desired outcomes can cause mental distress and may reinforce excessive exercise, compensatory purging behaviours, and other disordered eating behaviours.

> BK: Obviously, the negative side of that is chasing things that you're either not capable of or shouldn't be doing, and you start to obsess over them, which can lead to all of these really detrimental behaviours.

Many of the participants stated that digital self-tracking technologies and social media are contributing to the promotion, normalization, and pursuit of potentially unrealistic or unsustainable sport-specific body image ideals. DS suggests that, in isolation, wearable fitness tracking devices may not inherently promote body dissatisfaction but acknowledges that these products exist within a larger societal and technological context, which must be considered. Within this context, the use of wearable fitness tracking devices in combination with social media, social networking, and data-sharing features can facilitate comparison with the achievements and appearances of others, which may intensify competition and foster body dissatisfaction.

> DS: If wearables were to exist in a vacuum where the associated social media and community platforms like Strava didn't exist, I don't know if these wearables would drive a negative sense of body image. I think it's a coordination of all of these external factors plus the fact that you're able to measure what this other person is measuring. You're seeing them, and it's like, "Oh shit, they're doing that, and I don't look like that, and that sucks."

Participants noted that these social networking and data-sharing features can be especially problematic for users with competitive personality traits and those who associate positive self-evaluation with their personal or comparative performance. As noted by NP, this competitive mindset and a fixation on data can undermine progressive efforts within the fitness industry to create supportive, accepting, and non-competitive environments.

> NP: Especially the demographic that I service right now—extremely high achievers, they're all wealthy, they're all gorgeous, they're all extremely educated and accomplished —if they have the data in front of them that they "didn't do as well as they should have," they are definitely pushing themselves harder next time. And they're sitting over coffee after that workout going, "It said that I did x-number, but you only did y-number." And I think it creates a sense of competition that the people I love and care about in the fitness industry have tried really hard to get rid of. So, it feels like going backwards.

Many of the participants have observed that their clients and patients are increasingly seeking real in-person social interaction, as athletic training and disordered eating behaviours can be socially isolating or secretive activities. Therefore, the development of authentic social support networks is commonly incorporated into eating disorder treatment

protocols. Based on this information, it may be tempting for designers to integrate conventional social networking features into future digital self-tracking technologies and mental health tools on the basis of perceived community building and support. However, EL emphasizes caution and suggests that these social networking and support features need to be thoughtfully designed for the unique contexts and risk factors that are associated with disordered eating behaviours to reduce harm and improve the efficacy of treatment.

> EL: When the social piece comes into play in the context of treatment, we're actually putting a lot of thought and effort into curating how that social piece can be helpful … I think we can't just say, "We'll build a chat room or a leaderboard," and just let people have at it. I think we need to build some scaffolding to help that actually function appropriately and be helpful for people, because I don't think that's something we can do by ourselves in our own heads.

Regarding additional design criteria, RF identified that algorithms can identify what social media content may be contributing to body dissatisfaction, and this logic could be applied to wearable fitness tracking devices to better understand which metrics may be contributing to disordered eating behaviours. Additionally, RF stated that APIs (application programming interfaces) could be used to track user behaviours and patterns to develop predictive models and interventions for disordered eating behaviours. An example use pattern could be: viewing triggering content on social media, feeling compelled to check personal health data, and then engaging in excessive exercise or compensatory purging behaviours. Investigating these complex user engagement practices across multiple digital applications could help researchers and designers develop safer self-tracking technologies. Finally, NP suggested that GPS data and proximity tracking could be used to identify social isolation, promote real human interaction, and potentially mitigate disordered eating behaviours for some individuals.

4.6 Understanding the Impact of Self-Tracking Technologies on Personal Intuition and Internal Sensory Awareness

All of the interview participants who treat individuals with eating disorders noted that many of their patients feel disconnected from their bodies and exhibit a decreased awareness of their internal senses. These individuals often misinterpret or experience an impaired sensitivity towards their interoceptive signals related to hunger, satiety, fatigue, and pain that

can reinforce their disordered eating behaviours. This is a serious concern, and nearly all of the interview participants believe that an overreliance on self-tracking technologies is also contributing to the reduction of internal sensory awareness for all users. This includes members of the general public and athlete populations, in addition to individuals who are experiencing disordered eating behaviours, as illustrated with the following quotations.

> E5: In eating disorders, some of the core pathology is that you become very disconnected and dissociated from the body.

> LP: Within the world of eating disorders and disordered eating, and within our society as a whole, we are so disconnected from our bodies, and sometimes I think wearable technology can reinforce that.

Several participants stated that users may trust and prioritize the data collected from their self-tracking technologies over their personal judgement, intuition, and internal senses to determine their sleep quality, caloric requirements, exercise intensity, and other measures of health and performance. However, as previously discussed, contemporary self-tracking technologies typically do not account for critical contextual factors, which means the subsequent data presentation is incomplete and must be critically evaluated by the user. This is compounded by known inaccuracies with both sensor data and self-reported values. Therefore, participants speculate that an excessive reliance on self-tracking technologies can degrade personal intuition and internal sensory awareness, which can lead to the formation or reinforcement of disordered eating behaviours, typically observed as dietary restraint, binge eating, excessive exercise, and compensatory purging behaviours. The following quotation by LP illustrates this perspective.

> LP: You're relying on your watch to tell you whether or not you had a good sleep, instead of just waking up in the morning and saying, "I feel well rested or I don't." Or you're relying on your watch, and it says that you didn't close your rings, but you feel exhausted. But the patients negate that when they're like, "I have to do more activity because I didn't close my rings or get this many steps." Even though their body is telling them that they're sore, they're tired—but there's no connection from the neck down.

E6 builds upon this perspective and believes that an overreliance on self-tracking data is not sustainable and does not facilitate meaningful learning and skill development.

> E6: Thinking of the Oura Ring and their "Readiness Score," I know from my own experience that it's often off. It's valuable sometimes, but I'm not the biggest fan. I think that ideally, you should be feeling what those zones are for you and for yourself. You should be tapping into, "Was this good sleep for me?" And of course it provides information—if someone is trying to walk more, it is useful to know, "This is about how long this walk feels." But to always be relying on, "Did I get 10,000 steps? Am I satisfied?" just doesn't seem sustainable. Or it doesn't seem that there is really anything to build and deepen there.

Furthermore, LK believes that self-tracking technologies are frequently viewed as a "quick fix" or a "magic pill," but in practice they tend to distract users from "doing the work" to develop their intuition and internal sensory awareness, which are critical skills for high-performance athletes. Participants also noted that users may experience confusion and distress when their self-tracking data does not align with their feelings, emotions, and expectations. For example, NP observed that clients will often report feelings of fatigue and muscle soreness following an intense workout, but if their data does not reflect what "they were expecting to see," they may believe that they must "work harder next time," despite experiencing the "effects from the intensity of the workout." Alternatively, an overreliance on potentially inaccurate self-tracking data may exaggerate the user's confidence and foster a false understanding of their true health status and ability level. This misunderstanding, paired with problematic messaging from the fitness industry that often promotes working through pain and no rest days, can lead to serious injury and an increased risk for disordered eating behaviours. The following quotations elaborate on this range of perspectives.

> NP: I find myself having this internal dialogue of, "My body feels like I'm done, but the watch says I should probably do a little more," and I know it's wrong. I find my personal internal dialogue gets really hazy when I wear this.

> EL: Often people will exercise past internal body cues that suggest maybe they should stop now—their legs are hurting, they're shaking—that kind of thing.

> LK: I try to instill in them, "If you're not feeling great, take a rest day today. You can train again tomorrow." Versus, again, the industry as a whole, it's kind of like, "If you're missing your workout, you're getting inferior results." But again, they're not taking that big picture into consideration.

Based on this foundational information, many participants stated that a primary goal of both eating disorder treatment and athletic training is to help individuals reestablish a connection between their mind and their body through improved sensory awareness and intuition. However, the interview participants had mixed feelings regarding whether self-tracking technologies could be effective tools to reestablish these connections. For example, some of the interview participants believe that due to the documented risks, commercial self-tracking technologies are fundamentally incompatible with eating disorder treatment. Furthermore, these participants expressed skepticism regarding whether these technologies could help to cultivate an authentic, independent, and sustainable mind-body connection.

> E5: The key underlying principle of mindfulness interventions, is awareness of the present moment. And a lot of that is connecting with the body—it's not connecting with your fitness monitor. So, if you're talking about it in terms of "bringing awareness back to the body," I really don't think that it has a place there.

However, other participants believe that it is the responsibility of future self-tracking technologies to promote user education and the development of adaptive skills that could help users reconnect with their bodies and ultimately reduce their reliance on the technology itself. EL notes that this perspective is in opposition to conventional business strategies but believes that user education, empowerment, and independence are required within this domain to reduce the risks of disordered eating behaviours.

> EL: Devices or systems that promote adaptive skill use are really important. The more that we can incorporate lessons for people on how to handle these scenarios in the future and cue them to use skills that are helpful for them at any given point, I think, is helpful.

Some of the interview participants noted that visual and haptic biofeedback tools have been successfully utilized in both athletic and medical rehabilitation environments to help individuals strengthen their mind-to-muscle connections. Additionally, instantaneous heart

rate variability sensors and visual biofeedback training tools have illustrated promising potential in clinical counselling settings to help patients understand their stress responses and develop self-regulation techniques. Therefore, future self-tracking technologies could explore the thoughtful incorporation of biofeedback features to educate users and promote the development of sensory awareness and self-regulation skills. Additionally, biofeedback could deliver haptic notifications to identify and disrupt disordered eating behaviours as conceptualized in some advanced research studies.

While these recommendations are promising, participants noted that designers must exert caution during development and implementation to mitigate the identified concerns regarding complexity, self-quantification, goal-setting, and gamification design features. Additionally, designers must include safety features and intervention tools to prevent heightened sensory awareness itself from becoming pathological (e.g., hypersensitivity, hyperfixation, hypercritical) and contributing to disordered eating behaviours.

4.7 Enhanced User Customization and Intelligent Personalization Features to Improve Safety

Nearly all of the interview participants identified enhanced user customization and intelligent personalization features as promising methods to mitigate the potential risks associated with self-tracking technologies and disordered eating behaviours. These participants suggested that allowing users to customize and tailor their self-tracking technologies to their unique needs and circumstances could improve the overall safety and user experience of these products. In this context, intelligent personalization features refer to the technology's capability to learn from the user's behaviours and preferences over time and adjust its recommendations and settings accordingly. This form of machine learning was identified by participants as an essential requirement for many of the detection, intervention, and treatment features that are currently being explored in advanced research studies. The quotations directly below serve to introduce this theme, and the subsequent content describes the range of design criteria and recommendations related to user customization and intelligent personalization that were discussed in the interview sessions.

NP: If I had a wish, I would like it to be more easily customizable.

> RF: If it is truly coming from a prevention and intervention standpoint and not just a self-monitoring standpoint, there's been a lot of discussion around making sure that the tool actually captures what that person is experiencing, and that requires a lot of personalization.

Participants noted that some of their clients are aware that certain metrics, such as steps taken and caloric expenditure, are problematic and contribute to their disordered eating behaviours. Therefore, during initial setup, future technologies could prompt users to select the self-tracking metrics that are relevant and beneficial to them. Additionally, participants acknowledged that conventional quantitative data presentation methods such as precise numbers, detailed graphs, and colour-coded progress visualizations are known to trigger disordered eating behaviours for some users. Therefore, future technologies could explore personalized data presentation and communication methods. Finally, participants also stated that all customization options must be easy to locate within the user interface and easy to modify without any consequence or penalty to the user.

> E5: Being able to remove the activity rings displayed on the Apple Watch. If someone wants that off, let them be able to remove it from what they monitor. Let's be able to tailor it so the people who are at risk—at least they can have the choice to not facilitate that risk further—at least give them that choice.

> E6: It would be great if you could self-select what kind of output you're getting. For example, if you just want strictly recovery-oriented measures, being able to mute the others. I think that alone would be a huge improvement.

Other participants stated that technology developers need to take a greater responsibility for which health and performance metrics their products prioritize. Participants encouraged designers to thoughtfully incorporate and authentically promote metrics related to mental health and overall wellness as core components of a product's user interface and brand identity. Furthermore, future technologies could place a greater emphasis on health and performance metrics that indicate positive progression within eating disorder treatment, such as improvements to cardiovascular health and overall strength.

Participants also suggested that future technologies could provide personalized user interface configurations that take into account the risk factors associated with different

sports and user demographics. To assess these risk factors, future technologies could incorporate questions from established clinical screening tools, such as the Compulsive Exercise Test (CET), the Eating Disorder Examination Questionnaire (EDE-Q), and the Sociocultural Attitudes Towards Appearance Questionnaire-4 (SATAQ-4), amongst others.

Some of the participants advocated for the development of improved notifications to ask users compassionate questions, encourage them to check in with their emotions and interoceptive signals, and provide a range of flexible intervention options related to nutrition, movement, recovery, meditation, social interaction, and other components of overall wellness. Participants stressed that all notifications must respect the user's preferences and should avoid strict directives and disciplinary connotations. The following quotation from LP encapsulates this perspective.

> LP: Instead of, "Hey, you need to move," could they say, "Do you feel you need to stretch? Do you feel jittery? Do you feel calm?" Things like that instead, so it's actually encouraging the person to check in with their bodies instead of this external cue of, "Hey, you need to do this." … Just trying to cultivate those internal cues, bodily sensations, and somatic awareness of, "Do I actually want to move?" and "How do I want to move?" … And maybe giving them options like, "Do you need to stretch? Do you need to go for a walk? Do you need to have some water?"

Building upon this perspective, many of the interview participants suggested that future technologies should allow users to input qualitative and subjective information to increase personalization. This could include the ability for users to log their emotions (e.g., fear, sadness, guilt), moods (e.g., anxious, calm, stressed), interoceptive signals (e.g., pain, fatigue, hunger), contextual factors (e.g., travel, deadlines, social events), and other elements related to their use of self-tracking technologies that may contribute to disordered eating behaviours. Machine learning algorithms could be developed to enable future technologies to utilize this qualitative information to influence metrics such as recovery scores, complement traditional quantitative data presentations, and inform real-time intervention and treatment tools for disordered eating behaviours.

> EL: Garmin has this recovery score that indicates how your body is doing overall, but to my knowledge, that score doesn't take into account any subjective data at all. It's based on your heart rate variability, your sleep score, and whatever else. But you, as a person, also know how your body is feeling. I think giving people that power can be really helpful. To say, "Yes, my heart rate variability was low, and yes, I didn't sleep great, but actually, my body feels really good today," and allowing that to influence the algorithm can also be really helpful.

The fundamental goal of these customization and personalization features is to provide a nuanced and contextually relevant user experience that improves the safety of self-tracking technologies. However, some participants expressed an important concern regarding the balance that is required to ensure users are not overwhelmed with customization options and, most importantly, that the technologies do not remove the user's sense of personal autonomy. Therefore, future products must empower the user to critically interpret their data and emphasize the development of personal understanding rather than desensitizing interpretive cues through an overreliance and excessive trust in the collected data and the technology itself.

> RF: It almost feels overwhelming trying to figure out what needs to be customizable to facilitate engagement, but to also feel like they're not completely overwhelmed with options and not crossing that boundary where it feels like a piece of technology knows you too well, right? There still has to be some space for people to feel like they are the ones that are understanding themselves, and it's not a tool that's doing it for them.

Finally, some of the participants noted that any health and performance metric has the potential to become pathological for some users. For example, improvements to cardiovascular health in underweight individuals can indicate healthy weight gain, and some users could strategically utilize this metric to support their eating disorder. Therefore, safety features are required to identify the maladaptive use of metrics that may seem innocuous to designers, indicating the necessity to thoughtfully involve individuals with disordered eating behaviours throughout the product design and development process.

4.8 Future Self-Tracking Technologies for the Detection, Intervention, and Treatment of Disordered Eating Behaviours

As described in the Introduction and Literature Review chapters, research teams across the world are currently exploring the use of digital self-tracking technologies for intervention, treatment, and advanced research applications for disordered eating behaviours. Furthermore, as identified in the Research Approach chapter, some of the interview participants for this research project are active contributors to these innovative research and development initiatives. These participants graciously discussed their research programs and the exciting potential of future technologies to predict, detect, interrupt, and treat disordered eating behaviours. Additionally, all of the interview participants shared their interdisciplinary perspectives regarding how these future technologies could be designed and the potential barriers that may be encountered.

To begin, EL described the challenges that are associated with existing eating disorder treatment methods, stating that it can be difficult for patients to "take what they learn in therapy and immediately apply it successfully" within their daily lives, especially when these patients are simultaneously experiencing "intense negative affect" and the psychological consequences of low energy availability. RF shared this perspective and described how digital mental health tools and self-tracking technologies could be used in combination with these in-person treatment services to "help bridge the gap" and improve the overall efficacy of eating disorder treatment.

Therefore, within this context, EL and RF are currently using data from wearable sensor technologies to build increasingly advanced computational models and algorithms that can accurately predict disordered eating behaviours. RF noted that the basic premise for many of these advanced research studies is to utilize data collected from wearable sensors to detect periods of heightened risk and to deliver intervention notifications and treatment options directly to individuals in real time. For example, RF is using steps taken and heart rate data collected from Apple Watches to predict and disrupt compulsive exercise engagement. In a related but separate example, EL is using wearable sensor technologies to distinguish and disrupt maladaptive exercise engagement while permitting adaptive exercise engagement as a recovery tool. Additionally, one of EL's colleagues is currently developing an algorithm to identify negative affect and determine when these emotional states may predict binge eating

episodes. EL elaborates on these perspectives in the following quotation and describes how these research initiatives could fundamentally transform eating disorder treatment and improve the safety of future technologies for all users.

> EL: There are certainly a lot of people working on this, building algorithms that can identify different risk factors and predict different behaviours. And once we can put all of that together into one system, and once we identify which interventions are the most effective on that small time scale, I think it's going to change the game for eating disorder treatment, honestly. I think it's going to change the game for how people use these devices to actually help them in recovery, rather than getting them into that negative reinforcement cycle.

Drawing from adjacent research fields, DS added to this discussion, hypothesizing that future self-tracking technologies could become "less wearable" and utilize camera sensors and machine vision algorithms to collect momentary health and performance data. These devices could be positioned throughout the user's environment for "predictive medical analysis" or to monitor "ongoing disease progression." While these technologies raise important ethical concerns regarding privacy, surveillance, and consent, they could become useful tools for eating disorder treatment, offering a non-contact alternative to wearable sensors.

All of the interview participants who treat individuals with eating disorders expressed interest in future clinical technologies that could collect patient data, transmit this data directly to the treatment team, but shield this data from the patient themselves, provided that this is done in a voluntary and consensual manner. E5 noted that this model is frequently used within advanced research studies, where participants wear a device with no display or limited user interface functionality, and all their health and performance data is sent directly to the research team for review and analysis. This approach allows clinicians to objectively monitor patients, develop personalized treatments, deploy precision interventions, and avoid data misinterpretation by patients. GC expressed the benefits of this model, stating that, "As a clinician, when I have more visibility into what you're doing at home, our conversations can be much richer." E6 agreed that this model could "improve the quality of care" and "advance understanding." Additionally, in the following quotation, LP describes how this model could combat the manipulative nature of eating disorders by providing critical insights into the actual behaviours of patients.

> LP: If the patient couldn't see (the data) and it got directly sent to their treatment team, that would be really interesting. Because eating disorders are very deceitful and manipulative, our patients will often lie about what they're doing in the evenings after the program. If there was a way for that data to be sent directly to the clinicians, that could influence treatment quite exponentially.

While these technology-based intervention and treatment tools are promising, the interview participants expressed a range of concerns and potential challenges that designers may encounter throughout the product design, development, and implementation processes. Participants noted that many clinicians are either unaware of effective digital tools or hold strong negative opinions and biases towards them. This is partly due to the known risks that are associated with traditional self-tracking technologies and disordered eating behaviours, which become especially evident within clinical treatment settings. RF stated that clinicians often "have a lot of skepticism around digital mental health tools" in general. This skepticism is frequently accompanied by concerns related to cost, complexity, training, and occupational security. Additionally, treatment tools that are integrated into commercial technologies, such as an Apple Watch, may be perceived as less sophisticated or less effective than purpose-built medical devices, despite evidence from clinical trials. RF stated, "I certainly understand the concerns and the potential negatives," but believes there are also "dramatic upsides to using these types of technologies" within treatment.

GC also acknowledged these concerns, noting that the needs and preferences of patients, clinicians, and investors often seem incompatible. However, GC emphasized the importance of involving all stakeholders throughout the product design and development process to ensure the safety, efficacy, and viability of future technologies. Participants highlighted the need to reduce costs and improve accessibility of intervention and treatment tools, with BK suggesting subsidization or a needs-based model as potential solutions. Finally, many of the interview participants called for increased awareness, education, and training programs to promote the positive potential of these technologies, ensure proper implementation, and reduce the likelihood of abandonment.

4.9 Exploring Increased Ethical Responsibility Requirements for Designers and Future Technologies

Regarding the development of digital self-tracking technologies, BK acknowledged that there is often a "level of altruism at the root of most of these companies. … where the founders identified something, wanted to inspire people to be active, or there was a problem that they were trying to resolve." However, BK noted that as these companies grow, they frequently face economic and profitability pressures that can outweigh their initial altruistic intentions. Investors typically desire a "continual, reliable, long-term revenue stream," and this often leads to the adoption of addictive user engagement strategies that seek to "monetize every interaction as much as possible."

BK observed that designers are frequently positioned "downstream from the decision-makers," and if these decisions prioritize profit over authentic user needs and societal benefit, designers can become complicit in potentially harmful scenarios where their professional skills are employed to manipulate consumers. The following quotations from BK and NP provide deeper insight into this situation, with BK describing how designers may leverage the emotions and behaviours of people to create artificial needs, followed by NP validating this perspective based upon their independent observation within the fitness industry.

> BK: Designers are good at tapping into people's emotions, like their fears and their behaviours. We're really good at tapping into those things that you just can't get from straight demographic information, and that can be exceptionally harmful because by tapping into those things once someone is in your (technological) ecosystem, you are potentially creating false cravings for things that you don't actually need to resolve. … Visually and through language, we are so good at persuading people that this is something that you need to pay attention to and that you need in your life. So, we're using our compelling means to convince people who don't have this problem that, "You have this problem."
>
> NP: I would like to believe that the average person didn't recognize that there was a hole in their life because they didn't know how many calories they were burning in a day—does that make sense? I don't think they thought they needed that information until the marketing wheels said, "You need this information."

DS noted that self-tracking technologies are advancing rapidly and developers may intentionally or unintentionally exclude thoughtful, human-centred design initiatives to capitalize on their innovations within a competitive marketplace. The following quotation describes how rapid technological development, coupled with insufficient research and user participation, could contribute to the risks and unintended negative consequences that are associated with these products.

> DS: We're at the stage where the technology is advancing so fast—we're just pushing more and more and more tech into these products—that thoughtful design just can't keep pace. The pace of technical development is significantly faster because there is no "human-centredness" about it, right? I can develop a new heart rate sensor and a new heart rate algorithm independent of "how it makes this person feel or what it provides to them." It doesn't matter. I don't need to do interviews like this to make a piece of tech work. Now, whether it works for the intended user, for the intended purpose, and provides contextual information that is important? That's a whole different thing.

With an understanding of these business practices, some of the interview participants critically questioned whether self-tracking technologies, as they are currently designed, are actually effective tools to foster positive behaviour change, enhance athletic performance, and improve overall public health—or whether these products simply reinforce the existing habits of users who are predisposed to health-conscious behaviours and introduce significant health risks for others. To address this question, some of the participants called for rigorous longitudinal research studies to investigate the true impact of self-tracking technologies on health and quality of life over time.

EL echoed many of these concerns, stating that without increased research and regulation, companies "will do whatever they can to stay relevant and keep selling products." EL believes that without reform, "the path of least resistance" will be to "capitalize on" the "addictive nature" and "sense of reward gained from the device," to the point where these technologies "become really detrimental" because they are "just capturing people's desire to control their bodies in some way" and "keeping people addicted to that cycle." Therefore, EL believes that designers must be "purposeful moving forward," promoting the "socioculturally conscious development of technology" that is "actually helpful for people." EL noted that designers will

"have to work from the inside out" to "build public awareness" in addition to creating "marketable devices" that are "not harmful."

Based on these shared perspectives, nearly all of the interview participants called for increased ethical responsibility requirements for the designers and developers of self-tracking technologies. Participants strongly believe that designers must focus on identifying and solving real problems rather than creating artificial needs and using compelling products and persuasive marketing to capitalize on people's fears, vulnerabilities, and maladaptive behaviours. To support these initiatives, some of the participants suggested that design education and professional development should place a greater emphasis on ethical research methods and interdisciplinary collaboration to discover, understand, and thoughtfully evaluate the true complexities of design problems.

Furthermore, several participants indirectly called for increased participatory design initiatives that meaningfully involve athletes and individuals with disordered eating behaviours throughout the product design and development process. For example, E5 observed that self-tracking technologies are typically promoted within our North American public health discourse as tools to mitigate the risks associated with obesity and sedentary behaviour. While these conditions are prevalent, E5 and others believe that designers should also address the specific needs of underrepresented populations, including athletes and individuals with disordered eating behaviours. The interview participants also called for increased conversations with real users and other key stakeholders, with GC emphasizing the importance of asking critical questions that seek to discover the truth rather than reinforcing the preconceptions and biases of the designer. Finally, DS stated that future technologies must be thoroughly evaluated with prototypes and user testing to ensure their safety and utility, noting that "slowing down" the "deployment of technology" could be beneficial for consumers.

However, the interview participants expressed mixed feelings regarding whether self-tracking technologies should require increased clinical trials or medical device classification. Some of the participants stated that these processes could help to ensure the accuracy of sensor technologies and the reliability of collected data. Conversely, some participants with experience in medical device development revealed that these processes are time-consuming, challenging, and costly, but most importantly, they do not guarantee the creation

of improved products. In the following quotation, DS describes their experience with clinical trials and medical device classification, arguing that these processes can hinder product design and development and actually degrade the user experience of future technologies.

> DS: The route of clinical trials and medical device classification is not the way to get a good user experience. If you look at actual medical electrical devices that are in a hospital, they have the worst user interface. They're hard to use, they're outdated, and they don't employ any of the new techniques because it's such a hard industry to change within. You don't get to make rapid adaptations based on user feedback. It's a hard space to be in, and I would hate to see all consumer-facing health tech have to go through that same thing because it really is a bottleneck with respect to user friendliness.

Despite this disagreement, nearly all of the interview participants agreed that there is a critical requirement for increased education and public awareness to inform users about the known risks and unintended negative consequences that are associated with self-tracking technologies in relation to disordered eating behaviours. EL stated, "I don't think people in the world, going about their business, know that there are inherent risks to wearing a Garmin (or) a Fitbit." This perspective was shared by many, and these participants suggested a range of solutions, including warning labels, in-technology educational content, ethical advertising regulations, and safe self-tracking technology guidelines from the Government of Canada or sport governing bodies. In addition to providing increased education and awareness, these initiatives could also promote self-compassion, holistic health and wellness practices, safe and sustainable training approaches, and foster a genuine love for movement and physical activity.

5.0 Discussion

5.1 Chapter Introduction

This chapter will discuss and interpret the findings derived from the analysis of the interview transcript data. The following sections will: provide a detailed summary of the research findings; interpret these findings in relation to the existing research literature and the interpretative theoretical lens; address the known limitations of these findings and this research project; propose recommendations for further research opportunities; and describe the implications of these findings and the contributions of this research project in relation to the original research aim, questions, and objective (APA, 2020; Creswell, 2016; Creswell & Creswell, 2018).

5.2 Summary of Findings

Observed Associations, Unintended Negative Consequences, and Potential Risk Factors

This theme identified both the positive and negative elements of digital self-tracking technologies but primarily focused on the observed relationships between these technologies and disordered eating behaviours within athlete populations. The interview participants stated that an athlete's relationship with these technologies can be adaptive or maladaptive and evolve due to a variety of complex and interconnected variables. The participants identified an extensive range of common traits and observable risk factors that often accompany the maladaptive use of these technologies or could indicate an increased susceptibility to their unintended negative consequences in relation to disordered eating behaviours. For example, individuals with genetic predispositions or those with preexisting disordered eating behaviour pathologies are at a heightened risk. Co-morbid conditions such as anxiety, depression, low self-esteem, and low energy availability further increase this risk. Those with past emotional difficulties related to eating, body image, and physical activity are also vulnerable, especially if they exhibit rigid, perfectionist, or obsessive-compulsive personality traits. Individuals who are data-driven, goal-oriented, achievement-focused, or rely on external validation may be particularly susceptible to the addictive qualities of these technologies. Other risk factors include an explicit desire to exert control over the body or an intense fear of naturally occurring and non-preventable outcomes. Furthermore, any individual whose appearance or performance is considered a central part of their identity,

brand image, or perceived value as a person may be especially vulnerable. However, the interview participants stated that these risk factors are typically not recognized or fully understood by designers, technology developers, athletes, or the general public, revealing the need for increased research, education, and advocacy.

Addressing Complexity, Presentation, and Contextualization of Health and Performance Data

This theme explored the complexity of health and performance data in relation to disordered eating behaviours. The interview participants expressed concerns regarding how these forms of data are currently collected, presented, and contextualized by contemporary self-tracking technologies. The participants identified a core socio-technological issue regarding the overwhelming abundance and increasing pervasiveness of complex and decontextualized information and how this situation can impair judgment and increase susceptibility to disordered eating behaviours. The participants acknowledged that self-tracking technologies are relatively new and rapidly advancing products, and developers have not yet determined the optimal methods for safe, meaningful, and actionable data presentation. The participants expressed skepticism regarding the utility of increased data points and granular data presentation for most athletes and urged designers to de-emphasize health and performance metrics that are known to be arbitrary, flawed, or potentially dangerous (e.g., 10,000 steps per day, body weight, and body mass index). The participants also advocated for the integration of enhanced education and support features to help users interpret and contextualize their data through long-term use and provide information and actionable steps to safely modify their health and performance metrics over time. Finally, the participants strongly encouraged designers to purposefully reduce complexity for all users and present information in a simple and understandable way that relieves cognitive strain and the potential for emotional distress.

Recognizing Control, Obsession, and Addiction in Health and Performance Data

This theme described how athletes will frequently utilize self-tracking technologies to monitor and control their behaviours and physiology in an attempt to optimize their performance and health. However, the interview participants identified that an over-abundance of decontextualized data, combined with an over-fixation and over-analysis of this data, can lead athletes to obsessive and compulsive behaviour formation and drastic

attempts to over-control their bodies and performance. Athletes may become addicted to positive reinforcement mechanisms, such as notifications and rewards, regardless of whether their targets are healthy and sustainable. Some athletes may link their self-worth to their goals and their data, may experience severe psychological distress if they do not meet these objectives, and may utilize a variety of disordered eating behaviours as potential goal-attainment strategies or emotional coping mechanisms. Participants noted that the wearable device itself can serve as a tangible representation and constant reminder of unmet goals, which can trigger harmful emotions and behaviours. Furthermore, many of these technologies do not account for natural contextual factors such as the aging process, which can cause demotivating and distressing comparisons with former performance and ability levels. The interview participants viewed the self-quantification, goal-setting, and gamification design features as especially problematic for many users and indirectly challenged designers to conceptualize safer self-tracking and user engagement techniques that are less invasive, less addictive, and less disciplinary. Additionally, the participants encouraged designers to thoughtfully incorporate improved safety and prevention measures that can identify and disrupt use patterns commonly associated with disordered eating behaviours such as prolonged dietary restraint and excessive exercise.

The Conflicting Potential of Social Media,
Social Networking, and Data-Sharing Features

This theme described both the advantages and disadvantages of integrated social networking and data-sharing features for digital self-tracking technologies. The interview participants acknowledged that these features can offer community support, foster healthy competition, and provide inspiration for some users. However, the participants also acknowledged that these features can promote unhealthy comparison and excessive competition that can escalate and cause several unintended negative consequences, including the development of disordered eating behaviours. The participants emphasized that self-tracking technologies exist within a larger societal and technological context that cannot be ignored. The use of these technologies in combination with social media, social networking, and data-sharing features can facilitate comparison with the achievements and appearances of others, which may intensify competition and foster body dissatisfaction. Therefore, the participants believe that self-tracking technologies and social media are contributing to the promotion, normalization, and pursuit of potentially unrealistic or unsustainable sport-specific body image ideals. In this context, failure to

meet unrealistic goals or desired outcomes can cause mental distress and may initiate or reinforce disordered eating behaviours typically observed as excessive exercise and compensatory purging behaviours. These integrated social networking and data-sharing features can be especially problematic for users with competitive personality traits and those who associate positive self-evaluation with their personal or comparative performance. Therefore, the interview participants expressed caution, advocating for increased research to better understand these complex user engagement practices and to inform the development of safe future technologies.

Understanding the Impact of Self-Tracking Technologies on Personal Intuition and Internal Sensory Awareness

This theme described how an excessive reliance on self-tracking technologies can degrade personal intuition, reduce internal sensory awareness, and impair sensitivity of interoceptive signals related to hunger, satiety, fatigue, and pain, which can lead to the formation or reinforcement of disordered eating behaviours, typically observed as dietary restraint, binge eating, excessive exercise, and compensatory purging behaviours. The interview participants stated that users may trust and prioritize the data collected from these technologies over their personal judgement and internal senses despite known inaccuracies with sensor data, self-reported values, and the exclusion of critical contextual factors. Due to these risks, some participants believe that commercial self-tracking technologies are fundamentally incompatible with eating disorder treatment and expressed skepticism regarding their ability to foster an authentic, independent, and sustainable mind-body connection. Conversely, other participants believe it is the responsibility of future technologies to promote user education and the development of adaptive skills to help users reconnect with their bodies and ultimately reduce their reliance on the technology itself. These participants identified the thoughtful incorporation of visual and haptic biofeedback features to educate users, promote the development of sensory awareness and self-regulation skills, and deliver haptic notifications to identify and disrupt disordered eating behaviours in real time. The participants noted that designers must exert caution to mitigate the previously identified concerns regarding complexity, self-quantification, goal-setting, and gamification design features. Furthermore, designers must include safety features and intervention tools to prevent heightened sensory awareness itself from becoming pathological (e.g., hypersensitivity) and contributing to disordered eating behaviours.

Enhanced User Customization and Intelligent Personalization Features for Improved Safety

This theme identified the integration of enhanced user customization and intelligent personalization features as potential strategies to improve the safety of digital self-tracking technologies and mitigate the potential for disordered eating behaviours. These features allow users to tailor their technologies to their unique needs and circumstances and utilize machine learning to better understand their behaviours and preferences, adjusting recommendations and settings accordingly. The interview participants stated that certain metrics and data presentation methods are known to contribute to disordered eating behaviours, suggesting that future technologies should empower users to easily disable harmful metrics and incorporate alternative data presentation options. Future technologies could also allow users to input contextual information, such as their emotions, interoceptive signals, and lifestyle factors, to supplement sensor data presentation and inform predictive interventions for disordered eating behaviours. The participants advocated for improved notifications that ask users compassionate questions, encourage them to check in with their emotions and bodies, and provide a range of flexible intervention options. The participants stated that care is required to ensure users are not overwhelmed with customization options and that these intelligent personalization features do not undermine personal autonomy. Ultimately, these features should encourage users to critically analyze and interpret their health and performance data and foster personal understanding, rather than desensitizing interpretive cues and promoting an overreliance and excessive trust in the technology itself. Finally, the participants noted that any health and performance metric has the potential to become pathological and recommended the integration of established clinical screening tools and personalized safety features to identify and disrupt maladaptive use patterns.

Future Self-Tracking Technologies for the Detection, Intervention, and Treatment of Disordered Eating Behaviours

This theme provided additional insight into the exciting potential of future digital self-tracking technologies, which are currently being explored in advanced research settings that can effectively predict, detect, interrupt, and treat disordered eating behaviours in real time. The interview participants explained how health and performance data has been collected from wearable sensor technologies and used to build advanced computational models and algorithms that can identify periods of heightened risk and accurately predict occurrences of disordered eating behaviours. These technologies would deliver notifications to disrupt these

behaviours and provide personalized treatment options directly to users. The participants also discussed how camera sensors and machine vision algorithms could be used to collect momentary health and performance data, monitor the progression of disordered eating behaviours, and provide predictive medical analysis as a non-contact alternative to wearable sensors. Furthermore, the participants expressed interest in future clinical technologies that could collect and transmit patient data directly to treatment teams but shield this data from patients themselves, provided that this is done in a voluntary and consensual manner. This approach would allow clinicians to objectively monitor patients, develop personalized treatments, deploy precision interventions, and avoid data misinterpretation. The participants stated that these research initiatives could improve the safety of future self-tracking technologies for all users and fundamentally transform eating disorder treatment. However, these future technologies raise important ethical concerns regarding privacy, surveillance, and consent, and the participants shared their interdisciplinary perspectives regarding how these technologies could be ethically designed and implemented.

Exploring Increased Ethical Responsibility

Requirements for Designers and Future Technologies

This theme described how designers can become complicit in potentially harmful business practices where profit is prioritized over authentic user needs and societal benefit and their professional skills are employed to lock-in and manipulate consumers. The interview participants described how economic and profitability pressures can outweigh a company's initial altruistic intentions, which can lead to the adoption of addictive user engagement strategies that seek to generate continuous, reliable, long-term revenue streams. These business practices, coupled with rapid technological development cycles and insufficient research, regulation, and user participation, can contribute to the observed risks and unintended negative consequences that are associated with self-tracking technologies. Therefore, the participants called for increased research, regulation, and ethical responsibility requirements for the designers and developers of these technologies. The participants believe that designers must focus on identifying and solving real problems rather than creating artificial needs and using compelling products and persuasive marketing to capitalize on people's fears, vulnerabilities, and maladaptive behaviours. The participants suggested that design education and professional development should place a greater emphasis on ethical research methods and interdisciplinary collaboration to thoughtfully understand the true complexities of design problems. The participants indirectly

called for increased participatory design initiatives that meaningfully involve athletes and individuals with disordered eating behaviours throughout the product design and development process. Finally, the participants advocated for increased education and awareness to inform the public of the known risks associated with self-tracking technologies in relation to disordered eating behaviours, suggesting a range of potential solutions, including warning labels, in-technology educational content, ethical advertising regulations, and safe self-tracking technology guidelines set by governing bodies.

5.3 Interpretation of Findings

The findings from this research project are generally consistent with and expand upon previous quantitative, qualitative, and mixed methods research studies, which identified relationships between digital self-tracking technologies and disordered eating behaviours across multiple populations (Blackstone & Herrmann, 2020; Eikey, 2021; Eikey & Reddy, 2017; Guo et al., 2022; Hahn, Sonneville, et al., 2021; Honary et al., 2019; McCaig et al., 2020; Messer et al., 2021; Moody et al., 2023; Plateau et al., 2018; Simpson & Mazzeo, 2017). These findings provide additional insight into the dynamic user engagement practices associated with digital self-tracking technologies and the complex and interconnected variables that can influence adaptive and maladaptive technology use within athlete populations. These findings extend previous research that challenged conventional binary classifications of digital self-tracking technologies as solely positive or negative (Eikey & Reddy, 2017). Additionally, these findings build upon existing knowledge, providing detailed participant perspectives regarding the predominant physiological, psychological, societal, environmental, and technological risk factors correlated with digital self-tracking technologies and disordered eating behaviours within athlete populations (Grogan, 2021; Mancine et al., 2020; Mountjoy et al., 2023; Petrie & Greenleaf, 2012; Šmahel et al., 2018; Stoyel et al., 2020; Wells et al., 2020). The acknowledgement that these risk factors and unintended negative consequences are generally not recognized or fully understood by designers, technology developers, athletes, or the general public supports previous research findings that suggest the true impact of digital self-tracking technologies and disordered eating behaviours remains unknown or unacknowledged (Ghazzawi et al., 2024; Joy et al., 2016; Lima, 2023; Silén & Keski-Rahkonen, 2022).

The findings that link the over-abundance of complex and decontextualized health and performance data to impaired judgment and the increased susceptibility to disordered eating behaviours provide additional evidence for the concept and consequences of technological optimism discussed within the interpretative theoretical lens (Lima, 2023; Norman, 2023). The participant-identified design criteria and recommendations for addressing the complexity, presentation, and contextualization of health and performance data, including additional research to determine safe, meaningful, and actionable data presentation methods and the integration of user education and support features, are critical findings that build upon previous research (Eikey, 2021; Honary et al., 2019).

The findings related to recognizing control, optimization, and addiction in health and performance data align with Byung-Chul Han's concept of an internally motivated achievement society that can promote and normalize unrealistic and unsustainable personal expectations and lead to self-exploitation and negative health outcomes (Han, 2015). The concept of an achievement society could help to further contextualize the research findings that link unmet self-tracking objectives with negative self-evaluation, severe psychological distress, and the utilization of disordered eating behaviours as strategies to meet these objectives. The findings on the conflicting potential of social media, social networking, and data-sharing features also align with the concept of an achievement society (Han, 2015) and extend prior research (Honary et al., 2019), offering new insights into how these elements can foster unhealthy comparison, excessive competition, unrealistic body image ideals, and disordered eating behaviours within athlete populations. The findings from these two themes advocate for the development of safer self-tracking and user engagement techniques and the integration of improved safety and prevention measures, advancing prior research that identified the harmful potential of self-quantification, goal-setting, gamification, social media, social networking, and data sharing design features (Eikey, 2021; Honary et al., 2019; McCaig et al., 2020). Significant new findings from this research project also included the potentially demotivating and distressing comparisons between previous performance and ability levels that result from the inability of current self-tracking technologies to account for naturally occurring contextual factors, such as the aging process.

The findings related to understanding the impact of self-tracking technologies on personal intuition and internal sensory awareness provide additional evidence for the concept of automation bias, where individuals increasingly trust algorithms, automated systems, and artificial intelligence models over their own knowledge, judgment, and intuition, viewing these technologies as objective tools to evaluate and manage their personal health and wellbeing (Lima, 2023; Norman, 2023). These findings build upon prior athletic performance research (Boldi & Rapp, 2022), providing new and important interdisciplinary perspectives and observations regarding how the excessive reliance on self-tracking technologies can degrade personal intuition, internal sensory awareness, and the sensitivity of interoceptive signals and lead to the formation or reinforcement of disordered eating behaviours. Significant new findings also include important design criteria and recommendations for future technologies, including haptic notifications to identify and disrupt disordered eating behaviours and the integration of user education features to strengthen sensory awareness, develop self-regulation skills, and reduce technology dependency.

The findings related to enhanced user customization and intelligent personalization features present some of the most promising design criteria and recommendations to improve the safety of digital self-tracking technologies and mitigate the potential for disordered eating behaviours. Some of these features, criteria, and recommendations relate to prior research (Eikey, 2021; Flatt & Taylor, 2018; Honary et al., 2019), while others have emerged from advanced research settings investigating the development of future self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours (Bulik et al., 2020; Kilshaw et al., 2022; Presseller et al., 2022, 2023; Ralph-Nearman et al., 2024). The findings from both of these themes provide significant new knowledge to inform the design and development of future technologies. However, the exciting potential of advanced sensors and machine learning to predict, detect, interrupt, and treat disordered eating behaviours is balanced with ethical concerns regarding privacy, surveillance, and consent, which relate to the concepts of disciplinary society, technological optimism, and automation bias (Foucault, 1975/2012; Lima, 2023; Norman, 2023; Tunstall, 2023).

Possibly the most important findings from this research project relate to increased research, regulation, and ethical responsibility requirements for the designers and developers of future digital self-tracking technologies. The interview participants identified important concerns that are consistent with observations from contemporary design

researchers, where human-centred design approaches and critical knowledge from the disciplines of human psychology and cognitive science are increasingly utilized to create intentionally addictive technologies that deliberately exploit, control, and capitalize upon the vulnerabilities, biases, and behaviours of people (Lima, 2023; Norman, 2023). Collectively, these findings support reforms of design education, professional practice, and technology development proposed by several researchers and publications (Eikey, 2021; Graham et al., 2023; Lima, 2023; Norman, 2023; Tunstall, 2023). Within the context of this research project, these reforms would include increased interdisciplinary collaboration and the utilization of ethical research methods to thoughtfully understand the true complexities of design problems and recognize potential negative consequences; increased participatory design initiatives that meaningfully involve athletes and individuals with disordered eating behaviours throughout the product design and development process; and increased education and awareness to inform the public about the known risks associated with digital self-tracking technologies in relation to disordered eating behaviours (Eikey, 2021; Graham et al., 2023; Lima, 2023; Norman, 2023; Tunstall, 2023).

5.4 Limitations

The findings from this research project must be evaluated within the context of the following known limitations. To address the original design problem and research aim, the entire research project, including the interview conversations, data analysis, and resultant findings, purposefully focused on recognizing, understanding, and mitigating the potential risks and unintended negative consequences that are associated with digital self-tracking technologies and disordered eating behaviours in athlete populations. Therefore, the interview participant inclusion criteria may have unintentionally excluded or deterred potential participants who are strong advocates of current digital self-tracking technologies or those who have not observed links between these technologies and disordered eating behaviours in athlete populations. As the semi-structured interview format prioritizes depth of insight over breadth (Knott et al., 2022), the research process was time-consuming, and due to practical constraints, it was not possible to achieve a sample size larger than 10 interview participants. Recognizing the epistemological assumptions of the social constructivism philosophical paradigm, the knowledge generated from the analysis of these semi-structured interview sessions should not be considered universal, context-independent facts but rather situated, socially constructed perspectives (Brinkmann & Kvale, 2018). Additionally, the

flexible nature of the semi-structured interview format, in combination with these epistemological assumptions, means it is impossible to precisely replicate these interview interactions and the resultant findings (Brinkmann & Kvale, 2018; Knott et al., 2022). However, it is important to acknowledge that many of these limitations were anticipated as inherent characteristics of qualitative research and semi-structured interviews (Creswell, 2016; Knott et al., 2022). Finally, while these findings discuss several design criteria and recommendations, some topics require further research to determine user requirements, technical criteria, integration methods, and other specialized information to inform the design and development of safe and ethical future technologies. Some of these further research opportunities will be discussed in the following section.

5.5 Recommendations for Further Research

The following recommendations for further research represent potential pathways to build upon this current research project and the presented findings (Creswell, 2016). These research opportunities were identified directly by the interview participants, determined through the interpretation of the research findings, or developed in response to the limitations of this research project. In accordance with the findings from this research project and prior literature, the following opportunities should seek to integrate participatory design initiatives that meaningfully involve athletes and individuals with disordered eating behaviours throughout the research, design, and development processes (Eikey, 2021; Graham et al., 2023; Lima, 2023; Norman, 2023; Tunstall, 2023).

1. Further longitudinal research studies are needed to investigate the true impact of digital self-tracking technologies, including whether these technologies are actually effective tools to foster positive behaviour change, enhance athletic performance, and improve overall public health—or whether these technologies simply reinforce the existing habits of users who are predisposed to health-conscious behaviours and introduce significant health risks for others.

2. Further research is needed to determine the optimal methods to increase awareness and educate designers, technology developers, athletes, and the general public about the known risks and unintended negative consequences that are associated with current consumer digital self-tracking technologies in relation to disordered eating

behaviours. Potential methods could include warning labels, in-technology educational content, ethical advertising regulations, and safe self-tracking technology guidelines set by governing bodies.

3. Further research is needed to determine the optimal methods to present and contextualize health and performance data in a safe, meaningful, and actionable manner that simultaneously reduces complexity and cognitive strain, mitigates the potential for emotional distress and disordered eating behaviours, and preserves user freedom and personal autonomy. Potential methods could involve the integration of education and support features to help users interpret and contextualize their health and performance data through long-term use and provide actionable information to safely modify their metrics over time.

4. Further research is needed to identify safe self-tracking, user engagement, and data communication methods that are less invasive, less addictive, and less disciplinary. These new methods should address the documented issues associated with self-quantification, goal-setting, and gamification design features as well as the issues with conventional quantitative data presentation methods, such as precise numbers, detailed graphs, and colour-coded progress visualizations, which are known to trigger disordered eating behaviours in some users.

5. Further research is needed to develop improved social networking and data-sharing features that foster the creation of authentic social interaction and support networks while mitigating the potential for unhealthy comparison, excessive competition, unrealistic body image ideals, and the development of disordered eating behaviours. Algorithms could be developed to identify social media and data-sharing content that may be contributing to disordered eating behaviours, and APIs (application programming interfaces) could be used to track user engagement practices across multiple digital applications to develop predictive models and intervention features.

6. Further research is needed to develop future self-tracking technologies that allow users to input contextual information, such as their emotions, interoceptive signals, and lifestyle factors, and utilize this information to supplement sensor data presentation, inform intelligent personalization features, and enhance detection,

intervention, and treatment tools for disordered eating behaviours. These future technologies should also account for dynamic contextual factors such as the aging process and evolving ability levels for long-term users.

7. Further research is needed to explore safe and effective methods to help users reconnect with their bodies, strengthen sensory awareness, understand stress responses, develop self-regulation skills, and ultimately reduce technology dependency. Potential methods could involve the integration of instantaneous heart rate variability sensors and visual and haptic biofeedback features.

8. Further interdisciplinary research is needed to support the design and development of future digital self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours, recognizing the important ethical concerns regarding privacy, surveillance, and consent, in addition to the potential implementation barriers that may be encountered from patients, clinicians, and governing bodies. Current self-tracking technologies could immediately incorporate improved safety and prevention measures that identify and disrupt use patterns commonly associated with disordered eating behaviours such as prolonged dietary restraint and excessive exercise.

9. Further research is needed to explore potential reforms of design education, professional practice, and technology development, including the integration of increased research, regulation, and ethical responsibility requirements for the designers and developers of future digital self-tracking technologies.

5.6 Implications of Findings and Contribution of Research Project

The findings generated from this research project achieve the original research aim and purpose, extending prior research and enhancing our understanding of the complex relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations. The interdisciplinary knowledge and perspectives contained within these findings provide in-depth answers to the original research questions. Specifically, these findings:

1. Identified several unique risk factors that can influence disordered eating behaviours within athlete populations, including key physiological, psychological, societal, environmental, and technological risk factors;

2. Strengthened our understanding of how existing digital self-tracking technologies influence disordered eating behaviours within athlete populations, revealing their potential roles in causation, aggravation, prevention, and treatment;

3. Defined potential design criteria that future digital self-tracking technologies could incorporate to improve safety, reduce unintended negative consequences, and effectively mitigate disordered eating behaviours within athlete populations.

Responding to the original research objective, the collective information embedded within this thesis document serves as a comprehensive design brief to educate the design community about this complex and emerging topic and provides a foundation for further research. Additionally, the findings from this research project could inform the design and development of safe and ethical future digital self-tracking technologies that seek to mitigate disordered eating behaviours in both athlete and general populations.

This research project demonstrates the benefits of integrating interdisciplinary research approaches, philosophy, and theory within a research-based product design and development process. The findings from this research project could benefit several populations, including but not limited to the fields of product design and development, clinical psychology and counselling, health sciences and kinesiology, education and policy development, marketing and advertising, and human-computer interaction.

6.0 Conclusion

The purpose of this Master of Design research project was to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations. Eight primary themes were established from the research findings, which included: (1) observed associations, unintended negative consequences, and potential risk factors; (2) addressing the complexity, presentation, and contextualization of health and performance data; (3) recognizing control, obsession, and addiction in health and performance data; (4) the conflicting potential of social media, social networking, and data-sharing features; (5) understanding the impact of self-tracking technologies on personal intuition and internal sensory awareness; (6) enhanced user customization and intelligent personalization features for improved safety; (7) future self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours; and (8) exploring increased ethical responsibility requirements for designers and future technologies. These comprehensive findings serve to educate the design community about this complex and emerging design problem and provide a foundation for further research to build upon. Furthermore, these findings could be used to inform the design and development of safe and ethical future digital self-tracking technologies that seek to mitigate disordered eating behaviours in both athlete and general populations.

References

Agostino, H., Burstein, B., Moubayed, D., Taddeo, D., Grady, R., Vyver, E., Dimitropoulos, G., Dominic, A., & Coelho, J. S. (2021). Trends in the Incidence of New-Onset Anorexia Nervosa and Atypical Anorexia Nervosa Among Youth During the COVID-19 Pandemic in Canada. *JAMA Network Open, 4*(12), e2137395. https://doi.org/10.1001/jamanetworkopen.2021.37395

Alcaraz-Ibáñez, M., Paterna, A., Sicilia, Á., & Griffiths, M. D. (2020). Morbid exercise behaviour and eating disorders: A meta-analysis. *Journal of Behavioral Addictions, 9*(2), 206–224. https://doi.org/10.1556/2006.2020.00027

American Psychiatric Association. (2022). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed., text rev.). https://doi.org/10.1176/appi.books.9780890425787

American Psychological Association. (2020). *Publication manual of the American psychological association* (7th ed.). American Psychological Association.

Apple. (n.d.). [Images of the Apple Fitness digital application] Apple. Retrieved September 10, 2024, from https://support.apple.com/en-kw/guide/iphone/ipha5dddb411/ios

Berkman, S. (2024). [Images of the Fitbit digital application] The New York Times Wirecutter. Retrieved September 10, 2024, from https://www.nytimes.com/wirecutter/reviews/the-best-fitness-trackers/

Berry, R. A., Driscoll, G., Fuller–Tyszkiewicz, M., & Rodgers, R. F. (2024). Exploring longitudinal relationships between fitness tracking and disordered eating outcomes in college–aged women. *International Journal of Eating Disorders, 57*(7), 1532–1541. https://doi.org/10.1002/eat.24192

Blackstone, S. R., & Herrmann, L. K. (2020). Fitness Wearables and Exercise Dependence in College Women: Considerations for University Health Education Specialists. *American Journal of Health Education, 51*(4), 225–233. https://doi.org/10.1080/19325037.2020.1767004

Blandford, A. (2014, January 1). *Semi-structured qualitative studies.* Interaction Design Foundation - IxDF. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/semi-structured-qualitative-studies

Bobble, T., Krzywinski, J., & Woelfel, C. (2016). A comparison of design process models from academic theory and professional practice. In D. Marjanović, M, Štorga, N. Pavković, N, Bojčetić, & S, Škec (Eds.), *DS 84: Proceedings of the DESIGN 2016 14th International Design Conference,* 1205–1214. The Design Society, Glasgow.

Boldi, A., & Rapp, A. (2022). Quantifying the Body: Body Image, Body Awareness and Self-Tracking Technologies. In: Wac, K., & Wulfovich, S. (eds) Quantifying *Quality of Life. Health Informatics* (pp. 189-207). Springer, Cham. https://doi.org/10.1007/978-3-030-94212-0_9

Branin, J. J. (2022). Improving Work Capacity and HRQoL: The Role of QoL Technologies. In: Wac, K., & Wulfovich, S. (eds) *Quantifying Quality of Life. Health Informatics.* Springer, Cham. https://doi.org/10.1007/978-3-030-94212-0_8

Braun, V., & Clarke, V. (2023). Thematic analysis. In H. Cooper, M. N. Coutanche, L. M. McMullen, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology: Research designs: Quantitative, qualitative, neuropsychological, and biological (Vol. 2) (2nd ed.)*. (pp. 65–81). American Psychological Association. https://doi.org/10.1037/0000319-004

Braun, V., Clarke, V., & Rance, N. (2015). How to use thematic analysis with interview data. In A. Vossler & N. Moller (Eds.), *The Counselling and Psychotherapy Research Handbook*. SAGE. https://doi.org/10.4135/9781473909847

Brinkmann, S., & Kvale, S. (2018). *Doing Interviews* (2nd ed.). SAGE Publications. https://doi.org/10.4135/9781529716665

Bulik, C. M., Butner, J. E., Tregarthen, J., Thornton, L. M., Flatt, R. E., Smith, T., Carroll, I. M., Baucom, B. R. W., & Deboeck, P. R. (2020). The Binge Eating Genetics Initiative (BEGIN): Study protocol. *BMC Psychiatry, 20*(1), 307. https://doi.org/10.1186/s12888-020-02698-7

Ceci, L. (2024, March 4). Leading fitness and sport apps worldwide in January 2024, by revenue. *Statista*. https://www.statista.com/statistics/1239716/top-fitness-and-sport-apps-by-revenue/

Chaves, E., Jeffrey, D. T., & Williams, D. R. (2023). Disordered Eating and Eating Disorders in Pediatric Obesity: Assessment and Next Steps. *International Journal of Environmental Research and Public Health, 20*(17), 6638. https://doi.org/10.3390/ijerph20176638

Colledge, F., Cody, R., Buchner, U. G., Schmidt, A., Pühse, U., Gerber, M., Wiesbeck, G., Lang, U. E., & Walter, M. (2020). Excessive Exercise—A Meta-Review. *Frontiers in Psychiatry, 11*, 521572. https://doi.org/10.3389/fpsyt.2020.521572

Collins, C. S., & Stockton, C. M. (2018). The Central Role of Theory in Qualitative Research. *International Journal of Qualitative Methods*, *17*(1), 160940691879747. https://doi.org/10.1177/1609406918797475

Cotton, J. (2024, January 30). How Off-Season Became Skinny Season for the Perma-Lean Pro Peloton. *VELO*. https://velo.outsideonline.com/road/road-training/how-off-season-became-skinny-season-for-the-perma-lean-pro-peloton/

Creswell, J. W. (2016). *30 essential skills for the qualitative researcher*. SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Cross, N. (2021). Engineering design methods: *Strategies for product design* (5th ed.). John Wiley & Sons, Inc.

Deloitte Access Economics. (2020). The social and economic cost of eating disorders in the United States of America: A report for the strategic training initiative for the prevention of eating disorders and the academy for eating disorders. *Deloitte Access Economics*. https://www.hsph.harvard.edu/striped/report-economic-costs-of-eating-disorders/.

De Moya, J.-F., Pallud, J., & Wamba, S. F. (2021). Impacts of Risks Over Benefits in the Adoption of Self-Tracking Technologies: *Journal of Global Information Management, 29*(6), 1–46. https://doi.org/10.4018/JGIM.20211101.oa10

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The SAGE handbook of qualitative research* (5th ed.). SAGE.

Eating Disorder Support Network of Alberta. (2023, May 6). Eating Disorders Awareness and Risk Mitigation in the Fitness Industry. http://edsna.ca/

Eikey, E. V. (2021). Effects of diet and fitness apps on eating disorder behaviours: Qualitative study. *BJPsych Open, 7(*5), e176. https://doi.org/10.1192/bjo.2021.1011

Eikey, E. V., & Reddy, M. C. (2017). "It's Definitely Been a Journey": A Qualitative Study on How Women with Eating Disorders Use Weight Loss Apps. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 642–654. https://doi.org/10.1145/3025453.3025591

Feng, S., Mäntymäki, M., Dhir, A., & Salmela, H. (2021). How Self-tracking and the Quantified Self Promote Health and Well-being: Systematic Review. *Journal of Medical Internet Research, 23*(9), e25171. https://doi.org/10.2196/25171

Flatt, R. E., & Taylor, C. B. (2018). Adapting a Technology-Based Eating Disorder Model for Athletes. *Journal of Clinical Sport Psychology, 12*(4), 699–717. https://doi.org/10.1123/jcsp.2018-0015

Foucault, M. (2012). *Discipline and punish: The birth of the prison* (A. Sheridan, Trans.; 2nd ed.). Vintage. (Original work published 1975)

Frayling, C. (1993). Research in Art and Design. *Royal College of Art Research Papers*, *1*(1). https://researchonline.rca.ac.uk/384/

Fry, T. (2009). *Design futuring: Sustainability, ethics, and new practice.* Berg.

Galdon, F., & Hall, A. (2022). (Un)Frayling design research in design education for the 21Cth. *The Design Journal*, *25*(6), 915–933. https://doi.org/10.1080/14606925.2022.2112861

Ghazzawi, H. A., Nimer, L. S., Haddad, A. J., Alhaj, O. A., Amawi, A. T., Pandi-Perumal, S. R., Trabelsi, K., Seeman, M. V., & Jahrami, H. (2024). A systematic review, meta-analysis, and meta-regression of the prevalence of self-reported disordered eating and associated factors among athletes worldwide. *Journal of Eating Disorders, 12*(1), 24. https://doi.org/10.1186/s40337-024-00982-5

Gittus, M., Fuller-Tyszkiewicz, M., Brown, H. E., Richardson, B., Fassnacht, D. B., Lennard, G. R., Holland, E., & Krug, I. (2020). Are Fitbits implicated in body image concerns and disordered eating in women? *Health Psychology, 39*(10), 900–904. https://doi.org/10.1037/hea0000881

Google. (n.d.). *Design Sprint Methodology*. Design Sprints. https://designsprintkit.withgoogle.com/methodology/overview

Graham, A. K., Kosmas, J. A., & Massion, T. A. (2023). Designing Digital Interventions for Eating Disorders. *Current Psychiatry Reports, 25*(4), 125–138. https://doi.org/10.1007/s11920-023-01415-x

Grogan, S. (2021). *Body Image: Understanding Body Dissatisfaction in Men, Women, and Children* (4th ed.). Routledge. https://doi.org/10.4324/9781003100041

Guo, L., Gu, L., Peng, Y., Gao, Y., Mei, L., Kang, Q., Chen, C., Hu, Y., Xu, W., & Chen, J. (2022). Online media exposure and weight and fitness management app use correlate with disordered eating symptoms: Evidence from the mainland of China. *Journal of Eating Disorders, 10*(1), 58. https://doi.org/10.1186/s40337-022-00577-y

Hahn, S. L., Hazzard, V. M., Loth, K. A., Larson, N., Klein, L., & Neumark-Sztainer, D. (2022). Using apps to self-monitor diet and physical activity is linked to greater use of disordered eating behaviors among emerging adults. *Preventive Medicine*, *155*, 106967. https://doi.org/10.1016/j.ypmed.2022.106967

Hahn, S. L., Kaciroti, N., Eisenberg, D., Weeks, H. M., Bauer, K. W., & Sonneville, K. R. (2021). Introducing Dietary Self-Monitoring to Undergraduate Women via a Calorie Counting App Has No Effect on Mental Health or Health Behaviors: Results From a Randomized Controlled Trial. *Journal of the Academy of Nutrition and Dietetics*, *121*(12), 2377–2388. https://doi.org/10.1016/j.jand.2021.06.311

Hahn, S. L., Sonneville, K. R., Kaciroti, N., Eisenberg, D., & Bauer, K. W. (2021). Relationships between patterns of technology-based weight-related self-monitoring and eating disorder behaviors among first year university students. *Eating Behaviors*, *42*, 101520. https://doi.org/10.1016/j.eatbeh.2021.101520

Han, B.-C. (2015). *The Burnout Society* (E. Butler, Trans.). Stanford University Press.

Holloway, I., & Brown, L. (2012). *Essentials of a qualitative doctorate*. Left Coast Press.

Honary, M., Bell, B. T., Clinch, S., Wild, S. E., & McNaney, R. (2019). Understanding the Role of Healthy Eating and Fitness Mobile Apps in the Formation of Maladaptive Eating and Exercise Behaviors in Young People. *JMIR mHealth and uHealth, 7*(6), e14239. https://doi.org/10.2196/14239

Joy, E., Kussman, A., & Nattiv, A. (2016). 2016 update on eating disorders in athletes: A comprehensive narrative review with a focus on clinical assessment and management. *British Journal of Sports Medicine, 50*(3), 154–162. https://doi.org/10.1136/bjsports-2015-095735

Kilshaw, R. E., Adamo, C., Butner, J. E., Deboeck, P. R., Shi, Q., Bulik, C. M., Flatt, R. E., Thornton, L. M., Argue, S., Tregarthen, J., & Baucom, B. R. W. (2022). Passive Sensor Data for Characterizing States of Increased Risk for Eating Disorder Behaviors in the Digital Phenotyping Arm of the Binge Eating Genetics Initiative: Protocol for an Observational Study. *JMIR Research Protocols, 11*(6), e38294. https://doi.org/10.2196/38294

Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in the social sciences. *Nature Reviews Methods Primers*, *2*(1), 73. https://doi.org/10.1038/s43586-022-00150-6

Laricchia, F. (2024a, January 10). Fitness trackers—Statistics & facts. *Statista*. https://www.statista.com/topics/4393/fitness-and-activity-tracker/#topicOverview

Laricchia, F. (2024b, April 26). Quarterly smartwatch unit shipment share worldwide from 2018 to 2023, by vendor. *Statista*. https://www.statista.com/statistics/910862/worldwide-smartwatch-shipment-market-share/

Laricchia, F. (2024c, May 22). Global wearable device shipments from 2021 to 2028, by product category. *Statista*. https://www.statista.com/statistics/1265326/wearables-worldwide-shipments-quarterly-by-product-category/

Levinson, C. A., Fewell, L., & Brosof, L. C. (2017). My Fitness Pal calorie tracker usage in the eating disorders. *Eating Behaviors, 27*, 14–16. https://doi.org/10.1016/j.eatbeh.2017.08.003

Lima, M. (2023). *The new designer: Rejecting myths, embracing change*. The MIT Press.

Linardon, J., & Messer, M. (2019). My fitness pal usage in men: Associations with eating disorder symptoms and psychosocial impairment. *Eating Behaviors, 33*, 13–17. https://doi.org/10.1016/j.eatbeh.2019.02.003

Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2018). Paradigmatic controversies, contradictions, and emerging confluences, revisited. In Denzin, N. K., & Lincoln, Y. S. (Eds.), *The SAGE handbook of qualitative research* (5th ed.). SAGE.

Mancine, R. P., Gusfa, D. W., Moshrefi, A., & Kennedy, S. F. (2020). Prevalence of disordered eating in athletes categorized by emphasis on leanness and activity type – a systematic review. *Journal of Eating Disorders, 8*(1), 47. https://doi.org/10.1186/s40337-020-00323-2

Martin, B., & Hanington, B. (2019). *Universal methods of design: 125 ways to research complex problems, develop innovative ideas, and design effective solutions* (2nd ed.). Rockport.

McCaig, D., Elliott, M. T., Prnjak, K., Walasek, L., & Meyer, C. (2020). Engagement with MyFitnessPal in eating disorders: Qualitative insights from online forums. *International Journal of Eating Disorders, 53*(3), 404–411. https://doi.org/10.1002/eat.23205

Messer, M., McClure, Z., Norton, B., Smart, M., & Linardon, J. (2021). Using an app to count calories: Motives, perceptions, and connections to thinness- and muscularity-oriented disordered eating. *Eating Behaviors, 43*, 101568. https://doi.org/10.1016/j.eatbeh.2021.101568

Milton, A., & Rodgers, P. A. (2013). *Research methods for product design*. Laurence King Publishing.

Mond, J., & Gorrell, S. (2021). "Excessive exercise" in eating disorders research: Problems of definition and perspective. *Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity, 26*(4), 1017–1020. https://doi.org/10.1007/s40519-020-01075-3

Moody, S., Ross, L., Opitz, M.-C., Hemmings, A., İnce, B., Kuehne, C., Phillips, M., Schmidt, U., & Sharpe, H. (2023). *Associations between the use of fitness and diet tracking technology and disordered eating behaviour: A systematic review.* OSF Preprints. https://doi.org/10.31219/osf.io/8c75k

Mountjoy, M., Ackerman, K. E., Bailey, D. M., Burke, L. M., Constantini, N., Hackney, A. C., Heikura, I. A., Melin, A., Pensgaard, A. M., Stellingwerff, T., Sundgot-Borgen, J. K., Torstveit, M. K., Jacobsen, A. U., Verhagen, E., Budgett, R., Engebretsen, L., & Erdener, U. (2023). 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). *British Journal of Sports Medicine, 57*(17), 1073–1098. https://doi.org/10.1136/bjsports-2023-106994

Muratovski, G., Friedman, K. S., Norman, D. A., & Heller, S. (2022). *Research for designers: A guide to methods and practice*. SAGE Publications.

Murray, S. B., Nagata, J. M., Griffiths, S., Calzo, J. P., Brown, T. A., Mitchison, D., Blashill, A. J., & Mond, J. M. (2017). The enigma of male eating disorders: A critical review and synthesis. *Clinical Psychology Review, 57*, 1–11. https://doi.org/10.1016/j.cpr.2017.08.001

Nagata, J. M., Murray, S. B., Bibbins–Domingo, K., Garber, A. K., Mitchison, D., & Griffiths, S. (2019). Predictors of muscularity–oriented disordered eating behaviors in U.S. young adults: A prospective cohort study. *International Journal of Eating Disorders, 52*(12), 1380–1388. https://doi.org/10.1002/eat.23094

Norman, D. A. (2023). *Design for a better world: Meaningful, sustainable, humanity centered.* The MIT Press.

Pabel, A., Pryce, J., & Anderson, A. (Eds.). (2021). *Research Paradigm Considerations for Emerging Scholars*. Channel View Publications. https://doi.org/10.21832/PABEL8274

Petrie, T. A., & Greenleaf, C. (2012). Eating Disorders in Sport. In S. M. Murphy (Ed.), *The Oxford Handbook of Sport and Performance Psychology* (1st ed., pp. 635–659). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199731763.013.0034

Plateau, C. R., Bone, S., Lanning, E., & Meyer, C. (2018). Monitoring eating and activity: Links with disordered eating, compulsive exercise, and general wellbeing among young adults. *International Journal of Eating Disorders, 51*(11), 1270–1276. https://doi.org/10.1002/eat.22966

Presseller, E. K., Lampe, E. W., Zhang, F., Gable, P. A., Guetterman, T. C., Forman, E. M., & Juarascio, A. S. (2023). Using Wearable Passive Sensing to Predict Binge Eating in Response to Negative Affect Among Individuals With Transdiagnostic Binge Eating: Protocol for an Observational Study. *JMIR Research Protocols, 12*, e47098. https://doi.org/10.2196/47098

Presseller, E. K., Patarinski, A. G. G., Fan, S. C., Lampe, E. W., & Juarascio, A. S. (2022). Sensor technology in eating disorders research: A systematic review. *International Journal of Eating Disorders, 55*(5), 573–624. https://doi.org/10.1002/eat.23715

Ralph-Nearman, C., Sandoval-Araujo, L. E., Karem, A., Cusack, C. E., Glatt, S., Hooper, M. A., Rodriguez Pena, C., Cohen, D., Allen, S., Cash, E. D., Welch, K., & Levinson, C. A. (2024). Using machine learning with passive wearable sensors to pilot the detection of eating disorder behaviors in everyday life. *Psychological Medicine, 54*(6), 1084–1090. https://doi.org/10.1017/S003329172300288X

Rapp, A., & Tirabeni, L. (2020). Self-tracking while doing sport: Comfort, motivation, attention and lifestyle of athletes using personal informatics tools. *International Journal of Human-Computer Studies, 140*, 102434. https://doi.org/10.1016/j.ijhcs.2020.102434

Ridley, D. (2012). *The literature review: A step-by-step guide for students* (2nd ed.). Sage.

Samsung. (2022, September 29). *Galaxy Watch5: See how your body improves | Samsung* [Video]. YouTube. https://www.youtube.com/watch?v=1R8nEGVVOCM

Sanders, E. B.-N., & Stappers, P. J. (2012). *Convivial design toolbox: Generative research for the front end of design*. BIS.

Schaumberg, K., Anderson, D. A., Anderson, L. M., Reilly, E. E., & Gorrell, S. (2016). Dietary restraint: What's the harm? A review of the relationship between dietary restraint, weight trajectory and the development of eating pathology. *Clinical Obesity, 6*(2), 89–100. https://doi.org/10.1111/cob.12134

Scheid, J. L., & Lupien, S. P. (2021). Fitness Watches and Nutrition Apps: Behavioral Benefits and Emerging Concerns. *ACSM'S Health & Fitness Journal, 25*(2), 21–25. https://doi.org/10.1249/FIT.0000000000000644

Silén, Y., & Keski-Rahkonen, A. (2022). Worldwide prevalence of DSM-5 eating disorders among young people. *Current Opinion in Psychiatry, 35*(6), 362–371. https://doi.org/10.1097/YCO.0000000000000818

Simonsen, J., Bærenholdt, J. O., Büscher, M., & Scheur, J. D. (Eds.). (2010). *Design research: Synergies from interdisciplinary perspectives*. Routledge.

Simpson, C. C., & Mazzeo, S. E. (2017). Calorie counting and fitness tracking technology: Associations with eating disorder symptomatology. *Eating Behaviors, 26*, 89–92. https://doi.org/10.1016/j.eatbeh.2017.02.002

Šmahel, D., Macháčková, H., Šmahelová, M., Čevelíček, M., Almenara, C. A., & Holubčíková, J. (2018). *Digital Technology, Eating Behaviors, and Eating Disorders.* Springer International Publishing. https://doi.org/10.1007/978-3-319-93221-7

Smus, B. (2023, October 25). *The Burnout Society by Byung-Chul Han*. Boris Smus Interaction Engineering. https://smus.com/books/the-burnout-society-by-byung-chul-han/

Statista Research Department. (2023a, November 16). Revenue of mobile apps worldwide 2019-2027, by segment. *Statista*. https://www.statista.com/forecasts/1262892/mobile-app-revenue-worldwide-by-segment

Statista Research Department. (2023b, November 23). Revenue of the digital fitness & well-being device market worldwide from 2019 to 2028, by segment. *Statista*. https://www.statista.com/forecasts/1314353/worldwide-digital-fitness-and-well-being-device-market-revenue-by-segment

Statista Research Department. (2024, February 22). Number of users in the Digital Fitness & Well-Being market for different segments Worldwide from 2017 to 2027. *Statista*. https://www.statista.com/forecasts/1443010/number-of-users-digital-fitness-well-being-market-for-different-segments-worldwide

Stoyel, H., Shanmuganathan-Felton, V., Meyer, C., & Serpell, L. (2020). Psychological risk indicators of disordered eating in athletes. *PLOS ONE, 15*(5), e0232979. https://doi.org/10.1371/journal.pone.0232979

Sullivan, C. (2018). Theory and method in qualitative psychology. In Sullivan, C., & Forrester, M. A. (Eds.), *Doing qualitative research in psychology: A practical guide* (2nd ed.). SAGE Publications.

Sullivan, C., & Forrester, M. A. (Eds.). (2018). *Doing qualitative research in psychology: A practical guide* (2nd ed.). SAGE Publications.

Sutton, A., Clowes, M., Preston, L., & Booth, A. (2019). Meeting the review family: Exploring review types and associated information retrieval requirements. *Health Information & Libraries Journal, 36*(3), 202–222. https://doi.org/10.1111/hir.12276

Taylor, C. B., Graham, A. K., Flatt, R. E., Waldherr, K., & Fitzsimmons-Craft, E. E. (2021). Current state of scientific evidence on Internet-based interventions for the treatment of depression, anxiety, eating disorders and substance abuse: An overview of systematic reviews and meta-analyses. *European Journal of Public Health, 31*(Issue Supplement_1), i3–i10. https://doi.org/10.1093/eurpub/ckz208

Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a Qualitative Research Approach. *Journal of Graduate Medical Education, 7*(4), 669–670. https://doi.org/10.4300/JGME-D-15-00414.1

Thomas, D., & Hodges, I. (2010). *Designing and managing your research project: Core skills for social and health research.* SAGE Publications. https://doi.org/10.4135/9781446289044

Tunstall, E. (2023). *Decolonizing design: A cultural justice guidebook.* The MIT Press.

Ulrich, K. T., Eppinger, S. D., & Yang, M. C. (2020). *Product design and development* (7th ed.). McGraw-Hill Education.

Wells, K. R., Jeacocke, N. A., Appaneal, R., Smith, H. D., Vlahovich, N., Burke, L. M., & Hughes, D. (2020). The Australian Institute of Sport (AIS) and National Eating Disorders Collaboration (NEDC) position statement on disordered eating in high performance sport. *British Journal of Sports Medicine, 54*(21), 1247–1258. https://doi.org/10.1136/bjsports-2019-101813

Williams, M. (2024). [Photograph of wearable fitness tracking devices]. The New York Times Wirecutter. Retrieved September 10, 2024, from https://www.nytimes.com/wirecutter/reviews/the-best-fitness-trackers/

Wons, O., Lampe, E., Patarinski, A. G., Schaumberg, K., Butryn, M., & Juarascio, A. (2022). Perceived influence of wearable fitness trackers on eating disorder symptoms in a clinical transdiagnostic binge eating and restrictive eating sample. *Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity, 27*(8), 3367–3377. https://doi.org/10.1007/s40519-022-01466-8

Appendix A: Research Ethics Application

UNIVERSITY OF ALBERTA | ARISE Alberta Research Information Services

Date: Sunday, September 1, 2024 5:42:20 PM Print Close

Table of Contents

ID: Pro00125375 **Pro00125375** 1.1 Study Identification
Status: Approved

1.1 Study Identification

Please answer all relevant questions that will reasonably help to describe your study or proposed research.

1.0 * **Short Study Title** *(restricted to 100 characters)*:
Design research to inform future wearable health tracking devices which address body dissatisfaction and disordered eating behaviours in fitness athlete populations.

2.0 * **Complete Study Title** *(can be exactly the same as short title)*:
Design research to inform future wearable health tracking devices and associated digital applications which address body dissatisfaction and disordered eating behaviours in fitness athlete populations.

3.0 * **Select the appropriate Research Ethics Board (***Detailed descriptions are available at here***):**
Research Ethics Board 1

4.0 * **Is the proposed research:**
Unfunded

5.0 * **Name of local Principal Investigator:**
Michael Peel

6.0 * **Type of research/study:**
Graduate Student

7.0 * **Institutional Affiliation:**

8.0 **Investigator's Supervisor***(required for applications from undergraduate students, graduate students, post-doctoral fellows and medical residents to REBs 1 & 2. HREB does not accept applications from student PIs)*:
Aidan Rowe

9.0 **Study Coordinators or Research Assistants:** People listed here can edit this application and will receive all email notifications for the study:

Name	Employer

There are no items to display

10.0 **Co-Investigators:** People listed here can edit this application and will receive email notifications *(Co-investigators who do not wish to receive email, should be added to the study team below instead of here).*
If your searched name does not come up when you type it in the box, the user does not have the Principal Investigator role in the online system. Click the following link for instructions on how to Request an Additional Role.

Name	Employer

There are no items to display

11.0 **Primary Admin Contact** *(a member of study team)*:
Michael Peel

12.0 **Study Team:** *(co-investigators, supervising team, and other study team members) - People listed here cannot view or edit this application and do not receive email notifications.*

Last Name	First Name	Organization	Role/Area of Responsibility	Phone	Email

There are no items to display

ID: Pro00125375 **Pro00125375** 1.4 Conflict of Interest
Status: Approved

1.4 Conflict of Interest

1.0 * **Are any of the investigators or their immediate family receiving any personal remuneration (including investigator payments and recruitment incentives but excluding trainee remuneration or graduate student stipends) from the funding of this study that is not accounted for in the study budget?**
○ Yes ● **No**

2.0 * **Do any of investigators or their immediate family have any proprietary interests in the product under study or the outcome of the research including patents, trademarks, copyrights, and licensing agreements?**
○ Yes ● **No**

3.0 * **Is there any compensation for this study that is affected by the study outcome?**
○ Yes ● **No**

4.0 * **Do any of the investigators or their immediate family have equity interest in the sponsoring company? (This does not include Mutual Funds)**
○ Yes ● **No**

5.0 * **Do any of the investigators or their immediate family receive payments of other sorts, from this sponsor (i.e. grants, compensation in the form of equipment or supplies, retainers for ongoing consultation and honoraria)?**
○ Yes ● **No**

6.0 * **Are any of the investigators or their immediate family, members of the sponsor's Board of Directors, Scientific Advisory Panel or comparable body?**
○ Yes ● **No**

7.0 * **Do you have any other relationship, financial or non-financial, that, if not disclosed, could be construed as a conflict of interest?**
○ Yes ● **No**

Please explain if the answer to any of the above questions is Yes:
N/A

Important
If you answered YES to any of the questions above, you may be asked for more information.

ID: Pro00125375 **Pro00125375**
Status: Approved 1.5 Research Locations and Other Approvals

1.5 Research Locations and Other Approvals

1.0 * **List the locations of the proposed research, including recruitment activities. Provide name of institution, facility or organization, town, or province as applicable**
In-person expert interviews will be conducted on-campus at the University

of Alberta (Edmonton, AB). Remote expert interviews will be conducted online using video conferencing solutions (Zoom, Google Meet, etc.).

2.0 * **Indicate if the study will use or access facilities, programmes, resources, staff, students, specimens, patients or their records, at any of the sites affiliated with the following** *(select all that apply):*
Not applicable

List all health care research sites/locations:
N/A

3.0 **Multi-Institution Review**

* **3.1 Has this study already received approval from another REB?**
○ **Yes** ● **No**

4.0 **If this application is closely linked to research previously approved by one of the University of Alberta REBs or has already received ethics approval from an external ethics review board(s), provide the study number, REB name or other identifying information. Attach any external REB application and approval letter in the Documentation Section – Other Documents.**
N/A

ID: Pro00125375 **Pro00125375** 2.1 Study Objectives and Design
Status: Approved

2.1 Study Objectives and Design

1.0 * **Provide a lay summary of your proposed research which would be understandable to general public**

This research study will conduct expert interviews to better understand the relationship between wearable health tracking devices (e.g. Apple Watch, Fitbit, etc.) and their associated digital applications, and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information could then be used to inform the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate these potentially life-threatening behaviours.

2.0 * **Provide a full description of your research proposal outlining the following:**

- **Purpose**
- **Hypothesis**
- **Justification**
- **Objectives**
- **Research Method/Procedures**
- **Plan for Data Analysis**

Purpose

The purpose of this research study is to better understand the relationship between wearable health tracking devices (e.g. Apple Watch, Fitbit, etc.) and their associated digital applications, and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information could then be used to inform the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate these potentially life-threatening behaviours.

Hypothesis

Cardiovascular activity and resistance training are generally linked to improved mental and physical health for most individuals (Westcott, 2012; Wewege et al., 2018). However, some fitness athletes may experience negative mental and physical health consequences, including body dissatisfaction and disordered eating behaviours, as a result of specific body image expectations and athletic performance objectives associated

with these activities (Devrim et al., 2018; Joy et al., 2016; Whitehead et al., 2020).

Wearable health tracking devices and associated digital applications can be useful tools for athletes (Boldi & Rapp, 2022; Rapp & Tirabeni, 2020), however these products may also promote body dissatisfaction (Edwards, 2017) and disordered eating behaviours (Simpson & Mazzeo, 2017) for some users. Therefore, wearable health tracking devices and associated digital applications have the potential to improve, and to degrade, the mental and physical health of users.

I believe the conflicting potential of these products presents several distinct design challenges. To address these design challenges I believe user research is required to better understand the unique perspectives of fitness athletes who are experiencing body dissatisfaction and disordered eating behaviours. This information could then be used to inform the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate these potentially life-threatening behaviours.

Justification

This research study is relevant because body dissatisfaction and disordered eating behaviours can degrade a person's mental and physical health and may lead to potentially life-threatening conditions (Joy et al., 2016). According to the National Initiative for Eating Disorders (2020) approximately 1 million Canadians currently have a diagnosed eating disorder. Additionally, eating disorders have the highest overall mortality rate of any mental illness with suicide and cardiac disease as the primary causes of death (National Initiative for Eating Disorders, 2020). Therefore, research and development which seeks to address these behaviours and their underlying causes is of critical importance for the health and well-being of these individuals.

Objectives

This research study has the following objectives:

1. To better understand the features and limitations of existing wearable health tracking devices and associated digital applications.
2. To better understand the unique perspectives of fitness athletes who are experiencing body dissatisfaction and disordered eating behaviours, including the predominate psychological, physiological, societal, and environmental factors.
3. To establish the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate body dissatisfaction and disordered eating behaviours.

Research Method/Procedures

This research study will utilize the following methods and procedures:

1. Literature Review: Examination of existing research related to fitness athletes, body dissatisfaction, disordered eating behaviours, wearable health tracking devices, human centered design, and associated topics to establish a foundation of knowledge for further research.
2. Technology Review: Examination of existing wearable health tracking devices and associated digital applications to better understand their capabilities and limitations.
3. Expert Interviews: Semi-structured interviews to gain qualitative information from academic, professional, and lifestyle experts within the fields of health & fitness, psychology & counselling, nutrition & food science, design & engineering, human-computer interaction, and associated disciplines.
4. Design Criteria: Analysis of all research sources to inform the physical and experiential design criteria for future wearable health tracking devices and associated digital applications.

Plan for Data Analysis

Expert Interviews: The qualitative information from the expert interviews will be recorded, transcribed, coded for themes, and summarized.

References

Boldi, A., Rapp, A. (2022). Quantifying the Body: Body Image, Body Awareness and Self-Tracking Technologies. In: Wac, K., Wulfovich, S. (eds) *Quantifying Quality of Life. Health Informatics* (pp. 189-207). Springer, Cham. https://doi.org/10.1007/978-3-030-94212-0_9

Devrim, A., Bilgic, P., & Hongu, N. (2018). Is There Any Relationship Between Body Image Perception, Eating Disorders, and Muscle Dysmorphic Disorders in Male Bodybuilders? *American Journal of Men's Health, 12*(5), 1746–1758. https://doi.org/10.1177/1557988318786868

Edwards, A. (2017). The impact of body image on Fitbit use: A comparison across genders. *Health Information & Libraries Journal, 34*(3), 247–251. https://doi.org/10.1111/hir.12188

Joy, E., Kussman, A., & Nattiv, A. (2016). 2016 update on eating disorders in athletes: A comprehensive narrative review with a focus on clinical assessment and management. *British Journal of Sports Medicine, 50*(3), 154–162. https://doi.org/10.1136/bjsports-2015-095735

National Initiative for Eating Disorders. (2020). *Eating Disorders in Canada.* NIED. https://nied.ca/about-eating-disorders-in-canada/

Rapp, A., & Tirabeni, L. (2020). Self-tracking while doing sport: Comfort, motivation, attention and lifestyle of athletes using personal informatics tools. *International Journal of Human-Computer Studies, 140*, 102434. https://doi.org/10.1016/j.ijhcs.2020.102434

Simpson, C. C., & Mazzeo, S. E. (2017). Calorie counting and fitness tracking technology: Associations with eating disorder symptomatology. *Eating Behaviors, 26*, 89–92. https://doi.org/10.1016/j.eatbeh.2017.02.002

Westcott, W. L. (2012). Resistance Training is Medicine: Effects of Strength Training on Health. *Current Sports Medicine Reports, 11*(4), 209–216. https://doi.org/10.1249/JSR.0b013e31825dabb8

Wewege, M. A., Thom, J. M., Rye, K.-A., & Parmenter, B. J. (2018). Aerobic, resistance or combined training: A systematic review and meta-analysis of exercise to reduce cardiovascular risk in adults with metabolic syndrome. *Atherosclerosis, 274*, 162–171. https://doi.org/10.1016/j.atherosclerosis.2018.05.002

Whitehead, J., Slater, G., Wright, H., Martin, L., O'Connor, H., & Mitchell, L. (2020). Disordered eating behaviours in female physique athletes. *European Journal of Sport Science, 20*(9), 1206–1214. https://doi.org/10.1080/17461391.2019.1698659

3.0 **Describe procedures, treatment, or activities that are above or in addition to standard practices in this study area** *(eg. extra medical or health-related procedures, curriculum enhancements, extra follow-up, etc)*:
N/A

4.0 **If the proposed research is above minimal risk and is not funded via a competitive peer review grant or industry-sponsored clinical trial, the REB will require evidence of scientific review. Provide information about the review process and its results if appropriate.**
N/A

5.0 **For clinical trials, describe any sub-studies associated with this Protocol.**
N/A

ID: Pro00125375 **Pro00125375**
Status: Approved 2.2 Research Methods and Procedures

2.2 Research Methods and Procedures

Some research methods prompt specific ethical issues. The methods listed below have additional questions associated with them in this application. If your research does not involve any of the methods listed below, ensure that your proposed research is adequately

described in Section 2.1: Study Objectives and Design or attach documents in the Documentation Section if necessary.

1.0 * **This study will involve the following***(select all that apply)*
Interviews and/or Focus Groups

NOTE 1: Select this if you are directly collecting health information as part of your protocol OR will be conducting a chart/record review/reviewing health data secondarily. This includes anonymized or identifiable health information.

NOTE 2: Select this option if this research ONLY involves analysis of blood/tissue/specimens originally collected for another purpose but now being used to answer your research question. If you are enrolling people into the study to prospectively collect specimens to analyze you SHOULD NOT select this box.

NOTE 3: This section is intended to reflect the secondary use of non-health data. Do NOT select this if you are using data that originally came from health sources, i.e., anonymized administrative data.

ID: Pro00125375 **Pro00125375** 2.5 Interview and/or Focus Groups
Status: Approved

2.5 Interview and/or Focus Groups

1.0 **Will you conduct interviews, focus groups, or both? Provide detail.**
This research study will conduct semi-structured interviews to gain qualitative information from academic, professional, and lifestyle experts within the fields of health & fitness, psychology & counselling, nutrition & food science, design & engineering, human-computer interaction, and associated disciplines.

2.0 **How will participation take place (e.g. in-person, via phone, email, Skype)?**
The interviews will be conducted in-person and online through video conferencing solutions (Zoom, Google Meet, etc.).

3.0 **How will the data be collected (e.g. audio recording, video recording, field notes)?**
The interview data will be collected through audio recording and field notes.

ID: Pro00125375 **Pro00125375** 3.1 Risk Assessment
Status: Approved

3.1 Risk Assessment

1.0 * **Provide your assessment of the risks that may be associated with this research:**
Minimal Risk - research in which the probability and magnitude of possible harms implied by participation is no greater than those encountered by participants in those aspects of their everyday life that relate to the research (TCPS2)

2.0 * **Select all that might apply:**

Description of Possible Physical Risks and Discomforts	
No	Participants might feel physical fatigue, e.g. sleep deprivation
No	Participants might feel physical stress, e.g. cardiovascular stress tests
No	Participants might sustain injury, infection, and intervention side-effects or complications

No	The physical risks will be greater than those encountered by the participants in everyday life

Possible Psychological, Emotional, Social and Other Risks and Discomforts	
Possibly	Participants might feel psychologically or emotionally stressed, demeaned, embarrassed, worried, anxious, scared or distressed, e.g. description of painful or traumatic events
No	Participants might feel psychological or mental fatigue, e.g intense concentration required
No	Participants might experience cultural or social risk, e.g. loss of privacy or status or damage to reputation
No	Participants might be exposed to economic or legal risk, for instance non-anonymized workplace surveys
No	The risks will be greater than those encountered by the participants in everyday life

3.0 * **Provide details of all the risks and discomforts associated with the research for which you indicated YES or POSSIBLY above.**
The research study participants may experience emotional discomfort discussing the topics of body dissatisfaction and disordered eating behaviours. The sensitive nature of these topics may trigger traumatic memories and cause anxiety and embarrassment.

4.0 * **Describe how you will manage and minimize risks and discomforts, as well as mitigate harm:**
To decrease the potential for emotional discomfort the following strategies will be used: Participants will be notified of the interview subject matter prior to participation. Participants may stop the research activities at anytime without consequence. Participants will be supplied with mental health phone numbers and internet links.

5.0 **Is there a possibility that your research procedures will lead to unexpected findings, adverse reactions, or similar results that may require follow-up** *(i.e. individuals disclose that they are upset or distressed during an interview/questionnaire, unanticipated findings on MRI, etc.)***?**
● **Yes** ○ No

Describe the arrangements or referral the researcher will make. Explain if no arrangements have been made.
The research study participants will be supplied with mental health resources including phone numbers and internet links. Beyond these supplied resources, no further follow-up arrangements have been made.

6.0 **If you are using any tests in this study diagnostically, indicate the member(s) of the study team who will administer the measures/instruments:**

Test Name	Test Administrator	Organization	Administrator's Qualification
There are no items to display			

7.0 **If any research related procedures/tests could be interpreted diagnostically, will these be reported back to the participants and if so, how and by whom?**
N/A

ID: Pro00125375 **Pro00125375** 3.2 Benefits Analysis
Status: Approved

3.2 Benefits Analysis

1.0 * **Describe any potential benefits of the proposed research to the participants. If there are no benefits, state this explicitly:**
This research study provides no benefits to the participants.

2.0 * **Describe the scientific and/or scholarly benefits of the proposed research:**
This research study could have the following scientific and/or scholarly

benefits:

1. Increased information regarding the features and limitations of existing wearable health tracking devices and associated digital applications.

2. Increased information regarding the unique perspectives of fitness athletes who are experiencing body dissatisfaction and disordered eating behaviours, including the predominate psychological, physiological, societal, and environmental factors.

3. Increased information regarding the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate body dissatisfaction and disordered eating behaviours.

3.0 **If this research involves risk to participants explain how the benefits outweigh the risks.**
This research study involves minimal risk to the participants.

ID: Pro00125375 **Pro00125375** 4.1 Participant Information
Status: Approved

4.1 Participant Information

1.0 * **Will you be recruiting human participants** *(i.e. enrolling people into the study, sending people online surveys to complete)***?**
● **Yes** ○ No

1.1 Will participants be recruited or their data be collected from Alberta Health Services or Covenant Health or data custodian as defined in the Alberta Health Information Act?
○ Yes ● **No**

ID: Pro00125375 **Pro00125375** 4.2 Additional Participant Information
Status: Approved

4.2 Additional Participant Information

1.0 **Describe the participants that will be included in this study. Outline ALL participants** *(i.e. if you are enrolling healthy controls as well):*

Expert Interview Participants: Academic, professional, and lifestyle experts within the fields of health & fitness, psychology & counselling, nutrition & food science, design & engineering, human-computer interaction, and associated disciplines.

2.0 * **Describe and justify the inclusion criteria for participants** *(e.g. age range, health status, gender, etc.):*

Expert Interview Participants: Academic, professional, and lifestyle experts within the fields of health & fitness, psychology & counselling, nutrition & food science, design & engineering, human-computer interaction, and associated disciplines, as these individuals possess the necessary expertise to inform and benefit this research study.

3.0 **Describe and justify the exclusion criteria for participants:**

Participants who meet the inclusion criteria will be eligible for this study. There will be no further exclusion criteria within this participant selection.

4.0 **Participants**

4.1 How many participants do you hope to recruit *(including controls, if applicable?)*
10
4.2 Of these, how many are controls, if applicable?
N/A

4.3 If this is a multi-site study, how many participants do you anticipate will be enrolled in the entire study?
10

5.0 Justification for sample size:
Expert Interview Participants: The stated sample size aligns with other research studies within the disciplines of design. This sample size should be sufficient to provide useful qualitative information to address the research study objectives and inform further investigation.

ID: Pro00125375 **Pro00125375**
Status: Approved 4.4 Recruitment of Participants (non-Health)

4.4 Recruitment of Participants (non-Health)

1.0 Recruitment

1.1 How will you identify potential participants? Outline all of the means you will use to identify who may be eligible to be in the study*(i.e. response to advertising such as flyers, posters, ads in newspapers, websites, email, list serves, community organization referrals, etc.)*
Expert Interview Participants: Academic, professional, and lifestyle experts will be identified through university directories, company directories, LinkedIn searches, publications, and personal network referrals.

1.2 Once you have identified a list of potentially eligible participants, indicate how the potential participants' names will be passed on to the researchers AND how will the potential participants be approached about the research.
Expert Interview Participants: The principal investigator will initiate contact with selected individuals through their publicly listed professional contact methods, including private email and social media direct messaging. All correspondence between the principal investigator and potential participants will be private. The principal investigator will also provide the research study information and consent forms to the potential expert interview participants for review.

2.0 Pre-Existing Relationships

2.1 Will potential participants be recruited through pre-existing relationships with researchers*(e.g. Will an instructor recruit students from his classes, or a physician recruit patients from her practice? Other examples may be employees, acquaintances, own children or family members, etc.)?*
● **Yes** ○ No

2.2 If YES, identify the relationship between the researchers and participants that could compromise the freedom to decline*(e.g. clinician/patient, professor/student)*
Expert Interview Participants: Potential participants may include personal acquaintances and professional colleagues of the principal investigator.

2.3 How will you ensure that there is no undue pressure on the potential participants to agree to the study?
Potential participants will be informed that participation in this research study is voluntary and there are no consequences to decline. All participants will be informed that they may withdraw from the research study at anytime without consequence.

3.0 Will your study involve any of the following?*(select all that apply)*
None of the above

ID: Pro00125375 **Pro00125375** 4.5 Informed Consent Determination
Status: Approved

4.5 Informed Consent Determination

1.0 Describe who will provide informed consent for this study*(i.e. the participant, parent of child participant, substitute decision maker, no one will give consent – requesting a waiver)*
Participants will provide informed consent for this research study.

1.1 Waiver of Consent Requested
If you are asking for a waiver of participant consent, please justify the waiver or alteration and explain how the study meets all of the criteria for the waiver. Refer to Article 3.7 of TCPS2 **and provide justification for requesting a Waiver of Consent for ALL criteria (a-e)**
N/A

1.2 Waiver of Consent in Individual Medical Emergency
If you are asking for a waiver or alteration of participant consent in individual medical emergencies, please review our guidance document**. Justify the waiver or alteration and explain how the study meets all of the criteria outlined in** Article 3.8 of TCPS2 (a-f)
N/A

2.0 How will consent be obtained/documented? Select all that apply
Signed consent form
Verbal consent

If you are not using a signed consent form, explain how the study information will be provided to the participant and how consent will be obtained/documented. Provide details for EACH of the options selected above:
Expert Interview Participants: Study information will be provided to the participant in advance through a supplied Participant Consent Form. On the date of the interview the principal investigator will review the study information and consent form with the participant. All clarifying questions will be addressed by the principal investigator prior to beginning the interview. Participant consent will be obtained and documented through a signed consent form or through recorded verbal consent.

3.0 Will every participant have the capacity to give fully informed consent on his/her own behalf?
● **Yes** ○ No

4.0 What assistance will be provided to participants or those consenting on their behalf, who may require additional assistance? *(e.g. non-English speakers, visually impaired, etc.)*
No supplementary assistance will be provided for this research study.

5.0 * **If at any time a PARTICIPANT wishes to withdraw from the study or from certain parts of the study, describe when and how this can be done.**
Expert Interview Participants: Participants may stop and withdraw from the interview session at anytime without consequence. Additionally, participants do not have to answer any questions which they are not comfortable answering.

6.0 Describe the circumstances and limitations of DATA withdrawal from the study, including the last point at which participant DATA can be withdrawn *(i.e. 2 weeks after transcription of interview notes)*
Expert Interview Participants: Participants may withdraw their data from the research study within 14 days after their interview transcript is issued. After this point data analysis will be complete and data removal will not be possible.

7.0 **Will this study involve any group(s) where non-participants are present? For example, classroom research might involve groups**

which include participants and non-participants.
○ Yes ● **No**

ID: Pro00125375 **Pro00125375** 5.1 Data Collection
Status: Approved

5.1 Data Collection

1.0 * **Will the researcher or study team be able to identify any of the participants at any stage of the study?**
● **Yes** ○ No

2.0 **Primary/raw data collected will be** *(check all that apply)*:
Directly identifying information - the information identifies a specific individual through direct identifiers (e.g. name, social insurance number, personal health number, etc.)

3.0 **If this study involves secondary use of data, list all original sources:**
N/A

4.0 **In research where total anonymity and confidentiality is sought but cannot be guaranteed** *(eg. where participants talk in a group)* **how will confidentiality be achieved?**
N/A

ID: Pro00125375 **Pro00125375** 5.2 Data Identifiers
Status: Approved

5.2 Data Identifiers

1.0 * **Personal Identifiers:** will you be collecting - at any time during the study, including recruitment - any of the following *(check all that apply)*:
Surname and First Name
Telephone Number
Email Address
Other

If OTHER, please describe:
Professional Information (Profession / Position, Company / Institution)

2.0 **Will you be collecting - at any time of the study, including recruitment of participants - any of the following** *(check all that apply)*:
There are no items to display

3.0 * **If you are collecting any of the above, provide a comprehensive rationale to explain why it is necessary to collect this information:**
Expert Interview Participants: The collection of the participant's surname, first name, telephone number, email address, and professional information will be necessary for recruitment and correspondence purposes.

4.0 **If identifying information will be removed at some point, when and how will this be done?**
Expert Interview Participants: A participant's identifying information may be removed within 14 days after their interview transcript is issued. This can be done through written or verbal communication with the principal investigator.

5.0 * **Specify what identifiable information will be RETAINED once data collection is complete, and explain why retention is necessary. Include the retention of master lists that link participant identifiers with de-identified data:**
Expert Interview Participants: The participant's surname, first name, professional information, consent forms, and interview data will be retained for research documentation purposes. The participant's telephone number and email address will be retained for follow-up correspondence purposes.

6.0 **If applicable, describe your plans to link the data in this study with data associated with other studies (e.g within a data repository) or with data belonging to another organization:**
N/A

ID: Pro00125375 **Pro00125375** 5.3 Data Confidentiality and Privacy
Status: Approved

5.3 Data Confidentiality and Privacy

1.0 * **How will confidentiality of the data be maintained? Describe how the identity of participants will be protected both during and after research.**
Expert Interview Participants: The participant's identifying information will be securely stored on a master list on the principal investigator's personal laptop computer. The participant's interview data will be securely stored, separate from their identifying information, on the principal investigator's external hard drive. Only the principal investigator will have access to this computer, external hard drive, and the stored data. The computer, external hard drive, and the stored data will be password protected and encrypted for security. Additionally, participants may use a pseudonym to protect their identity.

2.0 **How will the principal investigator ensure that all study personnel are aware of their responsibilities concerning participants' privacy and the confidentiality of their information?**
N/A – The principal investigator will not have additional study personnel.

3.0 **External Data Access**

* **3.1 Will identifiable data be transferred or made available to persons or agencies outside the research team?**

Note: If you are conducting research recruiting patients or using data within an AHS facility, please note that AHS de-identification standards consider any FULL date as an identifier (i.e. full DOB, full date of admission, discharge or treatment). As such, please review your data collection forms and if any full date forms part of the data you are collecting and sending to a collaborator and/or sponsor you must indicate YES here AND your consent form must inform participants that their data will be sent off site.)

○ **Yes** ● **No**

ID: Pro00125375 **Pro00125375**
Status: Approved 5.4 Data Storage, Retention, and Disposal

5.4 Data Storage, Retention, and Disposal

1.0 * **Describe how research data will be stored, e.g. digital files, hard copies, audio recordings, other. Specify the physical location and how it will be secured to protect confidentiality and privacy.** *(For example, study documents must be kept in a locked filing cabinet and computer files are encrypted, etc. Write N/A if not applicable to your research)*
Expert Interview Participants: The participant's identifying information will be securely stored on a master list on the principal investigator's personal laptop computer. The participant's interview data will be securely stored, separate from their identifying information, on the principal investigator's external hard drive. Only the principal investigator will have access to this computer, external hard drive, and the stored data. The computer, external hard drive, and the stored data will be password protected and encrypted for security. Additionally, participants may use a pseudonym to protect their identity.

2.0 * **University policy requires that you keep your data for a minimum of 5 years following completion of the study but there is no limit on**

data retention. Specify any plans for future use of the data. If the data will become part of a data repository or if this study involves the creation of a research database or registry for future research use, please provide details. *(Write N/A if not applicable to your research)*
The data from this research study will be presented in the principal investigator's Master of Design thesis document and public exhibition. The data may also be used in academic and professional presentations and publications.

3.0

If you plan to destroy your data, describe when and how this will be done? Indicate your plans for the destruction of the identifiers at the earliest opportunity consistent with the conduct of the research and/or clinical needs:
Expert Interview Participants: The research data will be retained for a minimum of 5 years following the completion of the research study. Currently, there are no plans to destroy the data after 5 years.

ID: Pro00125375 **Pro00125375** Documentation
Status: Approved

Documentation

Add documents in this section according to the headers. Use Item 11.0 "Other Documents" for any material not specifically mentioned below.

Sample templates are available by clicking HERE.

1.0 Recruitment Materials:

Document Name	Version	Date	Description
There are no items to display			

2.0 Letter of Initial Contact:

Document Name	Version	Date	Description
Letter of Initial Contact - Interview.pdf(0.01)	0.01	2/28/2023 3:29 PM	

3.0 Informed Consent / Information Document(s):

3.1 What is the reading level of the Informed Consent Form(s):
Basic English Proficiency

3.2 Informed Consent Form(s)/Information Document(s):

Document Name	Version	Date	Description
Participant Consent Form - Interview.pdf(0.01)	0.01	2/28/2023 3:29 PM	

4.0 Assent Forms:

Document Name	Version	Date	Description
There are no items to display			

5.0 Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.:

Document Name	Version	Date	Description
Questions - Interview.pdf(0.01)	0.01	2/28/2023 3:29 PM	

6.0 Protocol/Research Proposal:

Document Name	Version	Date	Description
There are no items to display			

7.0 Investigator Brochures/Product Monographs:

Document Name	Version	Date	Description
There are no items to display			

8.0 Health Canada No Objection Letter *(NOL)*:

Document Name	Version	Date	Description
There are no items to display			

9.0 Confidentiality Agreement:

Document Name	Version	Date	Description
There are no items to display			

10.0 Conflict of Interest:

Document Name	Version	Date	Description
There are no items to display			

11.0 Other Documents:
For example, Study Budget, Course Outline, or other documents not mentioned above

Document Name	Version	Date	Description
There are no items to display			

ID: Pro00125375 **Pro00125375** Final Page
Status: Approved

Final Page

You have reached the end of the ethics application.
Click 'Continue' or 'Exit' below.

To submit for ethics review, click "SUBMIT for REVIEW" on the left side of the screen.

NOTE: Only the Principal Investigator can submit an application in Pre-submission (ie: the first time it is submitted).

Appendix B: Letter of Initial Contact

UNIVERSITY OF ALBERTA

Letter of Initial Contact

For Expert Interview Participants

Email Subject: Interview Session Inquiry

Dear *(prospective participant's name)*,

My name is Michael Peel and I am an Industrial Design graduate student within the Department of Art & Design at the University of Alberta.

I am currently working on my Master of Design thesis project. For this project I am researching the relationship between wearable health tracking devices and their associated digital applications, and instances of body dissatisfaction and disordered eating behaviours within athlete populations. The purpose of this research is to inform the physical and experiential design criteria for future devices and applications which seek to mitigate these potentially life-threatening behaviours.

As part of this research study I am conducting interviews with academic and professional experts. I believe your knowledge and expertise regarding *(prospective participant's field)* could benefit this research study. Therefore, I am contacting you to learn if you would be interested in participating in an interview session?

Please note that participation is voluntary and there are no consequences to decline. The attached Participant Consent Form provides additional information for this research study. Please review this form and let me know if you have any questions or concerns.

Best regards,

Michael Peel | Graduate Student
University of Alberta
Department of Art & Design
Faculty of Arts

Ethics ID: Pro00125375
Version: February 28, 2023

Appendix C: Participant Consent Form

UNIVERSITY OF ALBERTA

Participant Consent Form

For Expert Interview Participants

Title of Study:
Design research to inform future wearable health tracking devices which address body dissatisfaction and disordered eating behaviours in fitness athlete populations.

Contact Information:

Principal Investigator:	Michael Peel, MDes Student, Department of Art & Design
Mailing Address:	3-98 FAB, Edmonton, Alberta, Canada, T6G 2C9
Phone:	403-801-4809
Email:	mpeel@ualberta.ca
Supervisor:	Aidan Rowe, Chair, Department of Art & Design
Mailing Address:	3-81 FAB, Edmonton, Alberta, Canada, T6G 2C9
Phone:	780-492-7864
Email:	aidan.rowe@ualberta.ca

You are being invited to take part in a research study. Before you take part, a member of the study team is available to explain the project and you are free to ask any questions about anything you do not understand. You will be given a copy of this form for your records.

Why am I being asked to take part in this research study?
You are being asked to take part in this research study because you are an academic, professional, or lifestyle expert within the fields of health & fitness, psychology & counselling, nutrition & food science, design & engineering, or human-computer interaction. It is believed that your knowledge and expertise could benefit this research study.

What is the reason for doing the study?
Wearable health tracking devices (e.g. Apple Watch, Fitbit, etc.) and associated digital applications can be useful tools for athletes. However, these products may also promote body dissatisfaction and disordered eating behaviours for some users. As a result, wearable health tracking devices and associated digital applications have the potential to improve, and to degrade, the mental and physical health of users. The conflicting potential of these products presents several distinct challenges for designers.

The purpose of this research study is to better understand the relationship between wearable health tracking devices and their associated digital applications, and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information could then be used to inform the physical and experiential design criteria for future devices and applications which seek to mitigate these potentially life-threatening behaviours. This research study is part of Michael Peel's Master of Design thesis project.

What will I be asked to do?
As an expert within your field, you are being invited to take part in one interview session for this research study. The interview session will be one-on-one and will last between 60-90 minutes. The interview will be conducted either in-person or virtually (Zoom, Google Meet). If the interview takes place virtually, you have the option to turn your camera off at anytime.

The interview audio will be recorded and relevant portions of the conversation will be transcribed verbatim by the principal investigator. The written transcript will be sent to you via email for review, and you will have 14 days to make any revisions. Afterwards, the written transcript will become part of the research study data set.

Your surname, first name, professional information, consent forms, and interview data will be retained for research documentation purposes. Your telephone number and email address will be retained for follow-up correspondence purposes. Any of your identifying information can be removed upon request by contacting Michael Peel (mpeel@ualberta.ca).

You have been identified as an expert within your field based upon publicly available information within university directories, company directories, LinkedIn searches, and publications. In total 6-10 experts will be selected and interviewed for this research study.

What are the risks and discomforts?
This research study presents minimal risk to participants. However, it is possible participants may experience emotional discomfort discussing the topics of body dissatisfaction and disordered eating behaviours. To decrease the potential for emotional discomfort the following strategies will be used:

- Participants will be notified of the interview subject matter prior to participation.
- Participants may stop the research activities at anytime without consequence.
- Participants will be supplied with mental health phone numbers and internet links.

It is not possible to know all of the risks that may happen in a study, but the researchers have taken all reasonable safeguards to minimize any known risks to a study participant.

What are the benefits to me?
This research study may not provide any direct benefit to you. However, the results of this research study could benefit others in the future in the following ways:

- Increased information regarding the features and limitations of existing wearable health tracking devices and associated digital applications.
- Increased information regarding the unique perspectives of fitness athletes who are experiencing body dissatisfaction and disordered eating behaviours, including the predominate psychological, physiological, societal, and environmental factors.
- Increased information regarding the physical and experiential design criteria for future wearable health tracking devices and associated digital applications which seek to mitigate body dissatisfaction and disordered eating behaviours.

Do I have to take part in the study?
Being in this study is your choice. Participation is voluntary and there are no consequences to decline. If you decide to participate in an interview session, you may stop the interview session at anytime without consequence. Additionally, you do not have to answer any questions which you are not comfortable answering.

As stated above, the interview audio will be recorded and relevant portions of the conversation will be transcribed verbatim by the principal investigator. The interview transcript will be sent to you via email for review and you will have 14 days to make any revisions. Afterwards, the written transcript will become part of the research study data set.

If you decide to be in the study, you can change your mind and stop being in the study within 14 days after your interview transcript is issued. After this point we are unable to remove you from the study because data analysis will be complete. To withdraw from the study please contact Michael Peel (mpeel@ualberta.ca).

Even if you remain in the research study, you may decide to withdraw some, or all, of your responses within 14 days after your interview transcript is issued. After this point we are unable to remove your answers because data analysis will be complete. To withdraw some, or all, of your responses from the study please contact Michael Peel (mpeel@ualberta.ca).

Will my information be kept private?

During this research study we will do everything we can to make sure all information you provide is kept private. No information relating to this study, including your name, will be released outside of the researcher's office, or published by the researchers, unless you provide your express permission. Sometimes, by law, we may have to release your information with your name. Therefore, we cannot guarantee absolute privacy. However, we will make every legal effort to make sure that your information is kept private.

If you agree to participate in this research study you may use your real name, or you may use a pseudonym (fake name) to protect your identity. If you would like to use a pseudonym please indicate this on the signed consent form at the end of this document. During research studies it is important that the data we receive is accurate. For this reason, your data, including your name, may be reviewed by the Research Ethics Board.

After the study is done, we will need to securely store your data. Your data will be securely stored on the principal investigator's personal laptop computer. Only the principal investigator will have access to this computer and the stored data. The computer and the stored data will be password protected and encrypted for security. As per University of Alberta policy, your data will be retained for a minimum of 5 years following the completion of the research study.

This research study is part of Michael Peel's Master of Design thesis project. The data from this study will be presented in the thesis document and public exhibition. The data may also be used in academic and professional presentations and publications.

Will I be paid to be in the research?
There will be no payment for participation in this research study.

What if I have questions?
If you have any questions about the research study now, or later, please contact Michael Peel (mpeel@ualberta.ca).

If you have any questions regarding your rights as a research participant, you may contact the University of Alberta Research Ethics Office at reoffice@ualberta.ca or 780-492-2615 and quote Ethics ID Pro00125375. This office is independent of the study investigators.

How do I indicate my agreement to be in this study?
By signing below, you understand:

- That you have read the above information and have had anything that you do not understand explained to you to your satisfaction.
- That you will be taking part in a research study.
- That you may freely leave the research study at any time.
- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

Name of Participant	Pseudonym (if applicable)
I give permission for my real name to be used: ❑ Yes ❑ No	
Signature of Participant	Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Name of Principal Investigator	
Signature of Principal Investigator	Date

A copy of this consent form has been given to you to keep for your records and reference.

Appendix D: Signed Participant Consent Forms

How do I indicate my agreement to be in this study?
By signing below, you understand:

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SIGNATURE OF STUDY PARTICIPANT

Lacey Pawlsen
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☑ Yes ☐ No

[redacted]
Signature of Participant

July 11/2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

July 11, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

Ethics ID: Pro00125375
Version: February 23, 2023

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SIGNATURE OF STUDY PARTICIPANT

Naissa Preston
Name of Participant

—
Pseudonym (if applicable)

I give permission for my real name to be used: ☑ Yes ☐ No

[redacted]
Signature of Participant

Aug 2, 2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

August 2, 2023
Date

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Ethics ID: Pro00125375
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- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

Leo King
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☒ Yes ❑ No

[redacted]
Signature of Participant

August 23, 2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

August 23, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
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SIGNATURE OF STUDY PARTICIPANT

Ben King
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☒ Yes ❑ No

[redacted]
Signature of Participant

Sept. 14, 2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

September 14, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
By signing below, you understand:

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- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

[redacted]
Name of Participant

Expert 5
Pseudonym (if applicable)

I give permission for my real name to be used: ❑ Yes ☒ No

[redacted]
Signature of Participant

September 4, 2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

September 4, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
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- That you may freely leave the research study at any time.
- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

[redacted]
Name of Participant

Expert 6
Pseudonym (if applicable)

I give permission for my real name to be used: ❑ Yes ☒ No

[redacted]
Signature of Participant

09/23/2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

September 23, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
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- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

Elizabeth Lampe
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☑ Yes ❑ No

[redacted]
Signature of Participant

09/25/2023
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

September 25, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
By signing below, you understand:

- That you have read the above information and have had anything that you do not understand explained to you to your satisfaction.
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- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

Dylan Scott
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☒ Yes ❑ No

[redacted]
Signature of Participant

2023-10-03
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

October 3, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
By signing below, you understand:

- That you have read the above information and have had anything that you do not understand explained to you to your satisfaction.
- That you will be taking part in a research study.
- That you may freely leave the research study at any time.
- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

Gabriela Constantinescu
Name of Participant

Pseudonym (if applicable)

I give permission for my real name to be used: ☑ Yes ❑ No

[redacted]
Signature of Participant

September 29, 2023.
Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted]
Signature of Principal Investigator

September 29, 2023
Date

A copy of this consent form has been given to you to keep for your records and reference.

How do I indicate my agreement to be in this study?
By signing below, you understand:

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- That you do not waive your legal rights by being in the study.
- That the legal and professional obligations of the investigators and involved institutions are not changed by your taking part in this study.

SIGNATURE OF STUDY PARTICIPANT

_Rachael Flatt_____ _____
Name of Participant Pseudonym (if applicable)

I give permission for my real name to be used: X Yes ❑ No

[redacted] Oct 3, 2023_____
Signature of Participant Date

SIGNATURE OF PRINCIPAL INVESTIGATOR

Michael Peel
Name of Principal Investigator

[redacted] October 3, 2023
Signature of Principal Investigator Date

A copy of this consent form has been given to you to keep for your records and reference.

Appendix E: Interview Questions

UNIVERSITY OF ALBERTA

Interview Questions

For Expert Interview Participants

1. To start, can you tell me about your academic, professional, and research background?

2. What are your thoughts regarding current wearable health tracking devices and associated digital applications for athlete use?

    2.2. Are there particular devices that you prefer, and if so, why?
    2.3. Are there particular applications that you prefer, and if so, why?

3. What are your thoughts regarding wearable health tracking devices and instances of body dissatisfaction and disordered eating behaviours?

4. What are some key design considerations for these products that you feel could mitigate instances of body dissatisfaction and disordered eating behaviours?

    4.2. Are there features that you feel could be improved?
    4.3. Are there features that you feel are particularly problematic?
    4.4. Are there features that are not present that you would like to see?

5. What are your thoughts on the future of wearable health tracking devices and associated digital applications?

    5.2. What could these devices and applications be like in 5 or 10 years?

6. Are there key research studies or people related to these topics that you feel I should look into or speak with?

Ethics ID: Pro00125375
Version: February 28, 2023

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Appendix F: Interview Transcripts

Lacey Paulsen, July 26, 2023

Michael Peel (MP): Before we begin, I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information will be used to inform the physical and experiential design criteria for future devices and applications, with the goal of mitigating these potentially life-threatening behaviours. As part of this research study, I am conducting interviews with academic, professional, and lifestyle experts, such as yourself, to understand your perspectives regarding this subject matter. On the topic of subject matter, this interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. Additionally, I can provide mental health resources if needed. The scheduled duration for this interview is between 60 and 90 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding the form or the research study?

Lacey Paulsen (LP): No.

MP: Wonderful, thank you. Now we can begin the interview. To start, can you tell me a little bit about your professional background, specifically your role as a recreational therapist for Alberta Health Services?

LP: Like you said, I am a recreation therapist at the eating disorder program at the U of A hospital with Alberta Health Services. My background—I started in human kinetics, and I have a kinesiology degree with a major in therapeutic recreation. We didn't learn a lot about eating disorders in school, but I learned a little bit more about them when I was studying for my national designation, and I felt rec therapy could do so much for this

population. My goal was to work within that population, and about a year later, this position became available. Honestly, I just kind of fell into it, just kind of by luck. But I really understand the population, and I've found my niche in this world of eating disorders, disordered eating, and dysfunctional exercise.

MP: It's a really interesting crossover. The clients you work with, are they coming from the eating disorder program, or are they coming from recreational therapy? How does that work?

LP: I work full-time within the U of A eating disorder program. Our population is primarily anorexia nervosa and bulimia nervosa patients. Our outpatient clinic also works with ARFID [avoidant/restrictive food intake disorder], binge eating disorder, and a few other ones too, but not as regularly. Those are kind of the four regular ones that we see. I work in the inpatient program, the day patient program, and I will consult in the outpatient clinic as well.

MP: Thank you. (pause) I would like to transition into a topic related to wearable health tracking and self-tracking in general. It's an open-ended question. What are your thoughts regarding wearable health tracking devices and their associated digital applications for the general population or for athletes?

LP: (laughs) I think this is kind of a loaded question. In the general population, I can understand their application and their usefulness. And also, in an athlete population, I can understand the usefulness of having something that can track heart rate, sleep, stress levels, and those kinds of things. In my current position, or in my area, they typically tend to be more detrimental than helpful because my patients get stuck on "steps". So they're constantly worried about "how many steps they're taking," "closing their rings," or "how much they moved." And it's less about the fitness markers or the actual health markers that wearable technology can be utilized for. And it's more about "what I should, or must, be doing in order to be worthy of rest or food" in a lot of my patient's cases.

MP: It seems there's potentially a compulsion—or maybe a misunderstanding of the relationship between health markers and these quantified values?

LP: Yes, very much so.

MP: Do your patients use these devices and applications? Do they come into the program with them? Could you talk a bit about that? What is the percentage of people using them?

LP: (laughs) I would say 85%, if not higher—it's pretty high. And we have a lot of conversations about how they're not totally accurate and kind of arbitrary. Like the 10,000 steps number, "Why is that a number?" Because oftentimes my patients are doing 20,000, 30,000, or 40,000 steps a day—they're not just stopping at 10,000—so it gets very convoluted very quickly. And we have a lot of conversations around, "Why is that little machine that they're wearing so important? Why does it have such a hold over them?" Because if I ask them to take it off, holy smokes—the world is ending.

MP: Could you talk a bit more about that? Do you have any scenarios where this has impeded treatment?

LP: Yes. In my program, I run a group called Exercise and Eating Disorders, and we talk about dysfunctional exercise. One of the things that we discuss is Fitbits, Apple Watches, and the Android equivalent. And when I suggest, "Maybe let's get rid of the tracker?" they cannot comprehend. They get really, really anxious—and they're like, "I can't do that, I can't do that." And it's very interesting because, "Why? If you want to tell the time, just go get a little digital watch." But it's obviously not the time—it's all of these other things like, "Then I won't know how many steps I've taken," and "Then I don't know how much I can eat or not eat."

MP: Are you finding that these devices are potentially causing people to engage in behaviours that they otherwise would not do?

LP: Yes, for sure.

MP: Can you describe that? Do you have any examples of that?

LP: Yes. Our unit offers various activities like yoga, Zumba, stretch groups, walks, and just going outside to play soccer, badminton, or any of those leisure activities. Not really structured exercise, but more like, "Let's have fun." If they haven't given up their watch yet —which is what we always suggest as a program, either before coming in or while they're there—and if they haven't given it up yet, they feel they must be wearing their watch for all

of these activities. And if they aren't wearing their watch, then this activity doesn't "count" in their minds. And they will sometimes do the activities, even if they don't want to, just so that they can close the rings or get the steps.

MP: And that is causing mental distress?

LP: Yes. Our program is a weight restoration program. Our people come in, and they are very emaciated, underweight, or just have really complicated eating patterns. So, we're trying to normalize those. If they don't have the activity, they don't have a choice whether they eat or not—they still have their four meals a day. If they don't go on the walk, don't get the activity, don't track it on their watch, or don't close their rings, in their minds they "should not be allowed to eat" or they "have not worked hard enough to eat," and we're still forcing them to eat. Then there is a lot of anger and resentment towards the treatment team.

MP: So, there is an embedded sense of earning food or compensating food with activity?

LP: Yes.

MP: And then this device is very much involved in that relationship?

LP: The device is like a tangible representation of it. If they don't have the device, it's in their minds, but they're not being constantly reminded of it in a tangible way. Whereas, with a watch, it's vibrating to tell you to move.

MP: Do your patient's view the device as empowering? Or do they understand this conflicting relationship? Do they see a problem with it?

LP: Definitely. I would say nine times out of ten, they understand that it's problematic and detrimental, but they are not willing to part with it. It's a method of control—"I can't control how much food I'm eating because the treatment team is making me do this, but I can control how much energy I'm expending."

MP: Does your program require people to give up their watches? Or is that voluntary?

LP: It's voluntary. (laughs) Honestly, I think lots of patients probably wouldn't come to our program in the first place if we told them that they couldn't bring their watch. Which speaks to the level of dependence on it—or a commitment to it, maybe. So, we don't make it mandatory—we heavily encourage it, but we don't make it mandatory.

MP: Very interesting. Do you find that these devices are inhibiting the patient's ability to monitor and understand their own sensory experience?

LP: Yes, 100%.

MP: Could you speak about that?

LP: I don't know that this would be for everyone, but with my patients, what I have seen is that they're already so disconnected from their bodies. Within the world of eating disorders and disordered eating, and within our society as a whole, we are so disconnected from our bodies, and sometimes I think wearable technology can reinforce that. You're relying on your watch to tell you whether or not you had a good sleep, instead of just waking up in the morning and saying, "I feel well rested or I don't." Or you're relying on your watch, and it says that you didn't close your rings, but you feel exhausted. But the patients negate that when they're like, "I have to do more activity because I didn't close my rings or get this many steps." Even though their body is telling them that they're sore, they're tired—but there's no connection from the neck down.

MP: Is developing a sense of internal hunger cues a component of the weight restoration program?

LP: Ideally, yes. And for most people, I would say it does, once they start eating or nourishing properly. All of a sudden, their body is like, "Hey! You're giving me food now. I want more. I'm hungry!" However, for some people, those cues don't ever come back. So, for some people, yes, we can cultivate those internal cues or those somatic sensations. And for some people, it doesn't come back. Part of the recovery process for eating disorders is trying to cultivate those cues, and some people are able and willing to do it, and some are not.

MP: Understood. Regarding the health data the users receive from their devices, do you have to educate your patients and say, "This isn't a complete picture," and if so, can you speak about that?

LP: Yes, one of the things I talk a lot with them about is the accuracy of the trackers. I don't personally have one, so I've not experienced this, but my mother-in-law has one. One of the things that she said was that she went to Costco and was pushing a grocery cart for two or three hours—which is a lot of work, especially at Costco as those carts get really heavy—and her watch didn't count anything because she wasn't swinging her arm. Another time, she was folding towels at home, and her watch was like, "Are you swimming right now?" And she's like, "No." (laughs) I talk to my patients, give them those examples, and say, "The energy expenditure isn't matching what's actually happening. It's not a good representation of what is actually going on in your life, as well as in your body. And those numbers are kind of arbitrary because they can't be fully accurate."

MP: Thank you. Transitioning to the next question, what are your thoughts regarding wearable health tracking devices and instances of body dissatisfaction and disordered eating?

LP: It's interesting. I don't know that I've thought about it in terms of body dissatisfaction. (pause) I think that what I see most in my patients is feelings of "worthiness," "not being enough," or "not doing enough," coming with the wearable tracking devices. In terms of body dissatisfaction, I think that is difficult for me to differentiate between because a lot of my patients, the majority of them, will suffer from body dysmorphia, and that is separate from the wearable tracking devices. I don't know—I haven't made a correlation between those who wear wearable tracking devices and whether they have more or less body satisfaction. (pause) In my personal area anyway.

MP: We've talked about the devices and applications and their relationship to compulsive exercise. Do you feel these products are contributing to compulsive exercise or contributing to behaviours that they otherwise would not do?

LP: Yes, 100%. I have some patients in our day patient population that will come and sit all day at our program, and then at night they'll go home and walk, essentially, all night. Or if

they did walk a little bit during the day but didn't hit that certain step goal, then they will walk circles around their coffee table in the living room.

MP: And they are sharing this information with you?

LP: Some will, some won't, but we can tell by their weight graph what they're doing or not doing.

MP: I guess it doesn't lie, right? The calories should be taking effect. Related to this, are your patients logging what they eat? And if so, is that causing distress?

LP: Some do, and some don't. Some have come from a calorie counting background and some haven't, so it's pretty individualized. I would say I see it more in the fitness industry, in terms of people tracking their intake and macros. I do see it in my patients, but a lot of my patients don't come from a tracking background. The eating disorder is a biological illness, so once that switch gets flipped, you have a full-blown eating disorder. But the switch getting flipped doesn't necessarily have to come from tracking calories. It might be that they dropped weight after surgery or something, and they're just genetically predisposed to having an eating disorder. So, tracking calories, I don't think it's helpful in terms of eating disorder recovery. But I don't know that it's a primary cause or reason that we see. But I do see it more in the fitness industry.

MP: Something you brought up, which I wouldn't mind if you could explain to me, is the difference between things that start as behaviours and what you described as biological illness, and how that switch gets flipped.

LP: It kind of depends on the person. Eating disorders are a biological illness—biopsychosocial. Individuals will have a genetic predisposition to developing an eating disorder. Which would mean that they have personality traits like perfectionism, high achievement, impulsiveness, maybe lower emotion regulation, high anxiety, and those kinds of things. If they are genetically predisposed, then their environment might create situations in which the eating disorder would be activated. Maybe something happens at school—maybe they feel they're not meeting the demands of school and they need some control. Or the eating disorder becomes a coping skill and they restrict, or they start

bingeing and purging because that's something that they can control and that gives them relief, or they're able to numb their feelings enough—without the intensity of the anxiety, writing an exam is not as intense. Or it could be something like, "They've had surgery, and they lost weight by the nature of surgery sometimes, and that switch can get flipped if they have a genetic predisposition."

MP: Very interesting. With that in mind, do you have any suggestions to reduce the potential risks of these products?

LP: I was thinking about this last night in preparation for our conversation. I mentioned this earlier, but since we as a society are so disconnected from our bodies, I wonder if wearable technology, or wearable tracking devices, could be useful in reinstating that. Or trying to help us tune into our bodies more instead of taking us away from that, or further away from that. I wonder if, instead of throwing all of that information at the user, there could be a system where the user is "asked" if they want to see that data before actually using it. Because a lot of my patients, once they are weight restored and understand the detrimental effects of their wearable technology, really like it for being able to change music while they're driving, or using the talk-to-text function, or the actual really cool technology things—they really like those things. (laughs) We've found that you can turn off all of the other data, but it's kind of a process, and you have to go in on your phone to turn it off. I wonder if there could be an easier way to do that, or to actually "ask" the consumer's permission to see all of that data. And I also wonder if, instead of saying, "Hey, you haven't moved in this long," or "Your rings aren't closed," or whatever—like I said, I don't wear one, so I don't know all of the nuances—the technology could ask the user how they're feeling. Instead of, "Hey, you need to move," could they say, "Do you feel you need to stretch? Do you feel jittery? Do you feel calm?" Things like that instead, so it's actually encouraging the person to check in with their bodies instead of this external cue of, "Hey, you need to do this."

MP: Yes, that's really interesting. Instilling a greater connection with bodily sensations, the body in general, or having more nuanced data and understanding are really promising progress paths. With this in mind, are there particular health metrics, or performance metrics, that you feel are beneficial to track? Additionally, are there ones that you feel are problematic to track?

LP: I think it depends on the population. For athletes, I can absolutely see how tracking your heart rate would be helpful. Training zones, rest time, sleep patterns, stress—I can totally understand how useful that would be for an athlete. For the general population, and especially for my people, or people who may be predisposed to eating disorders, the steps thing is not helpful. (laughs) The other things, like tracking your activity, might be helpful for people who are more sedentary, and we're trying to encourage them to move. But again, I think wearable technology could ask it in a different way. Or ask it in general. Instead of, "Hey, remember to do this," could it be asked again so that those people are tuning into their bodies? Because I think that people who are more sedentary or are not moving are just as disconnected from their bodies as people who are overexercising. I think, just trying to cultivate those internal cues, bodily sensations, and somatic awareness of, "Do I actually want to move?" and "How do I want to move?"

MP: You brought up something that I'm facing in a lot of the literature and research. It is the idea that health and performance metrics are beneficial to athlete performance and goals, but if an athlete is predisposed to eating disorder symptoms and behaviours, it's almost a perfect storm waiting to happen.

LP: (laughs) Oh yeah.

MP: I think this is the crux of the current research that I'm trying to investigate. Maybe before people are in full-blown eating disorder territory, or maybe before they're seeing people like you, they could be in this realm of self-tracking, self-soothing, and self-medicating in various ways. I know it's a complex thing, but what are your thoughts on this conflicting nature? The benefits of tracking and wearables for athletes, but then also this potentially slippery slope for some people?

LP: To be honest, the majority of athletes—maybe I shouldn't say majority—many athletes are predisposed. They have the genetic predispositions—they're high-achieving, perfectionistic types. That's how they get to be elite athletes—you can't do it without those traits. And wearable technology will create the perfect storm. Because if they see all of that data, it can very quickly shift in their mind, and it can flip that switch and definitely send them down the wrong path. So, "Is it useful for athletes?" Yes, but it could be very detrimental too.

MP: It's really interesting. I think it could loop back to your idea of reframing how the data is presented and maybe asking more nuanced questions.

LP: I think for some of the markers that athletes train with—heart rate, RPE, stress, sleep, those kinds of things—we did it for so long without wearable technology. I think there needs to be a conversation or some education around, "Your body still tells you exactly what's happening." And again, this goes back to that somatic sensation, right? We used to track heart rate by (places fingers on neck) literally tracking our heart rate for sixty seconds, counting the beats for ten seconds, and then multiplying it by six—we can still do that to track our heart rate. Maybe for those athletes, if they're exhibiting signs of becoming more reliant on the watch and becoming more compulsive about, "I have to do this, I have to get this done, I have to do this many steps, my rings aren't closed," instead of actually tuning into their bodies, if coaches or trainers are noticing that, the watch and the wearables, as they are created right now, need to be removed. If there was a way that we could have that education and have the wearables ask questions like, "How are you actually feeling?" this would allow the person to stop and check in instead of being completely reliant on what this device is telling them.

MP: To transition again and to try and look for solutions in this ecosystem, I wanted to learn if you've experienced any positive technological interventions. This can be anything, for example, web-based client portals, neurofeedback, biofeedback, etc. Is there anything in the technological realm that you feel has been beneficial for disordered eating and body image disturbances?

LP: (laughs) The short answer is no. I mentioned this earlier—there are some cool things with wearable technology, like using the talk-to-text function, not having to have your phone on you all the time, being able to change the music when you're driving—those kinds of things are cool. In terms of the actual health data, in my area with eating disorders and body dissatisfaction, no, I have seen no benefit.

MP: Interesting, and is there any technology you use?

LP: (Laughs and implies "No")

MP: Is it more like a counselling approach where you have one-on-one conversations?

LP: Yes.

MP: Then I'll play the devil's advocate here. If you, as a clinician, were sent real-time health data from someone's wearable, would that be of any use? Or is that too much health data? What are your thoughts—if you saw their steps, saw their heart rate, saw their eating patterns?

LP: I think that would be really cool, as a clinician, if the patient couldn't see it. If the patient couldn't see it and it got directly sent to their treatment team, that would be really interesting. Because eating disorders are very deceitful and manipulative, our patients will often lie about what they're doing in the evenings after the program. If there was a way for that data to be sent directly to the clinicians, that could influence treatment quite exponentially.

MP: Yes, I could imagine that you would have the whole picture.

LP: Yes, because right now we only have what the patient tells us or is willing to offer us. And obviously, like I mentioned before, we have the weight graph. If their weight isn't going up and they're on however many calories that we would expect them to go up on, but they're not, that obviously tells us that they're doing something in the evening. But we don't know what they're doing, and if they're not willing to tell us and they'll just keep denying it, we can't really do anything about it, and it's just this kind of vicious cycle. So, that could be useful in terms of treatment.

MP: Interesting. Are you familiar with the treatment protocol or application called Recovery Record?

LP: No.

MP: I encountered it in the literature search. I believe it is a patient-clinician portal where the person experiencing the eating disorder can input data throughout the day, as opposed to the hour-long session with their clinician, so the clinician will receive a larger dataset. Then there was a study [The Binge Eating Genetics Initiative (BEGIN): study protocol] where they paired this application with Apple Watches, and the clinician received the health data that

surrounded these qualitative self-inputs. From a clinician's standpoint, it sounds like they could generate a robust picture. So, I suppose that anecdote is just helpful for context. To the actual question, what would be beneficial to see if you were getting health data continuously? Are there certain metrics or markers that are beneficial?

LP: That's so interesting that they did a study on that. I think for outpatients and for day patients, that could be incredibly useful. I think heart rate would be one thing that we would want to see because lots of our patients are bradycardic and tachycardic—we would want to know that and if they're having any episodes. Or what their heart rate is, because if they're at a lower heart rate, they might need to be moved to a higher level of care. And also activity. And sleep.

MP: Whether they are sleeping or not? Quality of sleep?

LP: Yes. And obviously, for eating disorders, it would be useful to have the food input of what they're actually eating when they're not in the program.

MP: It's really interesting. All that data in the hands of the patient is problematic, but in the hands of the clinician, it could be very helpful in treatment.

LP: Yes.

MP: Maybe it speaks to the idea of different user interfaces and things like this?

LP: And I think the literacy too, right? For the patient, the consumer, or the user, seeing all of that data could be very detrimental. But for the treatment team and for the clinicians, it can be very useful because we understand it and don't have that emotional or moral connection to it, whereas the user, the patient, would. If we can still have the data without them having the attachment to the device, (pause) how cool, how useful.

MP: You speak about literacy, and I think that is such an important topic. If you were going through the workflow of how a user would interact with the device and what data is presented, what would make sense to you? Is there a learning process? Or simply jump into the data and say, "Here are your steps and your heart rate." What would that look like to you?

LP: I think it depends on the person. I think it has to be really individualized, which is not conducive to the nature of the devices, right? It's a very generalized technology. If we were going to use it as a clinician or as a treatment team, it would be a conversation that you have with a patient. We get to know our patients really well, so we would probably decide, as clinicians and as a treatment team, which patients would be privy to the information. And if we would even explain it to them beforehand, or if it would just be like, "Here's the thing. You're going to wear it. It's going to track the data. It's going to send it to us. And then we'll talk about that as we go." Or with some patients—again, high-achieving, perfectionistic, very intelligent people—we might have to give them all of the data first and say, "This is the reason we're doing this, and this is how it works." It depends on the person.

MP: So you see the benefit of increased personalization and options?

LP: Yes.

MP: That brings up a topic I was thinking about, which is data and emerging health anxiety. Metrics that we couldn't track before or were too nuanced—now we're getting bombarded with this information. Are you finding that people are experiencing health anxiety or are overly concerned about their health? And if so, can you speak about that?

LP: Yes. One of the disorders that we're seeing a little more regularly now is orthorexia. It's the fixation on health, and I would be lying if I said that wearable technology would not be a part of that.

MP: How so?

LP: All of the patients that I have treated or dealt with that would fit under the orthorexia area have worn some sort of watch or some sort of tracking device. I think being bombarded with those messages all the time—and I would say inaccurate messages because I would guess that a lot of the metrics might be based on measures that aren't necessarily relevant for each person, like BMI. BMI is very problematic when taken by itself without any other context, and everybody knows how problematic it is when it's used by itself. So, if the watches are using BMI as a marker of what a person's weight category is, that could be problematic in

and of itself. Telling someone that they are overweight when, for their genetics and for their life situation, really they're not.

MP: Speaking about improvements that could be made to the physical design, the user experience, or the user interface—on the spectrum of all the areas in which a designer can have influence, they can change the form, the materials, the user interface, the metrics, how the data is visualized, and things like that—where do you feel the biggest room for improvement could be? What kinds of design improvements could be made?

LP: I wonder, and I think I kind of mentioned this before, that instead of having the data thrown at the user like that, is there an option to have to turn that data on? Because right now you can turn it off, but like I said earlier, you have to go on your phone and into the app, and it's a bit of a runaround. So, people are just going to say, "To hell with it." What if it was reversed? What if they had to go in to turn the data on?

MP: Yes, activating a feature as you need it, as opposed to the feature being so deeply ingrained or essential to the concept of the device.

LP: Yes, and then the other thing would be asking questions. Instead of, "Hey, did you move enough today? You didn't move enough today. You didn't close your rings. You didn't do your steps." Asking the user throughout the day, "How do you feel? Do you need to move? Do you feel like you need to stretch?" Instead of reminders, "You should do this. You have to do this." Asking the person, "How are you feeling?" And maybe giving them options like, "Do you need to stretch? Do you need to go for a walk? Do you need to have some water?"

MP: Yes, this type of qualitative assessment is really interesting. (pause) There is one more core question, and then we can go into the closing parts. The tech industry is here, and it's likely not going away without significant change. So, we have a choice. We could work to improve the technology, accept it as is, disregard it, etc. With this said, what are your thoughts on the future of wearable health tracking devices? In five to ten years, what could these products look like? Do you have any thoughts?

LP: I agree—it's not going anywhere, so we need to figure out how to make it work better for us as consumers. I think about the things that we talked about today. Making it more

conducive to the education or knowledge of the consumer. Not bombarding them with health data that maybe isn't relevant. Make it more nuanced and less generalized so that they are getting accurate information if they choose to receive that information. I think we have to stop bombarding people and essentially telling them that what they're doing is not good enough. Because I think that will probably increase body dissatisfaction—the feeling of not being worthy or enough. I think we have to use technology in a way that is going to be helpful for the consumer, not detrimental. In terms of treatment and clinicians, I think it would be really cool for clinicians to be able to receive that data—without the patient seeing it. (laughs)

MP: (laughs) A very interesting dual nature.

LP: Yes.

MP: Related to that, the sophistication of these devices is getting pretty high, and I don't see that slowing down. Do you feel that there is a point where increased regulations or clinical trials need to be implemented?

LP: Yes, I do. I think that actually might help in terms of regulating it and ensuring the accuracy of devices, instead of them missing a lot of data when people are wearing them and not moving their arms. (laughs) I wonder if clinical trials would help regulate that.

MP: It's an interesting thing to consider. Before we conclude, I would like to ask if there are any other topics you would like to discuss or if you have any questions for me?

LP: I was going to go back to one of your earlier questions—the health anxiety of people with trackers. Yes, I have definitely seen it. Some of my patients are very anxious about, "If they don't exercise, they are going to get XYZ disease," diabetes, cardiovascular disease, whatever. And that translates into, "They must take the stairs. They must do this amount of exercise per day." In a lot of my patients, their compulsive activity, or compulsive exercise, is based on behavioural rigidity, based on those rules, so that they don't get XYZ disease. So, they wear their watches religiously to make sure that they are meeting all of those markers so that they don't get those diseases. Because they adhere to these rules and wear the devices out of fear, and fear is a very powerful motivator. As a society, we hear these messages all the time, like, "Take the stairs—it's better for your heart," or whatever.

And while those messages are useful for people with sedentary behaviour, they are not helpful for my people or my patients. A lot of the things we talk about are, "How can we distance ourselves from those messages? How do we determine if we're doing enough activity to not get XYZ disease? Why is a watch or wearable device going to help us avoid that?" Because for some people, just genetically, like an eating disorder, you're genetically predisposed to cardiovascular disease, diabetes, whatever—it's genetics mostly. So, with the watches, I think the ones that really have trouble giving up the watches are those ones.

MP: It's really interesting because it impacts the immediate quality of life in hopes of a prolonged quantity of life. Or dodging a...

LP: ...hypothetical scenario.

MP: Yes. It's all so relatable. But it's understandable how problematic it is. (pause) Just so I understand, do you find this mindset in the majority of your patients?

LP: I wouldn't say the majority. Another facet of eating disorders is that there are typically some comorbid illnesses as well, such as anxiety, depression, and OCD. I see that mindset in the patients who have OCD personality traits or have been diagnosed with OCD because it's a rule-driven behaviour that is based on fear.

MP: It is fascinating speaking with you and understanding how a user can come in with certain predispositions, personality traits, and life experiences, and how this technology is not neutral and can potentially become problematic. (pause) It leads to the idea of enhanced screening at the time of purchase or even during the preliminary startup.

LP: I was just thinking that. Could there be a way that these people get screened out of buying these things before they purchase them? Or in the interface? If they want a smartwatch for the other cool features, when you're inputting your data, if the consumer is asked if they want to subscribe to receive that data, then could there be a screening tool in there that they have to answer before they can actually access that data?

MP: I really like that. Like a Body Appreciation Scale or an Eating Disorder Examination Questionnaire?

LP: Yes, or an OCD questionnaire too. Or something that combines the most important elements from each of those questionnaires and is some sort of screening tool. But again, this is kind of going into a medical device as well, because that would have to be validated.

MP: For sure. It's really interesting because, from a designer's perspective, I think about how artificial intelligence is progressing so rapidly—it's unreal, day by day. A smartwatch is still fairly "dumb" right now, but you could embed machine learning. For example, with most devices, you could log ten workouts in a day if you wanted, and it's not going to tell you to stop. But if it observed the whole picture and said, "Woah, you didn't log a lot of calories and you did 40,000 steps," or "You ate something and immediately did a workout, and this is starting to look like compulsive behaviour," maybe it could change the user interface, how the data is presented, or send you information.

LP: Yes, or like warning signs. I think that's amazing. I think that would be so cool and so useful. And in five to ten years, if we can get to that, I think that would be so helpful for people. "Hey, why are you doing this? Why have you logged ten workouts and not eaten anything?" or "As soon as you ate, you exercised right after—what's that about?" Again, just encouraging that curiosity for the user to be like, "Wait a second, what is happening?" And it would be cool if the wearable device noticed that and then could send some information on warning signs of eating disorders or dysfunctional exercise. And maybe some resources on who to contact if you're struggling.

MP: Yes, it would be really cool. Also, if everything was interconnected and the technology could recognize these scenarios, it could have the awareness to not bombard you with problematic content on social media. There are a lot of fascinating possibilities. Thank you for sharing your thoughts. I really appreciate it.

LP: Yes, absolutely.

MP: We are concluding now. Based on the nature of this conversation, did any thoughts come up regarding individuals that you think I should contact or speak with?

LP: Are you looking for just Canada or the US as well?

MP: It could be anywhere because I can do this remotely.

LP: Okay. I know some people in this realm in the US. One lady's name is Amanda Schlitzer-Tierney. I can email you her name if you want. Another would be Dr. Brian Cook. And another would be Dr. Riley Nikols. They are all within the exercise and eating disorders world in different facets. One is a psychiatrist, one is a psychologist, and one is a sports strength and conditioning coach, which is a little bit different—she works specifically with athletes with eating disorders. That might be a really cool connection. I'll email it to you.

MP: Okay, thank you. I'll look into these. So, that concludes the interview. I just wanted to remind you that, as noted in the Participant Consent Form, once all the interviews are complete, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. Afterwards, the written transcript will become part of the research study data set.

LP: Sure.

MP: If you have any questions, please feel free to email me at any time. And again, I would like to thank you for your time and participation. I really appreciate your interest.

LP: Yes, absolutely. This is fun. I think it's really interesting. I think I told you this in the email—I had literally just been talking about your research to someone right before you emailed me. I think it's really cool that this connection has been made, and I hope it can facilitate some more questions between other people as well.

MP: Absolutely, I really appreciate that. Thank you. It was great meeting you at the workshop, and I really appreciate this interview as well.

LP: Yes, you betcha. Thank you too.

MP: Alright, take care. Bye.

LP: Okay, bye. [Interview Duration: 01:11:20]

Naissa Preston, August 4, 2023

Michael Peel (MP): Before we begin, I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information will be used to inform the physical and experiential design criteria for future devices and applications that seek to mitigate these potentially life-threatening behaviours. As part of this research study, I am conducting interviews with academic, professional, and lifestyle experts, such as yourself, to understand your perspectives regarding this subject matter. A quick disclaimer about the subject matter: this interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. And finally, I can provide mental health resources if needed. The scheduled duration for this interview is between 60 and 90 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation.

Naissa Preston (NP): Good luck. (laughs)

MP: (laughs) I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding the form or the research study?

NP: Nope, not at all.

MP: Okay, now we can begin. To start, can you tell me a bit about your professional background as well as your current roles? I see you're at the Royal Glenora Club, and I believe you're consulting independently as well?

NP: I am, yep. My professional background—I have a nutrition degree [from the University of Alberta]. I have NAIT's Personal Fitness Trainer diploma. I have been a certified professional since 1999. I have worked in administration for various fitness places. I have operated as a personal trainer for all of that time. A group fitness leader for all of that time. Currently, I am in a position where I can train new fitness leaders and help them keep their skills up. I am the fitness manager at the Royal Glenora. I am also the primary dryland person for a couple of figure skating clubs in the local area, as well as a personal trainer and group fitness leader.

MP: Wonderful, thank you. It is great to speak with someone like you who has been in this game for so long. What type of clients do you currently work with? Are they high-level athletes, amateur athletes, or general people? Could you describe the various types of people you work with?

NP: In terms of the figure skaters, many of them are competing for a spot on the national team. Some of them will never get anywhere near that, but some of them are legitimate contenders. My clients range from masters-level tennis athletes to aging populations that are trying not to fall apart as they go through that process. I suspect the population you're looking towards is more the "young mom, two or three kids at home, wealthy people." Those are the people that generally attend my group fitness classes, and they're the people that I interact with day to day.

MP: I think the wide range is really beneficial. I'm interested in perspectives from everywhere along that chain. Or maybe three major areas. The general population—people who are interested in health and "not falling apart," as you said. Amateur fitness enthusiasts—people who may be very concerned about fitness but may not have a specific application or sport. And elite athletes, or aspiring elite athletes, who have their sport and also their time in the gym. So, feel free to speak about that whole ecosystem.

NP: Sure.

MP: I'll switch topics. What are your thoughts regarding current wearable health tracking devices and digital applications for athlete use?

NP: I think the best-case scenario is that they provide accountability. You turn your watch on, you look at the week, and you see what your habits are. But I do spend a fair amount of time with the statement, "You know, you're still doing the workout even if your watch doesn't recognize it." To the point where my dad, who is almost 80, goes for a walk every day, and he's curious how far he's going. So, I was like, "Okay, take my watch and see what happens." And he came back, and he was so mad because he said, "It was only this far, and I thought it would be way further." And I'm like, "Here's the thing..." (laughs) So, I had to talk him off the ledge and say, "No, you still have to do the walk. The walk is good. Don't trust the watch necessarily. You're still doing a good thing for yourself." So, I think that they are a piece of the wellness toolbox, but I really worry about folks who can't get by without them.

MP: Yes, absolutely. Could you elaborate on the observed negative elements? A good starting point could be the disconnect between the perceived effort from the user and the measured data from the watch. What implications does this have for the people you work with? Are they experiencing mental distress? Could you speak about that?

NP: I think my dad freaked out a little bit. He's 80, his balance is no good, and he's out on the planet. But now he's decided he's got to go further. He's got to do more hills. He's got to do this, that, and the other thing. And I'm like, "Can you please not have something go wrong with you out there?" So, whether that is his mental distress or mine, I don't know. (laughs) I think it falls on both sides. But in terms of the general population and fitness people, my primary modality is the TRX [Total Resistance Exercise System], and that's a tough go on a good day—that's a relatively intense tool. And people come to my class and say, "Aw, I only burned a hundred calories. I have to work harder next time." And I will talk to them the next day, and they will say, "Yeah, it was a hard go getting off the toilet this morning." Meaning, they're experiencing all these effects from the intensity of the workout, but they believe they must "work harder next time" because their watch didn't tell them whatever they were expecting to see. (pause) Primarily, what I am talking about is the Apple Watch. I don't have a lot of experience with the other ones, but it seems as though the Apple Watch tends to err on the side of "less work, fewer calories, lower heart rates." So, it's pushing people to do more than maybe they should have or could have—for better or for worse. And I feel like it gives them this feeling of, "I failed. I didn't do enough. I didn't work hard enough." And I think that's damaging at some point, whether right in the moment or in five years when they're sitting down to a midlife crisis. "I should have worked

harder—then I wouldn't need this plastic surgery." (pause) I do worry about those folks where the metrics of every workout have some sort of value.

MP: There are a lot of really interesting topics there. Do you find the health data is causing people to compensate with exercise or other behaviours they otherwise would not do? Perhaps because there is a disconnect? Like you said, they didn't go as far as they thought, so they are ramping up their distance or intensity for the next time. First, are you observing this? And second, as a health professional in your space, what are the implications of not listening to your body and ramping up training and intensity?

NP: I can speak from a personal standpoint. I hate running. I hate it. I think it's the stupidest thing. (laughs) But I also feel like it's hard, so I get this sense of, "Look at me, I went for a run." And I recognized that if I set my watch to "Walk," it recognizes a certain distance, a certain intensity, and a certain elevation. But when I do the exact same route and set it to "Run," suddenly I've gone further (laughs). So, I've realized within myself that I'm playing this stupid mental game. Ultimately, "Did I get out there, in my running shoes, in the sunshine, and in the fresh air?" But I do know for myself that I will work harder. "I need an extra 200 meters," or whatever. Whereas, if I didn't have this thing on my wrist, I wouldn't do any of that. And especially the demographic that I service right now—extremely high achievers, they're all wealthy, they're all gorgeous, they're all extremely educated and accomplished—if they have the data in front of them that they "didn't do as well as they should have," they are definitely pushing themselves harder next time. And they're sitting over coffee after that workout going, "It said that I did x-number, but you only did y-number." And I think it creates a sense of competition that the people I love and care about in the fitness industry have tried really hard to get rid of. So, it feels like going backwards. Because if you're an athlete and you actually need those metrics—you need an accurate heart rate, you need an accurate distance—I feel like they're not using the readily available technology. So, people get in this headspace of, "I can train like an Olympian because now I have access to that data." (pause) It's sort of weird.

MP: That is really interesting. Can you elaborate on that last point? The elite athletes—are they using the typical chest-mounted heart rate monitors and not the Apple Watch?

NP: I think so. The athlete who is a runner is not judging their performance with the over-the-counter Apple Watch that says, "I ran 5k today." They know exactly how far they ran and exactly how long it took them because they're using other tools.

MP: Some of the critiques of the common wearable technologies [Fitbit, Apple Watch, etc.] are exactly what you just described. Amateur and intermediate athletes may gravitate towards these devices, use them, get really fascinated by the data, and potentially fall into the data trap or adherence model. Whereas, the elite athlete is often very in tune with their own bodily sensations, like fatigue, pace, etc., and they are using these tools a bit more sparingly. I would love to hear your thoughts on this. Additionally, do you feel these devices are impacting people's embedded bodily sensations? For example, do you feel these products are enhancing or degrading internal sensations of fatigue, rest, pace, endurance, etc.?

NP: To take that on a bit of a tangent, what I know is that my athletes, who are essentially one step away from Olympic competition, don't wear them—they don't have them. And I get that figure skating is not necessarily measured in those metrics, but that doesn't mean that we're not challenging their physiology and their anatomy to do something they couldn't do yesterday. But they don't even think about it—their watch is legitimately a watch, like, "What time is it?" (laughs) But on the other side of that, I have a client who, at 69, tore his patella ligament off his patella. They sewed it back on, and now I spend quite a bit of time trying to get him back into function. He's a very high-end businessman, so metrics are a thing, and what fascinated him was the Apple Walking Asymmetry metric. I showed him that, and he loved it. He would go out for walks just to lower that asymmetry number—that was all he was looking for. He didn't care how far he went—he didn't care how fast he got there, but if that number was getting better, he saw that as success for him. And he was able to dial in how it felt on his feet and how he felt ambulating with what that number told him. He would reset it every night, go out and do the thing, and then observe, "There was no pain on this side." He was really able to connect those two pieces, and I thought that was really interesting coming from a 69-year-old dude who really didn't care about his carcass before that. I thought that was quite a neat success story that a lot of people don't use as data. They're looking for calories burned, heart rate, intensity—that type of thing. So, I've tried to switch some of that conversation into, "Well, no, what's this other data that is functionality?" I think there are positives in there that relate to that athlete mentality. (pause) I don't know if that really answered your question, but I felt like it was kind of similar.

MP: Yes, it's a really cool story. In that scenario, this man is using the tool to regain understanding of his walking patterns, make minor corrections, and understand what those sensations feel like. That is a really beautiful relationship between the device and the person. (pause) We'll carry on and see if that topic comes back up in other ways. Regarding health data in general, what are your thoughts on the complexity of the health data that is presented to the user? Do you have to educate some of your clients about heart rate, calories, and stress markers? Do you have to educate some of your staff? Or are they coming in with a good understanding of this?

NP: I think it is probably the other way around. I feel like a lot of the younger folks in my world have definitely tried to educate me on how to use some of the stuff a little bit better. (pause) But I try not to care about that stuff. For my own self-protection, I intentionally do not dig into a lot of that data. Which is sort of why this Walking Asymmetry thing really piqued my curiosity. Because that's my area—posture, movement patterns, and how we can make them better. So, no, I don't. I think the only one I spend time educating people about is the walking and balance metric in the Apple data.

MP: Yes, that makes sense. (pause) When did you start to encounter these devices? And have you noticed any attitude changes with these devices?

NP: I feel like I noticed it years ago. I want to say 2012, somewhere in there. Maybe even prior to that, when everybody had to have a Fitbit and it was this "10,000 steps" thing. I was working at the university at the time, and everybody was promoting, "You've got to get your 10,000 steps," and the university was giving out pedometers. But for me, right away, there was this feeling of, "I don't trust this data." Like, "I've only got 7,000 steps today, so I'm just going to sit here doing this (waves arm) for a while." But more recently, I would say in the last five to eight years, because that data is more complex and people are trying to connect the dots of their wellness, not just physical fitness, I find people are getting more caught up in what their watch data has to say. (pause) The majority of the people that I talk to use it as a piece of the puzzle. I don't know anybody, besides that one client with the Walking Asymmetry thing, who is just like, "That is the bible."

MP: That is good to hear. You've mentioned the type of people that you're working with, and I would love to learn if you have observed any common personality traits or common

motivations for why people are using these products. Do people explicitly say they're using it to change their body composition, track performance or health markers, or understand their body? Are you getting that kind of feedback?

NP: Yes, and I would suggest it boils down to "not getting a fat ass." They're using food trackers for "what's coming in?" Now they're using their Apple Watch for "what's going out?" "That TRX class didn't burn enough—I better get on the treadmill for a little while." (pause) From my world and from my thought process, I can see those things happening, and now it's an easier equation to quantify for some of those folks.

MP: So, you're explicitly seeing the relationship between what goes in and the energy expenditure out?

NP: Yes, because it's, "I've got this beautiful dress to get into for next week," or "I'm going to the beach," or whatever.

MP: I think this is a perfect time to transition. In general, what are your thoughts regarding wearable health tracking devices and instances of body dissatisfaction and disordered eating?

NP: I think they're quite closely linked. I think the days of posting a selfie in your sports bra with a screenshot of your watch and the impression, "Look at me, living the dream, looking like a superstar," or whatever—I think those two pieces are not as obviously linked anymore, from what I see. But definitely, I would say that for half of the people that I come across on a day-to-day basis, their primary reason for physical activity is to make sure that their body looks a certain way. So I think the watch gives them that immediate feedback. "Did I do enough to look a certain way today?" I feel like human beings are hardwired to see the negatives anyway. I feel like if it wasn't wearable tech, it would be something else they would find and use as a comparison tool. But I do think it's an easy one right now.

MP: The people you're working with, do they view the device, which is part of this relationship between tracking calories and tracking energy expenditure, as a healthy relationship without problems? Or do you get the impression that they may think, "I don't know, this is kind of risky—maybe I'm starting to go down a path I didn't think I was going to go down?" Could you speak about that?

NP: I don't know that I've spoken to anybody who sees any negative repercussions. For example, I have people that are working with a kettlebell, and I will say, "I'm going to advise you to either take off your watch or turn it around, so you don't damage the face of the watch with the kettlebell." And they get really weird: "What if I take it off? It's going to think that I'm... No, no, no." I haven't seen anybody who thinks some of that behaviour, which I would consider "kooky," is not. They see it as normal. I don't think the general population folks are connecting the dots.

MP: Have you seen it progress to a point where people become underweight? Or where the exercise increases too much and you have to step in? Or are they staying within a safe realm?

NP: It's interesting, and I think that I'm in a weird spot. The short answer is, no, I haven't had to intervene. Are there a couple of people that I make sure I've always got one eye on? Yes. And are those people always wearing some sort of tracking tech? Yes. (pause) But it's difficult for me. I've been a part of that eating disorder workshop three or four times, and it's difficult for me because of those five or six warning signs for dysfunctional exercise and disordered eating, these big bullets that we put up—"This is what you need to watch for"—those are also traits of highly successful people. "You're highly programmed, you're scheduled, you're on task, you've got a to-do list, you're looking after your health, you're all of these things." So, it's difficult in my current—to use your word—"ecosystem" to flush out whether that behaviour is tipped into something I need to worry about or if it is really the reason why they are successful, wealthy, and able to achieve all these amazing things that they're out there doing. The short answer is, no—the long answer is, maybe?

MP: Yes, that is fair. It's interesting to learn there are these observable traits that allow an athlete, or an individual, to reach a certain level of success within their fitness world, and these traits potentially allow them to be successful in the external world as well. You mentioned high achievement—are there other traits that you're seeing, such as perfectionist qualities?

NP: I think all of that is true. I mean, Apple and Google are huge companies with huge marketing wheels. Powerful, powerful marketing wheels. And again, in the ecosystem I'm living in right now, the amount of disposable money at their fingertips is something I can't comprehend. So, for me, it's a bit of a weird "chicken or egg" thing. These people are highly successful. They had to earn it. Multiple degrees. They're fighting for these CEO jobs. But they also have a bunch of disposable money. They're in their peer group, and something new and

shiny comes out. Of course they've got that—they're keeping up with the Joneses. Would they all generally care as much about "calories in, calories out" and all those metrics if they didn't have it sitting on their wrists? Because now it's a fashion accessory? I don't know. But there are those Type A's where, when I'm on the mic and say, "Okay guys, let's get going," they're like, "Okay, just wait, I need to set my watch." So, yes, they're perfectionists, they're note-takers, and they're attention-to-detail type people.

MP: You mentioned that these products are feeding into a hyper-competitive nature within the fitness world—what did you mean exactly? Was it a comparison of fitness metrics between individuals?

NP: I think both. I think it's, "Yesterday I ran 4k, and today I ran slightly further." So, you're competing with yourself, and you're able to look back and say, "I need to do 10% more this week because that's what the academic books tell me in terms of progression." And I think it is also, "You and I competed next to each other in this class. Why does your watch tell you that you did more? Stand there while I do another 20 push-ups." I think it's all of that. Again, it's keeping up with the Joneses—it's just a different piece of it.

MP: So, linking physical fitness and health metrics with a larger picture of success, progress, and competition?

NP: Yes. But with the folks I generally talk to, the word "competition" would never come from them. But you can see them comparing data, and I have a hard time with that. I've worked really hard to try not to compare, so this is something that I notice. I don't know what they think they're getting out of comparing. (laughs) But yes, they're definitely competing.

MP: You mentioned that whether or not the person feels that it is a problem, there is a connection between wearing the device and tracking the data for overall wellness, but also explicitly to control how their physique looks. And there could be complications as that progresses, especially as the person ages and the body deteriorates. In general, do you have any suggestions to reduce the risks associated with these products? Or do you even feel that there are any risks?

NP: Honestly, I don't know. You could put on warning labels, and you could do all that, but it still requires people to read it, to understand it, and to take it in. For me personally, if I knew that it was more accurate, that information might sit better in my head. I have convinced myself that it's not accurate, and then I've convinced myself that it's generally low-reporting. Whether that is true or not, I don't know. I find myself having this internal dialogue of, "My body feels like I'm done, but the watch says I should probably do a little more," and I know it's wrong. I find my personal internal dialogue gets really hazy when I wear this. To the point where I generally only wear my watch on a work day. Otherwise, I just don't want to know. I don't want it nagging me to tell me to "stand up" or whatever. So, in terms of making it a more positive experience, every morning, 20 minutes after I put the watch on, it sends me a little "ding," and it tells me to take a "mindful moment." I wonder if there could be more of those meditative and self-reflection practices pushed towards the forefront. I understand that some people in some professions will want a reminder to stand up every hour, but in my mind that is still a physical thing, which I am not saying does not have value, but if there was a way to push those notifications, whatever that is, that would take the user away from metrics of physical activity into practices of wellness.

MP: Yes, that is really interesting, and I feel it leads perfectly into the next question. Regarding technological interventions that are currently available, such as the Headspace meditation app and other things like this, do you feel there are any positive technological interventions to treat body image disturbances and disordered eating?

NP: I think so. Whatever it is that you choose that resonates with you, I think it does help alleviate some of the noise in your head. But again, I feel that if it isn't sexy, it doesn't hit the first page of the marketing material. So, I think it has value, like everything else, but it still requires me to go out and find it and know that I need it, and that may be the hardest part—recognizing that I've got a deficit here and I need to look for it. (pause) I would like to believe that the average person didn't recognize that there was a hole in their life because they didn't know how many calories they were burning in a day—does that make sense? I don't think they thought they needed that information until the marketing wheels said, "You need this information." So, when it comes to trying to practice positive mental health behaviours, maybe that is the same thing? The general population is just waiting for somebody to say, "Here it is, it's easily accessible, and it's got these five health benefits," or whatever.

MP: Yes, that is such an interesting point. Maybe the general population wasn't as aware of all these metrics to track until they became so accessible through such a ubiquitous product? And potentially shifting the emphasis from physical fitness markers to overall wellness and mental health markers could be beneficial not only in the fitness world but also in general society. (pause) I would love to learn why you wear your watch. Do you wear it for the other technological features, like texting or music?

NP: No. (laughs) Honestly, it sat in a drawer for years. We bought it quite a while ago, when I was at the university. And there would be times where I'm doing data entry all day, and it would be like, "Stand up," and I would be like, "Screw you—I don't have time!" So, I never got into the habit of using it. Then I got involved in the Royal Glenora Club, and everybody has one, and I was like, "Okay, I can be cool too and wear my watch." So, it is a bit of a "fitting in with the cool kids" kind of statement. (pause) What do I use on it? I use it for the time. (laughs) And I use it so that I don't have to have my phone in my hand. If I get a text message, I can read it and determine, "Okay, do I need to deal with it?" But I'll always go back and find a primary device to deal with it. And I think that was part of the reason why I sort of threw it in a corner originally—if I leave my device behind, I left it behind for a reason, and I don't need to be that accessible. But now I worry more about the optics of always having my phone in my hand. I think that's an ugly look. So, it lets me pretend that I'm not tagged in when I actually am.

MP: Absolutely, that is very relatable. You mentioned working at the Royal Glenora Club, where everyone has a watch. These technological devices are becoming more essential, and while a watch is still optional, a phone is not, especially during times like the pandemic with our QR codes. And this leads into another topic that I am interested in. What do you think the future of wearable health tracking devices and applications could look like? What do you think they will look like in five to ten years?

NP: Honestly, I don't know. Me and tech are not good bedfellows. I don't know if I even think in that way. The thing that I worry about, good and bad, that came out of the pandemic was this idea of exposure. To me, that's interesting. Again, does it go back to positive mental health? I don't know. But the idea of exposure and all of those apps that you could get with GPS that said, "You came within eight feet of somebody who had COVID." I thought that was really interesting. So, now are we tracking poor air quality exposure, noise exposure, these

various pollutions, and some sort of communicable disease? I feel like that is going to become part of the conversation as we continue to kill our environment and have these events that impact the human body. And I'm hoping that some of that data becomes more important than "whether or not I did enough exercise today."

MP: That is really interesting. The individual health markers are one thing—heart rate, sleep, etc. And then there are these larger societal health markers—what is the health of our society? We can measure that through air quality, global temperature, etc. I like what you said about the idea of exposure and awareness. Do you see any value in expanding the idea of tracking beyond these conventional metrics, looking at the bigger picture, and incorporating this data to create a holistic wellness profile for a person? What are your thoughts on this, and how could it look? To you, what are important things that are worth tracking and monitoring?

NP: I think movement—you can't get away from that. I spent my whole career worried about people's movement. Movement is important, but do I think we need to drill down to all those gory details? I don't think so. "Did you move enough today?" I think that is important. What would be really interesting, and I know people worry that Big Brother is watching and they're worried about their data, but I'm not one of those people. I think I am one of the more boring people on the planet, and if the government wants to know what I'm doing, I'm like, "Here it is." (laughs) But what I think would be really interesting is having the ability for the device to interact with you if it appears as though you're isolated. Or your heart rate and your sleep patterns are distilled down to, "What's going on with your stress level? We've noticed these five pieces that generally indicate a physiological response to stress. You haven't left your house. No other devices have come near you in the last, however long." I think trying to flush out some of that data that people don't see as part of the puzzle would be interesting. But it all sounds very Black Mirror, right? (laughs)

MP: I love the idea. And obviously, it does run into privacy concerns. But I think privacy concerns are going to evolve over the next five to ten years, simply because of how ubiquitous these devices are becoming. (pause) I really love the idea of an overall wellness picture that includes things like socialization, movement, exposure to the outdoors, and maybe even, "How much laughing did you do today? How much smiling?"

NP: Right.

MP: There are a lot of areas in which a designer can have influence. They can influence the data metrics. They can influence how the information is presented in the user interface. They can influence the physical design of the object, its form, the materials used, etc. In any of those categories, or others, are there any formal design qualities that you feel could be improved?

NP: In terms of personalization, I don't know that I've tried all that hard, but the tiny floating icons on the Apple Watch are difficult to use. I typically go and get something that is easier to navigate through. So, for me, they are almost too complex. To the point where, "It's a watch for crying out loud." I don't know if I have that "old-person mentality" going on with that. (pause) Again, hanging around the Royal Glenora, there are people that are in these gorgeous ball gowns that still have their Apple Watch on because they've got a gold band or whatever. If I had a wish, I would like it to be more easily customizable. And maybe to the point where, when you get a new phone, you have to walk through all these steps of, "How do you want it to look? How do you want it to talk to you?" If that process were more robust, maybe, "Do you want these 25 things reflected on your watch? Or do you only want two? What is important to you to see? You can pick five, or you can pick a hundred." So, that might be a piece of it.

MP: Absolutely. There is a big marketplace for these devices. There are a lot of players. But simultaneously, it feels like there's not a lot of personalization in terms of how the data is presented, what data is presented, and what things are important to a person. It seems to be a common theme. And different people have different use-case scenarios and different preferences. (pause) If the device by default tacks all these metrics, and they are the same metrics for every Apple Watch user, and you're witnessing an increase in competitiveness in relation to those particular metrics, perhaps in the startup procedure of the device the user actually needs to determine whether they care about each metric and whether they want to track it?

NP: Right, I see what you're saying. We can't force people to care about their sleep quality or whatever. (pause) I think that Western society is not going to stop worrying about aesthetics, and body aesthetics specifically. But maybe it sits on the manufacturers to mix it up? Like, "What are the defaults?" You have to work pretty hard to even find that walking asymmetry thing. I stumbled on it just because I was bored. But maybe that's it? The top five default metrics—maybe they have some random one that people don't think about, like walking

asymmetry, noise exposure, or whatever—just to put the light bulb in some heads to say, "Oh, I wonder why that's important?" Maybe get them curious about other aspects of wellness?

MP: Yes, that is wonderful. (pause) As a fitness professional who has been in the game for a long time, working with probably hundreds or thousands of clients, do you have a few core pillars of wellness, or things that you feel are pretty important? Maybe it's movement, sleep, etc. If we put technology aside for a moment and you were having a conversation with someone about wellness, what would be the most important things this person should be considering and incorporating? Regarding quality of life, are there core things that you speak to clients about?

NP: I try to emphasize love for and the quality of whatever movement you care about. For example, in your golf game, "Oh, my back was sore afterwards." "Okay, that is poor quality. Let's change your quality of movement so that you're not hurting." In terms of quality of life and overall wellness, it is generally a life free from pain, whatever that means. Since the pandemic, since people have been able to come back together, I have seen the majority of my personal training clients now working in pairs. Whereas before, it was just a one-on-one thing. So, if I were to talk to people about overall wellness, I think it is about finding human connection, finding pain-free joy of movement, whatever it is that you want to do, and finding mindful ways to enjoy the moment. Everybody has to go to work, and everybody has to clean the toilet, and everybody has to do these things that nobody loves to do. Asking folks to think about how those pieces interact—to me, that's wellness. But you know, "What are you eating? What are you doing?" Those conversations come into it. The science of "What do you put in your body? How are you treating it?" All of that stuff, for sure. But by the time people want to talk to me, they've already figured out what they're missing to a certain extent. (pause) But the interesting piece is this concept of working with a partner. "Can I bring my friend?" And I'm finding my personal training sessions have sort of shifted away from exercise prescription, like, "This is what you need to do to achieve that goal you told me you had," into, "Did you have a good time in that hour? Do you feel like you have accomplished something? When you left that session, did you feel the way you wanted to? Whether you wanted to be sore or whether you wanted to feel accomplished, did we get that? Great." So, that has been an interesting shift for me, and I think that's a positive shift.

MP: Excellent—that is really great. (pause) I'm looking at the time, and I am cognizant of your other appointment, so we can wrap up. (pause) Before we end, there's a few closing items. Based on the nature of this conversation, do you feel there are any individuals that I should speak with?

NP: In terms of people that could forward the conversation, that kind of thing? I have a few folks that use the tech in a more robust way. In a way that I would suggest those companies are hoping for. The folks that still post a picture of their rings, or whatever, that are in the fitness world. I could definitely put you in contact with them if that's something you want.

MP: Yes, that would be wonderful. Then I can determine if they are the right fit.

NP: Okay.

MP: Before we conclude, are there any other topics you want to discuss?

NP: I don't think so. I'm hoping I was useful for you, though. (laughs)

MP: Oh, absolutely! It was wonderful to get your perspective. You shared some really great knowledge. Again, thank you very much. (pause) Do you have any questions for me?

NP: No, not at all. I'm happy to do any follow-up if that's something that you need or want. Feel free to reach out.

MP: Absolutely, thank you. We'll see how this progresses and determine what is necessary. But I know that we had a very good conversation. Thank you very much.

NP: Yes. Always.

MP: As noted in the Participant Consent Form, once all the interviews are complete, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. Afterwards, the written transcript will become part of the research study data set. If you have any questions, please feel free to email me at any time. And again, I would like to thank you for your participation. I really appreciate your time, your energy, and your interest.

NP: Yay. Good luck with your project. It sounds huge. (laughs)

MP: (laughs) Yes, it feels big. Okay, thank you very much.

NP: Always. Good luck. See ya. [Interview Duration: 01:09:08]

Leo King, September 1, 2023

Michael Peel (MP): Before we begin, I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information will be used to inform the physical and experiential design criteria for future devices and applications, with the goal of mitigating these potentially life-threatening behaviours. As part of this research study, I am conducting interviews with academic, professional, and lifestyle experts, such as yourself, to understand your perspectives regarding this subject matter. A quick disclaimer about the subject matter: this interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. Finally, I can provide mental health resources if needed. The scheduled duration for this interview is between 60 and 90 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

Leo King (LK): No. I'm ready to get going.

MP: Alright, we can begin. Could you tell me a bit about your academic and professional background?

LK: Yes, for sure. I have a bachelor of science in kinesiology. I graduated from the University of Calgary in 2013. I went into the fitness industry and started an online body transformation coaching company, where, in the beginning, I specifically worked with natural physique athletes. This led me to open up a gym [Kings Fitness] in 2015, and this is where we currently are. I still work with athletes today. I still work with in-person clients. And we have a whole bunch of coaches that work inside Kings Fitness as well.

MP: Maybe you can clarify something for me? It says you're the Calgary director and show promoter for the INBF [International Natural Bodybuilding Federation], but sometimes I see the WNBF [World Natural Bodybuilding Federation]?

LK: Yes. I am a competitive athlete myself, and one of the ways that I wanted to give back to the sport of natural physique competitions and bodybuilding was to assist in running shows and provide a platform for athletes to compete on. I decided on this in 2013. In 2017, my wife and I took over the federation, and we rebranded as the WNBF. So, it's the same company, just under different branding, and that was due to the more worldwide proliferation of the [WNBF] federation and just to be more consistent with other countries. We're actually the presidents now. We don't only promote Calgary—we're also in seven different cities across Canada now.

MP: Wonderful. To build on that, could you tell me a bit about your training background and competition experience?

LK: I've been training since I was 14 years old. Probably even before that. I was probably doing sit-ups in the corner of the room (laughs). I've been active in a gym setting for 20 years now. Obviously, that's where my whole passion comes from. It comes from training and also helping others train and meet their goals. From the competition side, I started competing in natural bodybuilding in 2011. I've competed about 12 times over the last decade or so. I've competed internationally quite a bit. I am a professional natural bodybuilding athlete, and I have competed at three World Championships. I've placed as high as second in our lightweight class. It was always a goal of mine to crack the top five, so that was super amazing. On the powerlifting side, I also compete in drug-tested powerlifting. I've competed at four Canadian National Championships. I've also been to the Commonwealth Powerlifting Championships in New Zealand. So, again, I have competed on the international field there too.

MP: It is a very impressive background! (pause) The types of athletes that you are currently working with—are they primarily people involved in the fitness discipline, or are you working with athletes that are inside a gym setting but are training for other sports? Could you talk about the type of clientele that you're working with and what their goals are?

LK: It's a 50/50 split between competitive natural physique athletes—so, male, female, bikini, bodybuilding, and physique athletes who have the goal of stepping on stage. A lot of my focus is on first-time athletes who want to do it as healthy as possible. Through my coaching methods, I feel that is what I try to put out there and promote—competing, but in a healthier way. And then my other 50% of clients are the typical gym population who are just trying to live better lives, lose 20 pounds of body fat, get a bit stronger, and feel better about everything in general. That's more of my in-person clientele, and then my online clientele is more physique.

MP: How often do you encounter clients who are experiencing body image concerns or disordered eating behaviours? If you are experiencing that, could you describe what they're facing or what you're noticing?

LK: I don't see it super often, to be honest with you. I will give you some generalities, though. A lot of the people I work with—first-timers, often slightly older, they've had kids, they've been somewhat successful in their careers, and this has always been a bucket list thing of theirs. So, I don't think a lot of my clients come at it where they already have some sort of eating disorder habits and patterns, and then this is just an extension, right? But I will say that competing can create bad eating habits. Maybe not as extreme as full anorexia and, very rarely, bulimia. But since it's so focused on this quite challenging goal, where everything has to be in line with your nutrition, your exercise, and stuff like that, you can be so focused on just that, and I feel like it does create bad habits. At least for a period of time. But I don't think they stay for a long time afterwards, either. I feel like it's this short-term effect that's unfortunately part of the package when you get on stage. My goal is to focus on mitigating that as much as possible and trying to do it in a somewhat healthier manner, so that they're less food focused and less exercise focused, and it's almost part of a lifestyle at that point. But we're just chipping away at these goals to get onto the stage.

MP: That makes a lot of sense. With your awareness of what could happen to somebody's eating behaviours through contest preparation, are you cognizant of that and instilling a nutrition and training program with that in mind?

LK: Always, yes. It all comes from personal experience, whether it's myself or a backlog of hundreds of clients. It's applying these approaches, but taking experiences and trying to do it in the best possible way. So, I'm not overprescribing stuff for the sake of prescribing stuff. I'm

always factoring in a change of job, a change of situation within their families, vacations, and stuff like that. I want to make sure that I'm thinking about the big picture. And also that they're thinking about it because sometimes athletes in particular can become so narrow-focused that I also want to try and give them the big picture again and let them take a step back and be like, "It's okay to do this during this time," or "It's okay to take this job," or whatever. I'm trying to always focus on the big picture.

MP: Yes, I know from training with you that you have a very compassionate and sustainable approach to physical health and also to overall health. While we're on this topic, could you briefly describe some of the challenges a fitness athlete could face if they're dieting too drastically or if they're not taking a moderate approach?

LK: In the short term, if someone is being too extreme, there's very negative [physical] energy consequences. They become a full-on safety hazard in general. I've heard horror stories, not personally or with my clients, but in the industry, of people falling asleep while driving. As extreme as that. I mean, that's as stupid as it can be. But I think a lot of it comes from being in too much of a deprivation state. Now, I'm going to go on a little tangent, but often in the industry, there is this myth that a contest prep can only last, say, 12 weeks, right? So, you have people who are trying to lose 40 to 50 pounds in 12 weeks. That's a very big energy deficit due to a very low food intake and very low carbohydrate intake, as well as a very extreme energy output due to hours of cardio a day, plus your training and all of this stuff. Again, my general philosophy is to take that step back. "Let's elongate that time. Let's not come in at 40 to 50 pounds overweight. Let's try to be 20 to 30 pounds overweight, and now let's have a good, successful prep." Sorry, I kind of took a right angle on that question. But the consequences can be quite extreme because people may need to do way more than what was required if they had taken a slightly different approach at the very beginning.

MP: Yes, that makes sense. Depending on their starting condition before contest prep and depending on the type of trainer or coach they have, they might have to make fairly drastic decisions that could lead to, like you said, extreme energy deficits and potentially issues with food.

LK: For sure, 100%.

MP: Maybe we'll switch topics here. I wanted to understand your thoughts regarding the current wearable health tracking devices and associated digital applications for athlete use. Do you use them? Do you promote them? Do you have any general thoughts or feelings about them?

LK: My experience comes from a very simple step tracker, whether that's an Apple Watch, a Fitbit, or some of these things. I do use them, actually. Not in my everyday, but I do use them sometimes with my clients. I do like to track steps, in general, because the research shows that as someone gets leaner, their body becomes more efficient, but their normal activity [NEAT: non-exercise activity thermogenesis] actually slows down. One of the ways I like to offset that is to be like, "If we can at least maintain our step count, to an extent, at least we know we're mitigating some of those natural energy deficit differences over the course of a contest prep." Also, steps are very easy to recover from—they're easy to fit into your day, and they're really good for recovery in general. As opposed to spending an hour or two on the bike or something that's a little bit higher output, which is going to affect your performance in the gym and will affect your recovery. So, I do like to use wearable step trackers or some form of that, but that's about the extent of what I use.

MP: Do you have any familiarity with some of the other features, like heart rate or recovery? Is any of that of any interest to you or your clients?

LK: I feel like the Oura Ring, which tracks sleep and stuff like that, could be of some benefit, especially in the high-performance level of sports, for sure. And that's not just in bodybuilding, powerlifting, and stuff like that. I think that can be across the board in anything that's a performance-based sport. Your sleep will affect your recovery, which can affect your output. And I do know that coaches will use that, like, "Hey, if you're not feeling quite well, let's do more of a recovery session today, so that you do recover, so that the next day we can actually keep performing at a higher level of output." I try, without actively tracking that, because I don't want my athletes to be like, "Okay, you need to track your sleep, and you need to track this," and stuff like that. But some like it, and some will do it anyway. But I try to instill in them, "If you're not feeling great, take a rest day today. You can train again tomorrow." Versus, again, the industry as a whole, it's kind of like, "If you're missing your workout, you're getting inferior results." But again, they're not taking that big picture into consideration.

MP: Absolutely. Maybe this is a good opportunity to branch into another question about self-tracking in general for athlete use. There are so many metrics to track—whether this is with a logbook or whether it's with a device—you could track sets, reps, workouts, rest times, heart rate, etc. Do you see positive benefits to a certain amount of self-tracking? Or are you an advocate of developing internal sensations for intensity, fatigue, and things like this?

LK: I like to make sure all the foundations are covered. The big priority stuff that is going to drive the needle, like, "Where is someone's volume? Where is their intensity?" So, sets, reps—and I like to guide rest times, but I don't like to be like, "95 seconds and then you're hitting it again." No, I'm making sure that you're recovered enough, but you're still getting an efficient workout in. Because that's the other thing we're working with, most of my clients have to be done in the gym within an hour. They don't have five hours to train, right? So, I like to focus on the big picture stuff, which, in my opinion, is going to move the needle the majority of the way. Then all the other stuff—I'm going to call it more of the minutiae, all the other little things—it's like, "Just base it on how you're feeling," right? "If it's not a great day today," like I said, "We can miss a day, or just drop a set, or not go to failure today. Let's just be smart with our training in general." I think it's a personality type as well. Some people just like data. They like metrics. They just like it. Versus, I feel like 90% of people are like, "Tell me what to do. I'll go get it done." And if I can instill some good habits at that time, then we're probably on the right path.

MP: Yes, that makes a lot of sense. Have you observed any negative effects with these products or with tracking?

LK: I don't think so. Do you have any examples there? I know you're not supposed to be biased. (laughs) But off the top of my head, I would say, no. Again, just to go back to the simplest, the tracking of steps, sometimes it's just a bit of accountability, like, "Hey, we're hitting 10,000 steps a day. I'm only at 7,000 steps at 7:00 pm. Ok, let me go out for a 30-minute walk." So, I don't really see that as a negative, or a sort of bad habit, or whatever. I think it's probably actually a good thing, at least in my view anyway.

MP: Yes, I understand. I'm looking for a wide range of perspectives. For certain people, some of this stuff can become problematic. For example, if they have certain predispositions for disordered eating and then they have this tool, it can potentially cause a bit of compulsive exercise, potentially a compulsion to do things that they otherwise wouldn't do, and potentially

some rigidity in thinking. But it's really wonderful to hear that you're not necessarily experiencing that or seeing that with your clients. (pause) I'll move on to a new topic. The primary focus of this research project is wearable technology and digital applications and their relation to eating disorders and body image concerns. I wanted to talk now about bodily sensations. What are your thoughts regarding the impact of wearable health tracking devices and associated digital applications on the embedded bodily awareness or senses of the user? Do you feel that it is a useful tool to try to enhance that connection and those sensations? Or is there a bit of a disconnect between the data and what you're trying to achieve?

LK: I think it's almost the opposite of what you're trying to teach people sometimes. It is true—it's like, "Okay, I've got these numbers that I'm going to hit, and I've got these apps and these things that are helping me hit those targets." Versus, like you said, a bit more of this intuition. You pick someone who does it automatically, and it is intuitive, right? They don't need their apps and that stuff—they know. Some people can come to the gym and it's like, "Ah, I'm just not feeling quite right. I'm just going to drop my load today. I'll still get a workout in. But I just don't feel like it's quite there today." Versus, you've got the other side, which is like, "Okay, these are my sets, reps, weights, and loads." So, they're going to hit it no matter what. But what is the consequence of that as an after-effect? So, I totally think it's almost creating less and less intuition in people because we have all these things. It's almost like the quick fix—like, if someone could take a magic pill to get there, that's what everyone's looking for. It's like, "I'm doing anything that's easier for my time by using my phone or using my watch." Versus, "Actually doing the work and learning this stuff for yourself."

MP: It is very interesting. (pause) You are also a judge, and I saw that you did the Calgary show [2022 PRO/AM Intercontinental & Calgary Naturals] last fall. I think you did a recent show as well? I believe my buddy, Omar, won his class at this last show.

LK: Yeah!

MP: With this said, I was curious what you see in the industry with these elite athletes. Are you finding that their intuition is really strong? Are they relying on the tech? Are they really rigid with programming?

LK: It's kind of funny, really. Because usually the best athletes are the ones you don't want to learn from, right? (laughs) Honestly, with the best ones, it is all intuition, what we would call "bro-science." Often, everything is all bro-science to them. There's also this huge genetic factor involved and stuff like that. Almost no matter what they do, they're going to get the best results. Honestly, the top guys in the industry just know. And often, they are the most experienced. A lot of the guys at the top of the natural world are in their 40s, and they've been competing for 20+ years. They know, "Ah, you know what? I'm just going to miss a meal now," or "I'm going to take out this food," or "I just need to be a little bit more active, so I'm going to go for a walk." But they're not typically tracking as much. I will say that in the last five years or so, it has become more and more prominent. But like we were talking about just before, I think that people then focus solely on those numbers, and it removes themselves from the actual intuitive side of things. But you get top athletes who will take different approaches on all sides. But I do find that the more experienced athletes are the ones who don't need to track their steps, or they just do what they feel like doing for the day.

MP: That is really interesting. Maybe for beginners and intermediates, it is about learning and structure, and that could explain why they gravitate towards these tools? (pause) The next question is regarding health data—contextualizing it and making sense of it. It's a two-fold question. First, what are your thoughts regarding the trustworthiness of the data that comes from these devices? And second, if you feel there are discrepancies between things like energy expenditure or calories burned, do you educate your clients or your staff and say, "This is more of a guideline," or something like that? So, first, do you trust the data concretely? And second, do you have to educate your clients or your staff?

LK: Let's say you're riding on an exercise bike and the built-in display says, "You're burning 10 calories a minute." I don't rely on that because it's just taking the middle person, and that's what it's basing it on. I think you can modify it a little bit, but for the most part, it's a general rule of thumb. It doesn't factor in so many different things into that equation. So, I personally don't use it, and I try not to get my clients to specifically focus on that number in particular. I think an example that I do like to use is as simple as scale weight. Maybe it's slightly off, but as long as it's consistent, if it's always weighing someone heavy by two pounds, it doesn't really matter at that point because that number on the scale is arbitrary in a way. What we're often looking for is a change, right? As long as it's kind of consistent. Another thing is that some people like to use those body pods and those very simple body

fat measurements with the bioscans and stuff like that. I think the research shows that they can be off by plus or minus 6%, which is huge for a body fat percentage, right? So, I always just say, "Be aware of that, try and find something that's reliable, or at least do it consistently with regards to how you're taking the measurement." So, weighing in for me and my clients is done first thing in the morning after using the washroom. That way, it's kind of our most consistent time of the day that we can be as true as possible. And you could apply the same things to some of those other tracking devices.

MP: Yes, that makes sense. It's like tracking calories—in the beginning, it doesn't really matter if that meal is 200 or 250 calories. With consistency, you begin to understand what your benchmark or base level is, and then you can adjust from there. Maybe the absolute number is irrelevant, and it's about finding patterns in the data.

LK: Yes, it's having a consistent approach to most things that you do. Especially if you're looking to create a change. You don't want to artificially make changes. Because you can do that with anything. On a bench press, you can lift more weight by reducing the range of motion, but that doesn't affect the process of actually getting stronger, right? (laughs)

MP: Absolutely. That is a great example. (pause) I'll switch topics again. We've spoken about this, but I'll ask it plainly. What are your thoughts regarding wearable health tracking devices and instances of body dissatisfaction and disordered eating?

LK: I think it's kind of a personality-type thing. And on my side of things, I haven't noticed it too much. But again, I feel like it's those people that are a little bit more metrics-driven, or data-driven, that look into it more and more, and they like seeing that sort of data, the numbers, and stuff like that. (pause) But I don't know if it adds to the behaviour or if the behaviour almost leads to the act of using these more and more, if that makes sense?

MP: It does. Which comes first? Is the person coming in with preexisting issues, and then the tool aggravates them? Or the other way around? (pause) You mentioned that there could be some common traits that you could observe. As a professional trainer with many years of experience, are there certain things that would raise some red flags for you, things that might indicate some underlying issues that could turn into complications in the future? Are

there things that the client could express—the language they're using about their body, or about food, or how they're approaching fitness—that would cause concern?

LK: Again, for most of the people that I do work with, there haven't really ever been any red flags, to be honest with you. It's typically the middle-aged male or female that (pause) yes, for sure, there's some dissatisfaction with it. Again, these are my lifestyle clients and my contest prep clients. Contest prep is usually a bucket list goal. But for all the lifestyle ones, it's just years and years of "less activity than they should be doing and more social events than they should be consuming," kind of idea, right? So, no, I wouldn't say that for me personally. Maybe it's just the type of clientele that I work with? We always attract a certain type of person who wants to work with us. Whether it's based on relatability or the information that we are putting out there—I know that in particular, if some people are putting out mental health stuff, they're going to attract more people who have mental health issues. If people are putting out information about eating disorders and stuff like that, they're going to attract those sorts of people. Versus, for myself, as I think we've covered, it's kind of more balanced. I don't seem to attract any of the extremes. It's more of these people that are generally healthy, "but they're just a little overweight and they need to get a bit stronger," and that seems to be the type of clientele that I do attract.

MP: Yes, that makes a lot of sense. That could be a perfect explanation for this.

LK: Yes, I just don't have a ton of experience with people who may already have these underlying issues and disorders. Whether they're just not picking me as a coach or a trainer, right?

MP: Just to clarify, if you're not experiencing it with your clients, do you believe it is an issue in the community? Or because you're not experiencing it with your clients, does it maybe lead you to believe that it is not an issue within the community? Does that make sense?

LK: Whether people with disordered habits are... (pause) Could you reword that again?

MP: Yes, for sure. I understand that was vague. I'll provide some more context. For example, if I interview a person working in an eating disorder ward, they might describe a type of cascading workflow for how a patient may end up in the situation that they did. And it

might be a mixture of biological predispositions to certain behaviours or certain tendencies, like obsessive-compulsive disorder, or things like this. And then gravitating towards this very visual, body image-based sport. And then the combination of these elements could potentially progress into a disorder. So, some people will say that there's an inherent complication with the sport or with the discipline. But obviously, there's such an enormous population, there's so many people participating in it, and everyone's going to have different perspectives on this. So, I guess the question that I'm asking, with this contextual information in place, is—do you feel this is an issue within the sport or within the community? Have you heard about these types of scenarios from other trainers or colleagues of yours? Do you believe there could be some complications with this?

LK: This is my perspective. I do find that those who have some obsessive behaviours are, I'm not going to say, "successful" in terms of being better athletes, but they are generally successful with the tasks that they need to complete. One person that comes to mind, a very successful businessman, had a very bad alcohol problem, drinking behaviours, etc. He was able to take those obsessive behaviours from his business life, as well as his drinking life, and totally change them around into health and fitness. His goal was to step on the bodybuilding stage. So, it kind of sounds very similar. And we did it, absolutely. Granted, this guy is not the most genetic specimen. He is in his 50s, and he has horrible postural issues from 30+ years of work. But he was the most dedicated guy to doing what was needed to step on the stage. And it took three years—it wasn't like an overnight sort of thing. But I will say that those who have these sorts of obsessive tendencies and behaviours—and again, you could link that to eating disorders and stuff like that—in my opinion, that may make those habits more likely. And especially in a physique-based sport, because that's what people focus on, is that physique. So, that is my perspective. And I will always say, as a coach and as someone who's trying to take this big picture view, that when an athlete is stepping on stage, that is the worst physique for them to actually live with on a day-to-day basis. I am always trying to be like, "This is when the person is probably their least healthiest in the grand scheme of things." So, I try to say, "Just remember that this is a day in time. On the stage itself, you need to look like this because it's a competition and it's a subjective sport based on physicality. But remember, we don't want to stay like this after the show." I'm not sure if we're going to be talking about post-show stuff, but that's a whole different ball game. There's a lot of bad eating habits and disorders that can come out of that because the goal has been removed. So, you're trying to bring people out of a competition where they're not led to these

binge cycles and stuff like that. To try and do it in a way where we're gaining body fat and healthy muscle back so that they are ideally healthier post-show than when they either enter the prep or at least on the day of the competition. That one went sideways, sorry. (laughs)

MP: No, that is super interesting. I would love to talk about that topic a bit because I think it's good for context. When you're taking this balanced approach, you're doing it for some reasons, correct? In the lead-up to the competition, how does that balanced approach address some of these issues related to hunger and binge eating? And then, in the post-contest recovery procedure, what are you looking out for and trying to mitigate?

LK: Yes. First of all, it starts before our preparation begins. Ideally, we're looking a year out. We're trying to focus on these cycles to be able to get an athlete into a good position. So, the duration has been extended a long way. That means we're not in a really steep caloric deficit for a really short period of time. Because what happens then is that you have to become really restrictive, you have to remove a lot of food groups, and you have to deprive and deplete your clients just to be able to get them ready for the stage. Obviously, that leads into these urges post-show, where you're super food-focused and the body just wants energy. So, it's going to overcome all these habits that have been in place to get them onto the stage. Because the goal has been removed, you have these binge cycles. People will eat until they are beyond full. They may not be sick, but they just keep eating because they cannot control themselves. And this has happened for decades and decades. So, if you can take an athlete and you don't put them in as much of a caloric deficit, and they eat more food, and they eat more variety of foods with better nutrients, which means their body isn't as deprived and depleted, then after the show, they're not going to have as much of these binge urges and disorders. That is why I take the approach that I take. And I do work with my clients post-show. We still keep the accountability element of them checking in. But I also explain to them that, "It's okay—we are going to be gaining body weight right now. Some of it's going to be water, glycogen, and sodium, but some of it's going to be body fat. But that's okay because we want to bring your physiology to a healthy state again." But not done in a way that's super rapid.

MP: Absolutely. If a competitor wins, they're being rewarded for the aesthetics of their physique, which is the result of the hard work and dedication that they put in. But as you said, within this context, it is potentially one of the least healthy moments of their life.

These competitors have worked so hard for such a long period of time to develop their "dream physique." But this physique is not sustainable, and they have to move away from it and into a more stable body composition to avoid injury and to start growing again. As they start to go through this post-show procedure and drift away from their dream physique, do you find that transition challenging for people? Especially for first-time competitors? What types of things do you feel people are experiencing?

LK: It's one of the hardest things. It's almost harder than the actual dieting phase itself, even though food is higher and energy should be better. But you're right, it's because mentally, they are coming away from this physique that they've created over time. So, my general process is that I actually start a month or two in advance and just let them know, "Now we're going to start thinking about the post-show and our plans." And just make them aware that these things will happen after the show. I give them a document to read as well. We always have a plan post-show. Like I said before, "It's okay—this two pound increase this week is perfectly healthy, and it's normal. Some of those ab lines may be going away for a bit, but let's focus on your performance in the gym. Instead of using the 30 pound dumbbells, let's use the 35 pound dumbbells because you've got some strength and some energy back." So, "Let's now remove the weight-focused goal," which is a lot of it to be honest with you, or weight and physique, "and let's look at the more objective performance-based side of things. Let's put our effort and energy into the gym again." Which is where it all started from. If you think about it, way before people are getting ready for a show, it's all about feeling good in the gym. And that will be when they feel the best. So, if you can get them to remember some of those feelings, generally they will do better. But it is hard. I think the hardest thing about the whole competing side of the sport, for sure, is that post-show and sort of losing some of those feelings.

MP: I agree. It's really cool that you're reframing it and saying, "Okay, what can we observe now that are successes?" Things like strength and overall feelings of wellbeing.

LK: Also, bodybuilding is a very selfish sport. We have to make sacrifices from friends and family, business, social life, etc. So, I always say, "Let's focus on some of these aspects that you had to remove, or at least calm down a little bit, during this time." Again, I like to frame it from that perspective as well, to give back to the people that were supporting them in this journey.

MP: Absolutely, advocating a balanced lifestyle. I think that is sustainable and leads to long-term wellness. (pause) I would like to shift back to technology again. Regarding technological interventions for body image issues and disordered eating behaviours, within your area, have you heard of any positive technological interventions to treat these conditions?

LK: No, I don't think so. Not that I'm aware of anyway. Sorry. (laughs)

MP: (laughs) No, it's all good. Maybe we'll talk about design improvements to existing devices. When envisioning existing devices, like the Apple Watch you own and things like this, are there features that you feel could be improved? Are there features that are currently missing that you would prefer to have? Are there features that are clearly problematic that you think need more attention? Are there any metrics that you feel could be beneficial to track that are not currently tracked?

LK: I think everything comes back to, "What's the practicality of someone actually doing it or using it?" It's like, you have your phone, which has a step tracker as part of it, but you have to have it on you while walking around—again, not very practical. The Apple Watch is the same thing—the battery life is not very good, and you either have to charge it during the day at some point or you have to charge it overnight. So, the sleep portion of it—which I haven't delved into much, but it seems to be okay for this one in particular—but again, if you're not wearing it at night because you have to charge it, you're not getting that data. I personally don't like wearing things when I'm actually working out—again, I'm not going to be wearing it on my wrist, right? Practicality of steps outside of the gym—generally, most people are going to wear a watch, or they can wear some sort of basic Fitbit that still tells the time and gives them access to Bluetooth for their messages and stuff like that. So, I think it's creating a device that is going to be practical. The battery is going to be long-lasting, etc. Honestly, I did try the Oura Ring for some of those things, and I did play around with the heart rate stuff during prep for my last competition in 2021. And there was some fascinating stuff that I was finding out. It was more for my own personal knowledge—looking at heart rate, sleep duration, and things like that over the course of a prep. But it didn't track steps! At least from my understanding at the time, maybe that's changed. If it tracked steps, it would be a really practical solution because rings are fairly easy, you can generally do everything with them, they're waterproof, etc. If it had a really good step-tracking device in it, then maybe that would be a good solution as well. With regards to, "Is there anything else that I feel should be

monitored?" I don't think so, at least right now. Some people, like you said, can be really granular with some of these things, and maybe there's a purpose in research, but from a general coach-client relationship, I think the big bases are being covered. If we have an issue with someone and their sleep, it's easy to be like, "Well, just go buy an Apple Watch—they're only a thousand bucks." (laughs) Maybe the cost is prohibitive as well—maybe there's a financial aspect in here that can be considered? As something that could be more appealing for more people to potentially utilize them as needed. But in general, a cheap Fitbit is probably only 100 bucks, or 50 bucks, right?

MP: Those are great points. Regarding the Oura Ring, you mentioned there was some data that you found interesting—do you mind elaborating on that? And also elaborating on why you stopped using it?

LK: Yeah, I'm going to back this up a little bit. When I was at university, I liked to randomly partake in research studies. I can't remember the whole premise of it, but I remember that for one of them, they took our blood pressure and our heart rate before doing the experiment. I remember it was pretty much at the beginning of prep, and all my vitals were healthy—120 over 80, and my heart rate was 70ish beats per minute, or whatever. Pretty standard for a healthy human being. But when I did my next test, it was like a 12-week duration, and I was 5-weeks out from the competition, and my blood pressure was 100 over 50, and my heart rate was 37. So, you get to that point where you start looking at things, and it makes sense because the body just needs to be really efficient. I've got no body fat at this point, and the heart doesn't need to pump very hard to move blood around the body, and it doesn't need to do it very often because I've got no extra tissue that it needs to supply, right? Anyway, from that tangent back to the future, I was like, "Okay, let's actually track." Also, one of the things that happens in prep is that your sleep duration, at least in my experience, gets shorter and shorter. You find yourself waking up earlier and earlier. So, 4:30 am would roll around, and I'd be wide awake. Which is great because I was super productive and I could get all my work done and stuff like that. But generally, I didn't crash during the day. 10:00 pm would come, and as soon as I put my head on the pillow, I was asleep. So, I would say I had good quality sleep, but it was just less. Six, six and a half hours, probably on average. So, I just wanted to track the sleep, which did decrease. The heart rate variability on waking up was becoming lower. My resting heart rate was becoming lower and lower. It didn't track blood pressure, but you would see the same sort of thing again. Sleep disturbances do happen more often,

typically because people will go to the toilet more frequently because you've got fewer resources [carbohydrates, stored body fat, etc.] to hold things in. So, I do remember that there were more blips in the night. Again, that was just more of a personal research sort of thing, as I like to experience things on myself first before I apply them to my clients.

MP: Absolutely, I really understand that perspective. And then why did you stop using it? Was it due to practicality, as you mentioned?

LK: Yes, and I also think it just died on me. (laughs) And they weren't cheap, right? They're 400 or 500 bucks, or something like that. So, I was just like, "Ah, whatever. It's done now. My research on myself had been completed." But I think after the show, I was using it for a bit, and you did see these things reverse out with general energy consumption and body fat percentage slowly coming up.

MP: That is really interesting. (pause) These themes of practicality and longevity pose a question like, "How long do these companies expect you to use this product?" Speculative, blue-sky thinking—what do you think these devices will look like in five to ten years? Is that of any interest to you? Do you have any thoughts on that?

LK: My thoughts would be—a business like the Apple iPhone, every year they come out with a brand new phone, and it has these bells and whistles, and it's kind of attractive, and they want you to buy a new phone every year because it makes sense from a business standpoint. So, I'm not going to say that they're only going to make these things last for a certain period of time just to make people buy them more and more. But I feel like, ideally, with the way technology is improving and how it's becoming more efficient, batteries and battery life are getting better and better, and I feel like these things should last longer. But you've got the business side of things, and then you've got the actual helping humans side of things. So, it would be hard to get an exact answer on that one. (laughs)

MP: (laughs) Yes, I get it. (pause) Okay, some housekeeping questions, and then we're done. Based on the nature of this conversation and the topic in general, do you feel there are any individuals that I should speak with?

LK: I will think about that. Off the top of my head, no. But now that this topic has come up, you start to see more stuff. So, potentially, yes. Again, my clients are generally not focusing on this stuff. Most of the time, I'm doing it for a purpose, like getting them to track steps. Which is why I don't go overboard with a lot of my clients. A lot of them are not worrying about it to begin with, so they're not concerned afterwards either. But I will think about that in the industry and see if anyone does actively take more of that tracking approach with their athletes and/or clients in general.

MP: I would really appreciate that. And even if you identify any heavy technology users who love it and swear by it, I would love to hear from them too. But there is no pressure and no obligation. It is only if you are interested. (pause) One quick follow-up question that goes back to the post-show recovery period when you're starting to increase food for people—is there a way that you're tracking the food? Are you using MyFitnessPal?

LK: Good question. Yes, we usually use MyFitnessPal as a tracking device. There are some premium options for it now. But as a database of foods, it's used worldwide, and it's got a lot of good things going for it. It's super easy now. You can scan in barcodes, copy previous days, and then manipulate your day. So, it can be really time-efficient now, and I do like that. On a side note, on the scientific side of things, MacroFactor is really good. It's a bit more on the self-coaching side of things. It uses AI to manipulate changes in macros depending on your goals. But they're bodybuilders and powerlifters—they're PhDs—guys who are in the fitness realm and industry. I really like their app. If someone came to me and was like, "I can't afford coaching, but is there something that can help me, as well as track my food?" I would say, "MacroFactor is phenomenal."

MP: Cool, that is good to know. Thank you. (pause) Are you familiar with Dr. Mike Israetel and Jared Feather?

LK: I actually use his training app, Renaissance Periodization. Again, if you want to talk about tracking more stuff, you can track absolutely everything. I do like their way of approaching training. Again, they are a group of very scientific people, and I do like their training philosophies in general. So, I do like to use them on the training side. I know they have a nutrition stem—not as familiar with those guys. But MacroFactor has done a really good job on that side of things as well.

MP: Cool. So, you're using the RP Hypertrophy App, the new one they just released?

LK: Yes. Exactly.

MP: For my personal interest, do you like it?

LK: I do, yes. It's super customizable, but I like the way it tracks and changes volume for someone trying to build muscle. I think they've done a really good job. It's super user-friendly. It makes you put in options like, "How was the pump? How was the recovery? Was there any joint soreness?" and some things like that. Then, depending on what you put in, it will dictate how much volume it adds over time.

MP: Yes, it sounds super cool. Do you find there are any unexpected volume targets or deloads based on the previous session data?

LK: For the most part, it's quite predictable, assuming you don't overshoot your volume right away. It gives you the targets that you hit last week, and most of the time it will either add a rep or two, or it will increase the load by 2.5%, or something like that. That's what it's trying to do. But it will increase sets as the primary driver for volume increases. I ran two full cycles, like two training blocks, with it. And by the fifth week, which is kind of like the top volume week, it's definitely the week that you feel most destroyed, and maybe slightly run down, and all of these symptoms of overreaching. So, it nails it perfectly, and the next week is a deload week. And then you typically repeat the cycle or start a new training block. I feel like they have done a good job, but I also feel you have to have a good understanding of what you're using and how to apply it. If I gave it to a beginner, they would be like, "You're wanting me to do one set of this and two sets of that?" Or some intermediate-style athlete, where they're familiar with the gym but still want to push push push, right? Like four to five sets of everything, and stuff like that. But as you get more advanced in your training career, I feel like the volume is actually sometimes less than what you were originally doing closer to the beginning of your training career, right?

MP: 100%. There's a certain workload required to build the foundation, and then it's a different thing once you push past that boundary. I'm preaching to the expert here, but you

have to change things up a bit. What you did when you were young is not going to work quite the same when you're in your mid-30s.

LK: And just doing more all the time is probably not the recipe for success either. (laughs)

MP: No. (laughs) They have such an interesting model too. I believe it's a paid subscription and desktop-based? I believe I heard Dr. Mike Israetel say that the intention is to weed out the amateur, the beginner, with this barrier and to get it in the hands of people with a little bit more experience.

LK: Yes, for sure. It is in a desktop browser, but they've created it so that it does funnel into an app now. So, it's not so much a downloadable app from the App Store—you have to do it from the web browser. But it does work virtually seamlessly. I don't know if you can see (holds phone to screen), but this is the Renaissance app here (taps application icon), and then it comes up here, it goes through like so (scrolls through application), and then you have your sets and reps. It is slick. You get to pick the exercises as well. So, like you said, I think it is removing some of those more amateur beginners because they don't have the experience to understand what movements feel good for them. And that's one of their big things. It's not necessarily picking a squat. It's, "Let's just pick a quad exercise that you feel and go from there."

MP: Yes. He really stresses the stimulus-to-fatigue ratio. If squatting is just not hitting your quads, you're killing your lower back, and you're never reaching true failure, they advocate picking exercises that you can recover from and ones where you can actually feel the stimulus. (pause) Cool, we could talk about that all day. (laughs) Before we conclude, are there any topics that you want to bring up regarding this subject matter or things that you would like to discuss?

LK: No, I think we covered a lot. My experience with disordered eating and habits like that in general is generally quite low. But I will say that if anything brings it out, it's usually in that post-show recovery period. And it's typically short-term, but it's in that post-show recovery period that we talked about. So, I was happy we were able to cover that as well.

MP: Okay, cool. Do you have any questions for me before we end?

LK: No, I think that was good. That was a good discussion.

MP: Okay. I really appreciate it. It was an excellent interview, and I appreciate your time. I'll just quickly go through some housekeeping items here. As noted in the Participant Consent Form, once all the interviews are complete, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. Afterwards, the written transcript will become part of the research study data set. If you have any questions or concerns, please feel free to email me at any time. And once again, I would really like to thank you for your participation. I sincerely appreciate your time, your contribution, and your interest in this subject matter. Thank you.

LK: Thank you. [Interview Duration: 01:07:27]

Ben King, September 20, 2023

Michael Peel (MP): Before we begin, there are a few mandatory items that I must take care of. This will take approximately two minutes to complete, and then we can begin the interview.

Ben King (BK): Yes, I know this song and dance. (laughs)

MP: Okay, of course. I will restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This information will then be used to inform the physical and experiential design criteria for future devices and applications that seek to mitigate these potentially life-threatening behaviours. As part of this research study, I am conducting interviews with academic, professional, and lifestyle experts, such as yourself, to understand your perspectives regarding this subject matter. On the topic of subject matter, this interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. Finally, I can provide mental health resources if needed. The scheduled duration for this interview is approximately 60 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

BK: No, I'm ready to chat.

MP: Okay, now we can begin the interview. (pause) Like I mentioned before, I dove into your professional background through what's publicly available on the Internet, but I would love to hear about your academic, professional, and research background in your own words.

BK: It started with a practicum back in my undergrad. It was with COMPRU at the time, Craniofacial Osseointegration and Maxillofacial Rehabilitation Prosthetic Unit, hardcore reconstructive medicine, that kind of stuff. That really opened the doors to a lot of different medical and healthcare professionals and me working with them. Some of that work has been published, and some of it has not. I was at Compru, and that transitioned into iRSM [Institute for Reconstructive Sciences in Medicine]. I was there for about six years and mainly worked in that area of reconstructive medicine, but I made a lot of contacts outside of that as well. We constantly had people coming into our lab, which was called the Medical Modelling Research Lab, and it was a suite of technology that lots of politicians and people would like to come and visit. We had an investment from Western Economic Diversification —government dollars—that helped to pay for a lot of the 3D scanners, printers, haptic devices, and all that kind of stuff. They liked to come around and see where the money was being applied and the applications. And a lot of that was for surgical interventions. So, cutting down the amount of surgery that someone might go through by using technology and 3D modelling to plan their surgeries, as opposed to cutting them open and planning as you're doing it. (laughs) That was really rewarding. And then I worked as a consultant for several years after that. I bounced around with different startups and established entities, ranging from diabetic monitoring devices to in-hospital care for urine analysis—so that people could have a little more dignity when they weren't able to communicate during long-term stays. When they were reaching a level of being too soiled, their diaper, pad, or whatever they were sitting in would remotely let the nursing staff know that it was time to change them. And then I worked within peripheral neuropathy—that's where people lose feeling in their extremities—developing a device that is able to tell you when blood might be cut off to your extremities. Throughout this time, I kept in contact with a bunch of the people that I had worked with previously. Starting in about 2014, one of my former colleagues at iRSM started working on a PhD project supervised by another colleague from there. It was basically miniaturizing this device that they had in the hospital. It was the size of a refrigerator, and they had to lug around the hospital, push through elevators, and all that kind of stuff. Fundamentally, it was a biofeedback device that they would hook up to patients who were typically coming in as part of their rehabilitation process after having head and neck cancer and the associated surgery. They may have lost the function of speech. A lot of times they would have had their tongue resected—so, a big part of their tongue was taken out—and they had to learn how to talk and eat again. And part of this is speech therapy, which I like to imagine as having a piano teacher or physical therapist,

where everything is great when they're in the room next to you, and then you're supposed to go home and do this on your own, and you don't remember exactly how they taught you, you don't stick to a schedule, and you may lie a little bit the next time you see them, like, "Totally, I was doing this every day." So, after that initial phase where she worked with, I think, three undergrad students, they came up with an initial concept. And Gabi [Gabriela Constantinescu], who was the clinician on the project, went to her supervisor and said, "Hey, can we maybe pitch this somewhere?" They managed to get quite a bit of money from the Alberta Cancer Foundation, which allowed them to bridge that into a research project, which brought myself and one of my engineering colleagues on board. We got that to a prototype phase where we could test it on actual patients, and it turned into Mobili-T. It's this little, tiny wireless device that goes underneath a person's chin and can pick up on the electrical activity of their muscles. When a speech-language pathologist has said, "Okay, these are the types of exercises that we want you to do at home," they can now see on the screen if those muscles are actually being activated in terms of the efficacy of doing the right types of exercises to get better. Also, all of their activity gets sent to their clinicians, so it closes the feedback loop of, "Am I doing it for the right amount of time and intensity to get the desired results so that I can speak, or chew, or be out in public, and go for a coffee with someone?" And then, leading up to today, a lot of those colleagues are part of this tech startup called True Angle Medical. Part of my job has been working on Mobili-T. And then, on the other side of the R&D part of that company, I've been leading a lot of the ideation of new technologies, and some of that is dipping into athletics and more of a consumer market. We have a couple new patents that we're currently filing, so I can kind of talk around some of this stuff that I'm working on. I can definitely talk about some of the research that I've done with athletic populations. But yes, fun stuff. We're a growing company that started with really hospital-based medical professionals, and now we're branching off into some pretty exciting consumer stuff.

MP: It's really cool to hear about your journey and your progression. (pause) What type of clients do you currently work with? Do you work directly with athletes? And if so, what type of athletes?

BK: The area that we're focused on is athletic recovery. One of the things that we identified early on is that we have all of these amazing devices, whether it's a Peloton or your Apple Watch, that are very much focused on the activity itself—so, tracking it and reflecting on it.

And there are great devices like Whoop that will track your sleep and help you understand, "Maybe today is not the day that you do 400-meter repeats. Maybe you need to hold off on that and just go for a nice and easy hour-long walk," or something like that. So, there are devices that are starting to creep into this recovery market. But for the most part, it is kind of like this black hole of, "Am I overtraining? Am I working too much?" And I think that starts to tie in with some of the stuff that you are investigating. A lot of the individuals that I've been speaking with over the past month are people who love to track their progress. I'm focused on people who are very interested in "aging with capability" as opposed to "aging gracefully," people who, in their 40s, 50s, and 60s, still want to be very active and performing to the best of their abilities. They're very interested in knowing, "When is the right time to take a down day and just do some yoga? When is the right time to push myself? And how far can I push myself?" Because I think a lot of these individuals are chasing the ghosts of their athletic backgrounds, whether they were collegiate athletes or high school athletes, or whether they found athletic endeavours as they aged and are now in masters programs for swimming, running, biking, triathlons, and all this kind of stuff. Maybe they're chasing versions of themselves that no longer exist, and there's frustration in that? But at some point, it's like the Kübler-Ross model of grief, where eventually there is acceptance. (pause) But the technology that's available to them isn't necessarily helping them understand what their bodies should be doing. And part of that is listening to your own body—that's definitely a big part of it. And maybe there is an overreliance on technology. "My device is saying that my heart rate was good during my 8-hour sleep last night and that I should be ready to go. But it's 10 minutes into the workout, and I'm feeling it! Should I stop?" So yes, there are definitely some interesting things. I think just navigating the complexity and availability of information is a real challenge for these people who are very focused and driven and want to research this, understand their bodies, and understand what's best for them, but the enormity of that equation is horribly overwhelming.

MP: Absolutely, I agree 100%. These are themes that I'm encountering with my population as well. A lot of the things that you mentioned, like the complexity of data, adherence, rest and recovery, and trying to find ways to connect with embedded bodily sensations, are topics that I want to speak with you about. It's great that you've started to bring those topics to the surface. (pause) In your current area of research, are you encountering body image concerns or disordered eating behaviours with any of your clients?

BK: When I read your topic, I thought, "Have I encountered this?" And I wouldn't say that anyone has explicitly brought it up, and it's not something that I have been seeking, but it is definitely something that you can read between the lines that is there. One individual who I spoke with comes from a military background and has gotten into ultra-running. He loves doing these intense 50 to 120 kilometer races in the mountains. For a very long time, he tracked everything on Strava and was obsessed with his metrics. This worked really well for him until he started having kids. And then he realized he was now fighting between meeting these benchmarks and feeling a sense of satisfaction—and not getting the volume in and trying to squeeze it in during the morning or night, and now compromising his sleep to chase something where he's like, "Why am I doing this?" He finished all these amazing races and podiumed a bunch of them, and it's like, "What am I chasing?" And he realized at some point, "I just want my kids to have a love for being active for life—for being outdoors, running, or whatever they're interested in and not feeling like it's an obligation, but feeling like it's a joy." So, he deleted Strava, and I'm like, "Aw, I loved looking at all these crazy things that he's doing in training and in races." But I talked to him about it, and I totally got it. One of the things that tech is really capable of doing, especially when it comes to tracking on platforms like Strava, Garmin, or Apple, is that there's almost too much analysis and reflection about what you're doing. Instead of just being happy with something like, "I managed to get outside for an hour or two today, and that brought me joy. I got to hang out with these people, and we got to share the trail together." Instead, it's like, "Aw, I didn't hit my per-kilometer pace that I wanted to today." Or, "My heart rate was a little higher than it usually is—is there something wrong with me?" It's this overanalysis that can lead to body dysmorphia and all of these issues. I talked to one cyclist, and he had a really interesting perspective regarding obstacle course racing. He was talking about how he has to balance strength with these endurance endeavours. When he goes out and does longer races, whether it's on the bike or on the trail, he often has people commenting, "Oh, big boy! What are you doing here?" And if you saw him walking down the street, you'd be like, "That's just a fit dude." But in comparison to the rail-thin ultrarunners or mountain bikers, they just see him as this complete outlier, regardless of his performance. He might podium something, but they will comment on it. Other competitors and other people on the side will say, "Whoa, you're going to gas out. You shouldn't be bringing that much muscle to the course." And I think he's got a pretty level head, but those kinds of things impact everybody. I've done trail races where I was not a small human being. I'm 6'6" and about 240 lbs, and I've gotten comments like that too. Like, "Whoa! You're going to die at the top of the mountain. You're too big to be doing this." And I'm

like, "Okay, thanks." (laughs) And I have never been someone who is carrying a lot of excess body weight or anything like that, but when you get in these circles of ultra-fit people, all of a sudden it's like, "Whoa! Why are you judging me?" So, that kind of stuff resonated with my own personal experiences and stuff that I was hearing from interview subjects as well.

MP: That is very interesting. I really appreciate that you shared those perspectives, and they are very relatable. (pause) A lot of the design and human-computer interaction literature will talk about adherence to these devices and applications, often asking, "How do we increase adherence?" And one of the common themes that tends to come up is creating communities, meaning, having a social component, and methods for the users to interact. And, like you said, in general, this also opens the door to critiques, comments, and comparisons. But now this can occur in ways that were not feasible before because the social component is knit into the activity through the application. So, it is very interesting to hear your perspective. (pause) In a general sense, everything has pros and cons. Therefore, I would love to hear if you have observed any positive benefits or negative consequences with these devices or applications? And this could be in terms of behaviour, performance, or mental and physical health.

BK: There's so much to unpack there. I think I'll start with the keyword that you used, which is "community." Strava, to me, is one of the healthiest forms of social media that exists. It reminds me of the early days of Instagram, where it was literally just, "Post a picture. And if you like it? You like it. That's it." There was no extraneous baggage associated with it. It was just people posting beautiful pictures of sunrises and whatever. (laughs) There was a purity to sharing your life's experiences. But eventually it gets polluted with monetization—with people trying to promote lifestyles that don't exist. So, you're not getting the full spectrum—you're only getting the highlights. Like, "Oh my goodness, I had the best day ever," and you're not getting the 99% that is just ordinary or terrible. And I find that with Strava, for the most part, there's a really healthy dynamic. I do find that I've made some great connections on there where people will give you a "thumbs up" or leave a quick comment like, "Way to get out there at 6 am and get your run in." That kind of stuff. And as that platform grows, I'm sure the pollution will come in, and it already has to a certain degree. Obviously, the things that are more impressive are the things that get celebrated more. Invariably, Strava's algorithm is going to promote those more impressive things on your feed. As opposed to, "You did an hour of stretching tonight? Good job!" (laughs) You look at Strava as a platform bringing communities together, and it started with "King of the

Mountain." Basically, just doing roots around your neighbourhood, and then you'd be able to compete against other people you potentially have never met before. There's a lot of positivity in that. And like any competition, there is sometimes compulsion and obsession over things. And maybe you push yourself to do things that wreak havoc on your mental well-being and, obviously, on your physical well-being. From a very personal perspective, when the pandemic was going on, Strava became something that was so helpful for me. I signed up for a bunch of virtual races. There's an Alberta-based OCR [Obstacle Course Racing] company called X Warrior, and they put on this Arctic Ultra race, and you would log all of your runs on Strava. The sense of community—it was a month-long event where you would go out and put in as many kilometers as you could every single day through the month of December. It was cold and hard. It attracted people who, regardless of what was going on in their COVID lives, still just wanted to be active and push themselves. And I remember the first day—I intended to maybe run 5K a day—and the first day someone dropped a half marathon. It was a bitterly cold day, and I'm like, "Oh, man!" And at that point, the competitive side of me was like, "It's only seven o'clock—let's see how far we can go." So, every day—and my wife was super amazing with this—every day I just started adapting. I have four kids, and I would pop them in this sled that I could drag, and I would run them to school every day. That would be the start—and that's the hardest part because you're dragging a couple hundred pounds behind you—and as soon as that's off, it's a lot easier. And then I would keep going for another hour while they were at school. So, I averaged a half marathon a day for the entire month, finishing at 620 kilometers for the month. Instead of a metal, they give you an axe with your kilometer total on it, which was super awesome. I will always have a soft spot for Strava because of it. Everyone's experience with COVID was different, but for most people, it was horrible and just a shitty time. And this was a real bright spot for me where I got to show my kids, "You can push yourself to do really, really hard things." And this sense of community throughout the entire thing—I think there were like 250 of us doing the event—and just the amount of comments and people saying things like, "Holy crap! It was minus 35° and a blizzard, and you're still out there putting the kilometers in. Amazing work!" There was never any jealousy or anything, which was such a strange thing to experience on a form of social media. That, to me, encapsulates what these platforms and devices can be capable of. They can bring people together, they can encourage you to push yourself, and they can show you people who are incredibly inspirational. And then, obviously, the negative side of that is chasing

things that you're either not capable of or shouldn't be doing, and you start to obsess over them, which can lead to all of these really detrimental behaviours.

MP: Absolutely. I really appreciate learning your thoughts on that. I started using Strava in 2012. I was a mountain biker, and I thought it was such a cool idea. At the time, it was fascinating to see your route recorded and tracked. And it was such an interesting time because a lot of the zones hadn't been championed yet, right?

BK: Right!

MP: So you could be "Number One" in a lot of areas. But that lasted maybe a year, and then you were just obliterated. (laughs) And, from what I remember, it's one of the fastest-growing apps with some of the most users.

BK: Mmhmm.

MP: I would like to transition into the topic of bodily sensations, and this may relate to what you were speaking about with recovery. I feel there could also be a connection back to Mobili-T, where, I believe, you use visual biofeedback to help establish the patient's mind-to-muscle connection?

BK: Yes, it's in real time.

MP: With the ultimate goal of strengthening those muscles?

BK: Yes.

MP: So, that basic theory—performing an action and then seeing real-time results or viewing the data afterwards—is the basic theory for a lot of these tracking devices and applications. With all of this said, I would love to hear your thoughts on the impact of wearable technologies and associated digital applications on the embedded bodily awareness or senses of the user. Do you feel these products can help someone get in better touch with their body? Or do you feel the reliance on data can create a disconnect with the body? What are your thoughts?

BK: Like anything in this domain, there are layers to it. The rise of Peloton is a really interesting one to look at. They looked at a demographic of fairly affluent people who have busy lives and thought, "How can we bring the excitement and energy of a spin class—they don't have time to go to another place—so, how do we bring that into their home?" Obviously, there are other companies like NordicTrack that have these offerings where you're running along the mountain trail, cycling on the Tour de France, or something like that, where you're following along with either a real person or an avatar. And I think there is definitely prolonged motivation, where you're getting some kind of stimulus. If you look at interaction design, you've got this framework of "Cue > Routine > Reward." If the reward is not variable, people will drop off very quickly from whatever you're providing them. So, having a variable stimulus where you're seeing new locations, trainers, and challenges—those kinds of things can lead to great engagement and long-term adherence. There are real positives in that regard. A company that you might want to look at when it comes to biofeedback is Athos. I don't know if you've come across them. For a lot of my early research, I was looking at, "In terms of biofeedback, what are we capable of as a company?" And the types of sensors that we use in Mobili-T can be applied to any muscle group. So, you can put this on your quad, or you could put this on your bicep, and you can get real-time biofeedback. And there's a company that did try this, Athos, and they partnered early on with the NFL, with the American military, and those kinds of things. They managed to get a lot of early support, and they had different types of clothing embedded with these sensors that would show your muscle activation. I think they tried to make this a commercial venture—giving it to everyone who's a weekend warrior who wants to assess how they're doing at home. Like, "Am I doing my pull-up right? Am I activating the muscles that I think I'm activating when I'm doing my bicep curls? Am I using my shoulders instead of my bicep?" those kinds of things. And everything that they showed seemed to make sense. I managed to talk to one of the trainers for the Edmonton Oilers, and he had actually demoed this and tried it out. He was really interested, and he thought this would be fantastic. Especially for Return to Play, where they could get some kind of baseline for muscle activation, "How much energy is being produced from certain muscle groups?" For example, if a player gets injured, an ACL [anterior cruciate ligament] injury or something like that, "Okay, we can make sure they are in specific ranges where they're not going to hurt themselves." We can actually apply a scientific assessment to their recovery in a way that we can't right now. Currently, a lot of it is based on feel, and they will do a self-assessment like, "How are we feeling today on a scale of 1 to 10?" that kind of stuff,

and they will have a conversation. So, this is really interesting tech. He tried it out and said, "It was just too inconsistent—getting it to sync, getting it to setup." Eventually he was just like, "You're wrestling with the tech too much." So, the promise was amazing, but the actual implementation fell short of what people were looking for. Eventually, everything from them just started to trickle away, and the founder moved on to other things. But there was a lot of promise there. Especially from a trainer or a physiotherapist perspective, where you're connecting "what you think you're doing" with "what your body is actually doing." You can get a better sense of, "Oh, I'm actually compensating with this muscle group, and that's potentially going to lead to injury or reinjury." Which I think can be really beneficial in certain contexts. I'm kind of glad that the company didn't succeed because it just seemed like too much. Like, every run you go for, you're gearing up with your super soldier suit, and you're getting so much data and analysis. Again, it comes back to that sense of obligation and performance improvement. Versus, just the joy of being active and being grateful for the capability to do this stuff. You're an active guy, and I'm sure you have many friends who, when they're training for something hard, obsess over stuff. Whether it's training for a marathon or whatever, they can push themselves way too far. And I think that this kind of technology can really enable that. Those personality traits that have those compulsive behaviours when it comes to perfection and getting the most out of your body—it's one thing when that is your profession, it's another when you have families and work, and everything is playing second fiddle to this hobby of yours.

MP: Absolutely. There is a lot of really great content there. And I agree in many ways. (pause) Let's take a basic example, like getting somebody into the gym and teaching them how to squat. As they progress, you do want to make sure there are cues like, "Do you feel this in your glutes, in your hamstrings, and in your quads? Are you initiating with your quad on the upward movement?" But a lot of that is too complex for the novice. However, at a certain point, a lot of those sensations become embedded within the body. But if you don't develop them yourself and you're relying on the technology for them, I feel there is a disconnect and an inability to master the movement. Because so much of athletics, and so much of performance, is about thoroughly understanding your own body. Maybe you could speak about this? The literature is actually saying that amateur and novice athletes are very interested in the technology, that there's higher adherence and potentially an overreliance, but elite and professional athletes are more likely to find the data and the

technology somewhat useful but secondary, as they have a very intimate understanding of their bodies. Is that something that you have found?

BK: Yes. When you look at the products that are out there, like the Tonal Mirror—these devices that you can put on your wall, you have a virtual trainer, you can see yourself, you're imitating these movements—that's another way of accomplishing what these biofeedback systems like Athos were trying to accomplish. And they very much appeal to people who are starting their fitness journeys, who have a lot of self-confidence issues, who have a lack of knowledge and self-awareness of what their bodies should be doing or are capable of doing. "What weight should I be using? Is it safe to do this?" Like you were talking about, "What muscles should be activating?" They might not even know, "That is my glute that is being activated." So, I think these kinds of platforms have a real benefit for amateurs. But one of the huge discrepancies is the cost associated with them. These are $3,000 to $5,000 setups. A Peloton device, which could be beneficial for so many people, is exclusionary—it is for wealthy people. It is not something that invites people who would benefit the most from being active into that ecosystem. From a profitability standpoint, "Okay, cool, you get Serena Williams to rep your product and everybody wants to follow along," I get it. But let's look at North American numbers in terms of obesity, and let's look at kids and make sure that they're getting at least an hour of exercise a day. These are such niche and exclusionary products. And this is wishful thinking—this is me taking off my capitalist hat—I wish more companies looked at this from the perspective of, "How do we get more people active in a positive way, where they find sport and activity for life?" As opposed to these spectrums where you've got competition—where a lot of people find sport early on through competition, and then once they're no longer in high school or university, that drops off, and they have huge amounts of health issues associated with that because they don't have a team or a coach pushing them anymore, and that gets replaced with job and family responsibilities, and they have to find new ways to motivate themselves. Or the other end of the spectrum—where they never found sport as a kid, and now they're in their 30s or 40s, and they're dealing with all these health issues, and they're trying to touch their toes, and they're trying to get out for a 15-minute walk every day. Where's the middle ground to make sure that we're raising healthy populations? And you do find it in some countries that have invested way more in bike paths and things like that. But we're a winter country. Where is the infrastructure and tech development that is focused on building these healthy habits and behaviours for life? Not just when it's an acute issue where someone has to lose a couple hundred pounds, where they

have all these cardiac issues. How do we do better as a country when it comes to leveraging the capabilities of these technologies to help people learn and maintain a love for activity? We're all fighting against our office chairs, and we're all fighting against our screens, because those things are very compelling! (laughs)

MP: That is a really great perspective, and something I agree with too. This is just an aside, but I believe it's a Buddhist analogy that states, "The finger pointing at the moon is not the moon." With our current capitalist way of thinking, it can feel like the tech device—or the Peloton, or the Woop, or the $10,000 carbon fiber mountain bike—is the activity, or that it's the prerequisite for health, and it's not. The barrier to health is low, and if you have a certain amount of mobility, it's free. This reveals a bit of my bias, but I feel that because the technology is so ubiquitous, it potentially instills the attitude that the technology is a requirement for some of these activities. You spoke about Strava, and some of the mountain bike websites have featured critique articles that state, "Does a ride count if you don't track it?"

BK: Yes. (laughs)

MP: And generally, it's satirical, but I think everybody in the industry is aware of the changing behaviours and dynamics. (pause) I will stop talking and make sure this is your interview. (laughs) The next topic directly relates to something you mentioned before, which is the complexity of health data. As it is now, in the forms that you interact with, what are your thoughts regarding the complexity of health data? This can be in terms of the user interface, the user experience, contextualizing it, making sense of it, whether it causes overwhelming feelings, whether it's easy to understand, etc.

BK: I think Garmin is a wonderful company to look at in this regard. I could be wrong, but they seem to me like a "spaghetti on the wall" type of company, where "hopefully something sticks." If you go into their user interface, there is so much stuff to navigate, and you can pick things that are meaningful to you. But I think if we're looking at the majority, the 10th to 90th percentile of users, and not the outliers, most of them are just looking for data that is understandable and repeatable. There's a reason that "10,000 steps" has stuck around for as long as it has. I'm sure you're aware of its origins as a marketing campaign. But it's wonderful in some regards because it is so easy. You can get a super cheap pedometer, and every single watch and phone out there can track this. So, chances are,

people have access to it within something that they already own, which is wonderful. And it's something that is just crystal clear, like, "I achieved it" or "I did not, so tomorrow I'm going to try better." Versus the variability of heart rate training, "Okay, I'm supposed to be in zone 2, but I went too much into zone 3, and I was in zone 4 for a bit today, and I shouldn't have done that, but I was feeling fine, and I never felt bad." There are so many people who put everything they believe into deeper metrics. And just to bring it back to gear and the "finger or the moon" analogy, I think you'll see more people starting their journeys who are investing in really high-tech gear, like shoes and bikes. There's obviously a lot of reasons, but I think one of the main ones is that they want to feel like they're a part of something faster than they probably should. So, they're willing to go and spend $300 on a pair of Nike Alphaflys because it's giving them that much more speed than they have right now. And then you look at pros, and it's like, "You can put a pair of sandals on them and they'll still be within their performance metrics." (laughs) It doesn't matter what gear they're wearing because they have mastered that mind-body connection. And they have confidence, and that lack of confidence leads to a lot of spending. So, when we look back into the data that people are feasting on right now, it's kind of like this jump from, "I don't know what I'm doing," to, "Now I have some jargon, and it gives me a feeling of self-satisfaction and confidence to be able to speak the language that other people are talking about." Whether it's heart rate, training zones, cadence, revolutions per minute, or whatever it is, like, "Oh yeah, now I'm able to do this on my bike, and when I started, I was just mashing." Being able to understand some of that language makes you feel like you're a part of something and makes you feel like more of an expert. And when you're talking to someone who is at the beginning of that process of discovery, you sound like you know what you're talking about, and that's gratifying. And that in itself is part of the issue. When you are looking at idols—if you go and look at Eliud Kipchoge's stats—no one on planet earth should be chasing a sub-two-hour marathoner, but that's what people do—they try to emulate his training. And it's like, "No, you have to earn that. You can't jump into it. Even if you're scaling it by 50%, that's not healthy. His entire life has been built up to this point." And that is both the beauty and the damage that can be done with access to professionals and their advice and information. These are people who have likely been active since they were babies and probably haven't had many periods, other than injury, where they weren't extremely active. They don't know what it's like to put on an extra 50 pounds and be burdened by a 12-hour workday. Their advice, while probably in the right place from a heart perspective, is not in the right place from a physiological perspective. That in itself—the advice of expert trainers

who are working with professional athletes and the athletes themselves—is a data point that can be very harmful and something that people chase and aspire to that can cause a lot of mental and physical damage. Aside from the obvious metric-based tracking where you're constantly chasing something, whether it's your 50-meter time in the pool—"Oh, it was down this week. I've got to change my nutrition, or sleep, or something." You're always looking for those things to explain why things have changed, and that can be really positive, but when you start micromanaging, that can be really problematic and can lead to all these issues that you're investigating.

MP: There are so many great themes there. One theme that keeps coming up is the community component. When you said, "Once you understand the language and the gear, there's potentially acceptance within the community," from my personal experience, I feel this can be true. These disciplines have changed and if you're not showing up with the right kit, you might look and feel like you don't fit in. I remember racing a 24 Hours of Adrenalin mountain bike race in a white T-shirt, and people made a note of it—they were like, "Where's your jersey? Where's your moisture-wicking fabric?" (laughs)

BK: Right. (laughs)

MP: Anyway. These themes of acceptance within your social community, as well as acceptance of your personal limitations and who you are at that stage in your journey, are very interesting. Another interesting theme you brought up is the idea of "What advice actually applies to you?" I have training friends who are very high performers in all areas of their lives, and then they're bombarded with this optimization and hustle culture through social media. So, there will be people like David Goggins and others who will tell you…

BK: "Go die on the road today!" (laughs)

MP: Yes. (laughs) But you have to remind these people, "That advice isn't for you. That advice is for the person who is still on the couch. You've already completed your run, and now you're in the gym." I think it can be confusing. It's definitely confusing for the amateur and for the intermediate. But for the professional, one of their best traits is their ability to block out distractions and complexity, and that seems to be part of the reason they are so successful.

BK: Absolutely. I wanted to touch on the gear thing. So, all four of my kids did triathlons this summer. Even my youngest, who was four at the time, was competing against seven year olds. We just wanted to get a sense of, "Is this something you kids are interested in?" They all swim competitively, they come out for runs with me, and they go around on their mountain bikes. It's like, "Okay, here's a sport that offers you all three of these things you like—let's see if you like it." And just like how you showed up in your cotton T-shirt, they showed up with their mountain bikes. And every other kid they were competing against, as young as five years old, had an insanely expensive road bike and a one-piece suit with their name on their butt, which was wild to me. The four kids have wildly different personalities, as most kids do. Two of them were like, "Whatever, I'm going to crush these kids in their sparkly outfits." And the two older ones were like, "Oh man, I feel so out of place, like people are judging me." And it was like, "We're just here to try this." It's funny because the people organizing it were super receptive and were helping tune the bike beforehand and all this stuff. But it was the kids of the same age who were giving those glares and making little remarks like, "Yeah, you're going to have a rough time on the road with that one." Just stupid little comments, right? And it's those little things that start to stack up and impact people's perception of self and of fitting in. And it can have a negative impact on trying new things, being open to failing, and not being the best every time. Which is awful, because as you go through these stages of your life where you have way more responsibilities, that's going to be the first thing that drops off because, "Oh, I don't like the feeling I get when I'm trying something new." And, "I don't have organized sports anymore, and now I have to go find a new activity? Okay, not going to do that."

MP: It's so true. The intensity of everything is increasing. And maybe it's because of visibility and comparison through social media? I was having a conversation about hiking with a friend of mine. Hiking is typically a low-barrier activity. We were talking about overnight backcountry camping. They mentioned they were having a conversation with some people who were pretty intense about it. They were speaking about "how many grams of food per 100 calories" they were packing. And I can't knock it, because there are metrics that I track and things that I think are very important for my personal performance in the disciplines that I take seriously. But I view hiking as something leisurely, and when I think about measuring my "grams of food per 100 calories," I think that may take the fun out of it for me. The point I am trying to make is that once that dialogue begins, people start to be aware, and then they have to make a sort of introspective judgment regarding whether that applies to them,

whether they care, whether they are going to measure, etc. And some outcome occurs, whether they say, "I don't care—I'm just going to have fun," or they say, "No, that bothered me—I might not do this activity again, or I might not do it in the same way." And it's really difficult to tell within the marketing what's necessary and what's being pushed upon us.

BK: Yes. It's funny that you bring this up because I had multiple conversations in the exact same vein. I did the full Juan de Fuca Trail with my wife and a couple of my kids this summer. Again, I do all kinds of trail stuff, but we had other family members who were taking it very seriously. We had this group chat, and one of my brother-in-laws—my goodness—he was considering every little gram. He invested in this tent, which weighs two pounds. "How much did you pay for that?" He's like, "Oh, it was $1200." (laughs) I'm like, "What? Why? Yes, my tent is double that weight, but at the end of the day, I don't think that's going to impact me in any meaningful way." His approach was just so different. A couple weeks before, we tried a whole bunch of those freeze-dried and dehydrated foods. We had a buffet that evening with the kids. "Let's try some different ones and see what you like." So, it was about finding what was most delicious, as opposed to him, which was all about weight—all about matching his calorie intake to the weight of the pouches. And while you and I are looking at this as "That's absurd," for somebody, this is their central activity, and this is something that they want to obsess about. And to your point, they have to have this introspective discovery process of figuring out, "Is this something that I want to pursue with more passion and rigour? Or is this something that really doesn't matter to me, and I'm just going to do this for fun every now and then? And if I struggle a bit more, okay, who cares?"

MP: Yes. And to circle back to the wearables and the apps, now we're in an era where more people than ever are aware of their health data. If they own a phone, they have some very basic data, like their steps. At minimum, there is a sort of awareness. Whether or not it's truly important to that individual, it's there, and it's being tracked. It's an interesting thing, and I don't know what the future looks like, but when we talk about the progression of these sports and the positive and negative implications, I feel like we're on the threshold of a new era. Apple and Google are interested in these areas, and they're consistently releasing new and improved products, so they're likely not going away. (pause) I want to shift it back to the design side since you're involved in this area, you're heavily knowledgeable about this area, and you have both professional and personal expertise. Do you have any thoughts on design considerations to potentially mitigate some of the issues

that we've talked about? Things that you feel could be improved? Or things that you feel may be problematic? Is there anything that comes to mind?

BK: Yes. It's tricky stuff. I think, for the most part, there is some level of altruism at the root of most of these companies. Whether it's a platform or a piece of hardware, there is an altruistic root, where the founders identified something, wanted to inspire people to be active, or there was a problem that they were trying to resolve. And as the companies scale, that changes. The value proposition might be something to begin with, but then it's, "How can we sink our hooks into these people for as long as possible and monetize every interaction as much as possible?" This shift from offering standalone software or a piece of hardware—people don't invest in that anymore. Venture capitalists are just not interested in one-off hardware products. There has to be some kind of software as a service [SaaS] component for them to invest nowadays. They want that continual, reliable, long-term revenue stream coming in. And because we as designers are good at tapping into people's emotions, like their fears and their behaviours, we're really good at tapping into those things that you just can't get from straight demographic information, and that can be exceptionally harmful because by tapping into those things once someone is in your ecosystem, you are potentially creating false cravings for things that you don't actually need to resolve. I look at products that track how much water you're drinking each day, and, to me, that is such an extreme because you have this built in you. If you're thirsty, you drink—you have this mechanism built into your biology. But there are some people who are so locked into their devices and their work that they now rely on these external prompts to help them with something that shouldn't need to be helped. I think that is an example of the dangers of design—designing for problems that shouldn't be solved. We shouldn't be trying to convince people once we've bridged into marketing. We shouldn't be trying to persuade them that this is now an issue they need to pay attention to. And that's not to say there are no people who would benefit from it—there are always outliers who are going to benefit from it. But from a healthy population standpoint, there are so many things that are presented to us through our different social media streams that we have to ponder, "Does this apply to me? Is this something that I should be paying attention to?" I think that is one of the inherent dangers of design—as a profession, we are often downstream from the decision-makers. So, some decision has been made like, "This is something that we want to capitalize on—that we want to feast on—because we figured out that this is something that can be monetized," and then they go and talk to this whole profession of people [designers]. Visually and through

language, we are so good at persuading people that this is something that you need to pay attention to and that you need in your life. So, we're using our compelling means to convince people who don't have this problem that, "You have this problem." Like I said, that goes hand in hand with the scalability of a product and a company. Google, when they're buying a company, they're not looking to make cents—they're looking to make billions of dollars off of any of their investments. They're going to take giant swings at this. As opposed to, "Hey, this is going to benefit a thousand people," it's "We need this to impact a hundred million people." The scalability of the problems is one thing that's incredibly alarming to me. (pause) There are very few business models for small companies to be able to take losses or small profit margins. Which is just problematic for the whole design profession, where we're told that this is important, and we put our heart and soul into communicating its value, and it's like, "You shouldn't have done that." (laughs) But because you're being paid to do it, you did it, and you did it exceptionally well.

MP: These are excellent points—they are things that I agree with and things that I've wrestled with within this project. Thankfully, I've had the luxury of approaching this topic organically, meaning that I don't have a predetermined outcome. This is not necessarily an exercise to collect some data to create a new watch or a new app. Rather, I have the opportunity to take a step back and attempt to identify the problem. "What is the state of the field right now? What are some of the problems? How do we move forward? Do we move forward? Is it another technological solution? Or is it a critique and recommendations?"

BK: Right.

MP: And you are echoing so many things that are emerging in our design discourse. Don Norman's new book, Design for a Better World, speaks about the psychology that informed many designers and was ultimately applied to many products and systems. And now, there's potentially some regret because this empowered all of these people, who are essentially agents of major corporations, to thoroughly understand how to capture attention and manipulate people. So, I really appreciate hearing your perspective on this. And I feel it is quite a dilemma within the design discipline regarding how to proceed, especially when these companies are huge and powerful, and we almost look at them like they can do no wrong.

BK: Yes. There was a project in one of the Health Design courses that I taught a few years ago that was focused on sound, hearing health, and awareness of that. And this one group came up with this idea to implement into iOS or Android the ability to track different noise levels that you're being exposed to every day. Then, a couple years later, Apple obviously released this, and it was just built into iOS. And it was like, "Wow, that was so cool! This idea that you came up with, that would be really beneficial, was implemented by this company." And reflecting upon it, it's just a data point—that's all it is. You can put it into your HealthKit, and you can get notifications on it, but at the end of the day, there's limited value. Outside of the people who obsessively track these kinds of metrics, and this is an assumption on my part, I would imagine most people who have access to this feature have never paid attention to it. Or they saw it once when it was first rolled out and have never used it. When are they going to pay attention to it? When they have hearing damage, 10 years from now, after spending too much time with these things (earbuds) in their ears, at too many concerts, whatever it is, and now they only have 40% hearing in one ear—that's when they're going to pay attention to it. And that is the dilemma for design. I think, for most of us, we want to be proactive, but unfortunately, when our skills are brought to the table, it's when something has become an acute reactive issue that needs to be resolved, because that's when people are willing to spend money. When we're able to just provide them with data, the majority of people are not going to act on it. Behavioural change is such a harder issue to deal with. As opposed to, "You have a problem? Here's a piece of technology that's going to help you with it in some way."

MP: That is an excellent point. And you're right, it's like, "We have the ability to capture data through sensors. Now, what's the application for it? How do we make that desirable? How do we convince people that it's important?" But, as you said, actual behavioural change requires a personal desire to change and a dedicated regime for adherence. (pause) Moving into the final questions, what do you think these devices and applications will look like in the future? In five to ten years, where do you feel we will be?

BK: I think the goal for any device is seamless integration that promotes genuine behaviour change. I think the goal with every device is to take the heavy lifting away from the individual so that they're barely even thinking about it. Whoop as a company is a great example. I think they're tracking seven separate things with their sensors, but they don't burden people with all of the things that they're tracking. They've simplified it into a really understandable ranking like, "Here's how much you should do today," and perhaps, "Here's how little you

should do today." Like, "thumbs up, thumbs down," trying to make it as simple and understandable as possible. I think the goal for any great design is for it to be either discoverable or understandable—preferably where someone just picks it up, there's very little set up to it, they can just dive right into it, and start reaping the benefits. What I would love to see as things become more seamless would be eliminating some of the cost prohibition so that it's more accessible for more people—that would be phenomenal. I think a lot of that may have to do with shifts in business models. You're seeing this a lot more in software, and it would be great to see it from a hardware perspective too, where you're essentially giving out devices for free, and there's a kind of "needs assessment." Like, "You're a student or a child? Okay, here you go—here's this beneficial thing." Versus, "You're working at Apple or Nike? Okay, your company can pay for this." You're seeing that way more in the software domain, where it's trying to figure out how to get things into the hands of people at a scale that invites more discovery of the value of their product and then monetizing when appropriate, as opposed to putting up these walls of extreme cost. So many people would benefit from having the latest Apple Watch for a variety of afflictions that they're dealing with, but the cost is just too much. Being able to measure oxygenation, getting your ECG [electrocardiogram] scans, and things like that—and they may not be medical grade, but they are pretty darn close and pretty effective—and it would be wonderful to make that more accessible to people who actually need these things, not just the enthusiasts who love technology and want to better themselves. Wouldn't it be great to have some kind of subsidization of these technologies to help people who are actually in need? Going the medical device route is the most frustrating and costly process. There's a reason most companies do everything in their power to not get classified as a medical device. The language that you see Apple use—their watch could be considered a medical device, but everything they do from a legal perspective is to make sure that does not happen. So, in a very roundabout way, I would just love to see the benefits of these technologies find more of these niche needs that currently cannot be appealed to by these giant companies simply because the numbers aren't there. For example, someone with a heart arrhythmia at an early age and the ability to monitor their condition. There's a wonderful book, Design Meets Disability, where it's like, "Can we imagine a world where these high-end designers are designing amazing products for all of these different segments of need? As opposed to just the people that can afford them and are at an affluent consumer level. Wouldn't that be wonderful?" And you start to see that a bit more with hearing aids—they're way more appealing than they used to be. So, doing better in all those regards. (pause) And I think the

biggest jump, both from a worldview and from a technology view, is dealing with mental wellness. I think it's much easier to design for physical well-being. Like, "Okay, you measured that you're faster now and you're able to track that—cool!" It's a lot harder to apply technology to mental well-being. And there are lots of great apps and pieces of hardware out there that are trying to figure out this puzzle. But again, making it more accessible and seamless is something that would be wonderful.

MP: I love it. I think that's a great way to conclude the major part of this. I love hearing those thoughts. Thank you.

BK: Awesome.

MP: As an aside, I didn't have the opportunity to take your medical design courses during my undergraduate degree, but I did see the Design Meets Disability book on your reading list. While I wasn't in your class, I purchased that book, and I remember reading it, and it definitely had an influence on me. So, thank you.

BK: That's really cool.

MP: Based on the nature of this conversation, are there any individuals that you feel could be a good fit for this study?

BK: Dylan [Scott], who is our chief technology officer, is a biomedical engineer by trade, and he would likely be up your alley. And then Gabbi [Constantinescu], who recently left us and has taken a government job, is someone else that I think would be interesting to talk to. She can offer a clinician's perspective and has been working in the startup realm for a while now. I'd be happy to introduce you to them—give you a warm introduction over email—if you'd like that?

MP: I would love that. Thank you very much.

BK: Yes. I'll throw back to you and request that maybe you talk to one of my colleagues and give your perspective on things? She's doing interviews right now and looking at athletic populations who have an interest in technology and the recovery end of things. She's trying to learn more about one of the products that we're working on.

MP: Yes. I would absolutely speak to them if they're interested. And regarding other people, if you give me an idea of the type of people that they're looking for, I can kind of send you some contacts.

BK: Very cool. I'll send you an email and connect you. Depending on what she's looking for, that would be highly appreciated.

MP: Thank you, Ben. And before we end, do you have any other topics you would like to discuss? Or any questions for me?

BK: No. I think we're all good. I think it was great to chat about this. I think it's a really worthwhile and timely topic. A lot of people are trying to navigate this kind of stuff, and whether it's really apparent or not, they're having to deal with these kinds of issues, and it's just going to get worse and worse.

MP: Okay. Thank you very much. It was a really great interview. I appreciate speaking with you, and I appreciate this opportunity to finally work with you in some capacity. You're highly recommended by everybody that I've ever spoken with. So, thank you very much.

BK: That's amazing. Thank you so much. Yes, I've heard so many good things from your peers as well. It was great to spend some time with you.

MP: Thank you. Finally, as noted in the Participant Consent Form, once all the interviews are complete, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. Afterwards, the written transcript will become part of the research study data set. If you have any questions or concerns, please feel free to email me at any time.

BK: All good. I think I bit my tongue when I needed to about anything proprietary. So, I think I'm good. (laughs)

MP: (laughs) Okay. Thank you once again. I really appreciate your interest and your contribution.

BK: Absolutely. Have a great day, Michael. [Interview Duration: 01:27:51]

Expert 5, September 22, 2023

Michael Peel (MP): Before we begin, there are a few mandatory items that I must take care of. This will take approximately two minutes to complete, and then we can begin the interview. I will restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within athlete populations. As you're likely aware, this interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. Finally, I can provide mental health resources if needed, even though this is your area of expertise.

Expert 5 (E5): (laughs) Okay, thanks. I appreciate it either way.

MP: The scheduled duration for this interview is approximately 60 minutes. If you have a firm schedule, just let me know, and I can absolutely accommodate that. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation, which has been a bit of a challenge. (laughs)

E5: (laughs) It's fair. It's a challenge for everyone.

MP: It is. I would like to thank you for reading and signing the Participant Consent Form. On your form, you have indicated that you would like to withhold your real name from the research documentation. As previously discussed, I can absolutely accommodate this. I will substitute your name with a pseudonym and include a generalized biography. Without revealing your identity, I did speak with my supervisor about this scenario. They agreed that it would be fine, but they suggested that I ask whether you have a specific reason regarding why you would like to withhold your name? If there is no specific reason, or if you do not feel comfortable discussing this, it is totally fine. But if you do have a specific reason that you feel comfortable discussing, it would be beneficial for the research documentation.

E5 + MP: [Off the record discussion regarding privacy and confidentiality]

MP: Yes, that is totally understandable. I will be very sensitive with this. And if there are any grey areas, I will definitely consult with you.

E5: Great. Okay, that sounds good.

MP: Okay. I would like to start with a current academic, professional, and research background statement. You have a rich body at work, and it seems to be evolving, and you seem to be constantly engaged in new research. So, I would love to hear about this in your own words.
E5: That's so flattering. Thank you. I'm currently a second year PhD student in clinical psychology at [a distinguished public research university in Canada]. I started in kinesiology, and that led to a Masters in Science between psychology and health sciences. That's where I started doing work on eating disorders. And then it progressed, and I really had to make that decision between, "Are you going to be a health sciences researcher?" And I was like, "I don't think so." So, then I went back and did some courses and got into clinical psychology. My focus as I've gone into clinical psychology has really been this integration of the mind and body—so, using my health sciences and kinesiology background to bring those health promotion initiatives and those lifestyle considerations into clinical psychology. That's really the central idea that underscores my program of research. I focus a lot on exercise and mental health. There's been some work around advocacy. For example, we do a great job with our physical health in our Canadian healthcare system—your opinion on that may be different (laughs)—but we do a better job with that than our mental health care. So, "How do we get that system up to par with the real Canadian need?" Because it's there—Canadians are screaming for it at this point. And we're not quite doing the best job that we could yet, but we're hopefully getting there. And I've been doing some work in psychedelic psychotherapy. That's another area that involves the mind and the body, and some of these different states of consciousness, different states of physiology, and how that merges together in psychology. I've been really lucky with my training in the last little while. But I think for today we're focusing mostly on the exercise and mental health area, and specifically on eating disorders? Within that area, I've been really lucky to work with a great [research team that specializes in the safe incorporation of exercise in eating disorder treatment] and be really immersed in that field. Through the [research team and associated projects], we've had the opportunity to work with, publish, and learn from a lot of

wonderful experts across the world. That's been a real blessing and has been a project that I've put my heart into across all of these years of my training.

MP: Thank you very much. Your work is really interesting because of this interdisciplinary approach, which I feel is crucial within this field. I would love to hear about the types of clients that you're currently working with—whether you're working with clients, whether you're working with athletes, and if so, what type of athletes?

E5: I have not worked directly with athletes for a little while. Currently, I'm working with individuals with chronic pain. And I'm also working with individuals who are seeking psychedelic psychotherapy. So, less athletes, but some sprinkling of them in the clients that I've seen, but not a real focus on athletes recently. Most of them are clients who are seeking mental health services—so, coming to me as a psychologist.

MP: Wonderful. Are these types of clients encountering body image concerns or disordered eating behaviours?

E5: Yes, for sure. Eating disorder treatment hasn't been my main focus yet, but disordered eating has definitely been a focus for some of my clients. The other piece is that it isn't just individual clients—I've also been working with clients as organizations. So, "How to incorporate considerations of exercise and sport within private and public treatment units and even across organizations for larger sporting bodies?" So, if your perception of a client is just the individual, then some sprinkling. But if your perception of a client includes an organizational body, then there's been that work as well.

MP: Absolutely. Those organizational bodies are crucial because they're different avenues to actually create change and awareness. So, yes, I am absolutely interested in both perspectives.

E5: Totally. A top-down approach or bottom-up approach for addressing disordered eating and eating disorders.

MP: Yes, that is very interesting. (pause) I'll change topics and go directly into some of the core questions. In general, what are your thoughts regarding wearable health tracking devices and associated digital applications for athlete use?

E5: For athletes specifically?

MP: Yes.

E5: I think there are pros and cons to everything in life. There are definitely pros to having them, especially for athletes. Meeting their goals, having those tracking abilities, and keeping themselves in line with those goals—there's very clear evidence that it impacts motivation. So, there is a good and useful side to them. And there is also a side that might not be so useful for people. Where the relationship with those devices, with the apps, etc., can become detrimental to them and not as helpful. But I think there really are both sides of the coin. The individual relationship that the athletes have with them is really their own, and it can also change over time. It's different from person-to-person and from month-to-month. It's pretty complex.

MP: I appreciate that. In your area, have you observed any common motivations regarding the use of these products? For example, "to change body composition, to track performance and health markers, or to understand the body." There are a wide range of reasons, but are you encountering any common motivations?

E5: Do you mean specifically in the athlete population or in the general population as well?

MP: For this question, we could include the general population. I think "athlete" can become a contentious term. People could say, "I don't consider myself an athlete," but they're actually very conscious of their health and their training. So, yes, I would love to hear your perspectives.

E5: Yes. There's different perspectives and different motivations depending on the population. I think for everyone, the goal is "to track." For some, the uptake is to track to meet a goal. And depending on what that goal is, it kind of determines who the individual is. For some, it's "steps for weight loss." For some, it's "steps to make sure that I'm not as sedentary." Especially after the last three years, people have increasingly had to become intentional about things like incidental movements. I think these devices have also played into the need to be more intentional with movement once we stopped having to walk to the office or go into work and do things like that. So, those are some pieces of it. But I think it's just the general idea with everyone—it's like tracking sleep, tracking steps, and tracking different lifestyle factors that play into how you want to navigate your health.

MP: Yes, absolutely. Tying into this, some of your research is related to dysfunctional or compulsive exercise. And I was curious whether, in your research or in your experience, there is a connection between self-tracking, dysfunctional or compulsive exercise, and these devices or apps?

E5: Are you asking if there is a relationship between "more-or-less dysfunctional exercise endorsement" and "more-or-less wearing of trackers?"

MP: That is a good question. I don't want to lead the question, but one perspective might be, "A lot of my clients who are experiencing compulsive exercise are tracking their steps." Or another perspective might be, "They're not wearing a device, and they're not concerned with MyFitnessPal." Things like this.

E5: Okay, I see what you're saying. I think if you look at the evidence and the research, there's a clear connection where, "You're probably more likely to be wearing some sort of fitness monitor and endorsing higher difficulties with not just movement but nutrition as well." I think there's a clear consensus around that. But with that said, there's also an interesting piece to that, because there can also be some benefit to using these monitors and tracking when you're doing research with these individuals.

MP: I agree. I have heard that perspective from some clinicians, where the clinician-facing data that these products can provide could be very beneficial in treatment. So, I agree that it's a conflicting thing. (pause) Do you feel these products have caused or increased instances of body dissatisfaction or disordered eating? If so, could you explain your perspective?

E5: I think as humans, across the board, and in terms of any ailment, we're always looking for one reason for something. But if we could explain human behaviour with just one reason, then we'd be way ahead of where we're at now. (laughs) So, I don't necessarily think I would say it's "a cause" for something. There are a multitude of factors that lead to people having difficulties with their body image. I think there are definitely some pieces of interaction, but it is kind of like the chicken or the egg phenomenon. "Did you get the monitor to deal with the body image?" Or, "Did the monitor lead to you being more aware of your body image?" And it can be different for different people. And then there can be all of those other underlying and overarching factors. If you look at a biopsychosocial model,

there are a lot of factors to consider on a lot of different levels, and the little piece in the middle is the individual. And if you think about it, there's the individual in the middle with the monitor on. So, I would say there are all of those pieces to consider.

MP: On that topic, if you don't mind, could you list some of those larger contextual factors?

E5: Okay, no problem. I'm going to miss some because there are just so many. Starting from the larger outset—the country you're in, leading down to the school you attend, your education level, how you were raised, your socioeconomic status—all of these things play into how body image develops.

MP: Have you observed any common or observable traits that may indicate a person is susceptible to disordered eating behaviours or body image issues? Additionally, do you feel there is any connection between these traits and self-tracking?

E5: Totally. If you look at transdiagnostic factors in those areas, there are themes related to self-esteem and perfectionism. And I think those would have some interplay with the tendency to track—the drive to track and meet goals. Just thinking off the top of my head, I think those two could definitely be linked.

MP: For sure. (pause) Transitioning into a question regarding the general concept of self-tracking for athletes—is it something that you would recommend? From your professional standpoint, would you identify some potential risk factors? Or do you feel that it is neutral?

E5: We know that in therapy, bringing awareness to a behaviour is an intervention that we use to change a behaviour. By starting to track—regardless of who you are or what it is you're tracking—you're bringing awareness to it, and it's a foundation for some sort of behaviour change or behavioural activation. I think there are pieces of being considerate of that if you're starting to track. "Would I recommend it to someone?" I think it's very much a case-by-case basis. I think it's a tool, and just like how you could use a hammer to build a house, you could also use a hammer to cause personal harm. You can use a tool to create good or not-so-good outcomes in your life, and this is just one of those instances. "Are there some risk factors that I might consider?" I think individuals who are already struggling with difficulties around their eating or their activity, or if any of those pieces

have become really rigid and detrimental to their life, or if they are getting in the way of their psychosocial functioning and distressing to them—if that's already part of what's going on for you, then is adding a fitness tracking monitor going to be to your benefit? I am not sure. But I couldn't give you a hard and fast rule like, "This is the EDE-Q [Eating Disorder Examination Questionnaire] score where I would say, 'No fitness tracker for you.'"

MP: That is wonderful. It's a very balanced approach. It's also a very humanistic and individualistic approach. (pause) Are there any metrics that you feel are potentially problematic to track? For example, there are some recommendations against weighing yourself every day, or that body fat percentage values could be problematic or inaccurate. However, some people could feel very empowered by this data. So, I would love to hear if there is anything that you feel is potentially problematic to track?

E5: For some athletes in weight category sports, this stuff is being tracked for them in a way that is, to me, abrasive. To me, it's abrasive, but to them, they're probably used to it since they've done it for so long, so it might not be. Like, "Your weight is going up in public, on a scale, and in comparison with others." To say whether there is one piece that might not be as helpful as others in the athlete population specifically? (pause) I think that across the board, with athletes, the way that they use weight in different sports is problematic. I think there has been a lot of literature around that and also body fat percentages, like the pieces that you touched on. But at the same time, for some of these athletes, it's been a part of their lives for so long, and it's something that's so normalized to them—for better or for worse—that now it might not be problematic for them.

MP: That is an excellent point. Please correct me if I am wrong, but I believe one of the core pillars within clinical counselling is that if something is not causing the person distress or impacting their life, then it may not actually be considered a problem. Is that how you approach it?

E5: Yes, that's a great point. I think that's exactly what the piece is. In our diagnostic process as clinical psychologists, it's like, "Is it causing the person distress? Is it doing them harm? Is it doing others harm? And is it distressing?" And I think that goes along with this. It's like, "If it doesn't matter to them and it's not causing them distress, then should it be made an issue?" But I balance that thought with—I think the latest stat is that one third of our population

encounters an experience of disordered eating tendencies, wherever they fall in that dimension. So, given my last comment about, "If you're engaging in disordered eating and having a hard time with that, should you have a fitness monitor?" If you look at the fact that maybe one third of our population—who are female, mind you, I don't have the male stats off the top of my head—are experiencing this, is it okay to say that the widespread use of these, given that underlying stat, isn't playing into some risk and aggravating it further?

MP: Yes, that is a very good point. (pause) I spoke with a technology developer, and they were speaking about how these devices are able to escape a lot of clinical trials because they're not explicitly marketed as medical devices. There are components in them, like an ECG [electrocardiogram] monitor, for example, that have to get approval. (pause) But I see where you're going with this. If we have this data on disordered eating within our population and then we have these tools, and there may or may not be a correlation between the two, it may be something that we need to investigate. What are your thoughts on that?

E5: I think it's a great concluding sentence for somewhere in your dissertation. (laughs) But it's something to consider, "Are we aggravating the risk and the health of people by offering these tools in a widespread way that are tracking behaviours that can also become pathological?" As I bring this whole question together in my head, there are some really great features on these, like tracking your hydration and your sleep. Yes, there's argument and controversy around how accurate it all is. But all that aside, there's some really nice features that you can track on these. So, in terms of next steps around this, how is there not the capacity on these devices to remove things like your steps and your calories and just be able to have something where you can track the other pieces that can be useful to you?

MP: Absolutely, I agree with that general idea. The analogy I have used to describe this situation to others has been, "We developed the automobile, then we had automobiles for several decades, then we start to understand there are some consequences, then we need to have a discussion, and that impacts how we design them in the future." And I think we're at that crossroad with some of these devices right now. Maybe we can't ignore some of this stuff anymore? Even if the developers view it as a very altruistic and noble pursuit to promote health, or whatever their intention might be, maybe we have to pause and ask, "Is that what we're actually achieving?" Do you have any thoughts on that?

E5: Yes. If we compare fitness devices to the development of cars, we've made cars with no airbags. We run into the problem of, "There is a real risk for eating disorders that intersects with these devices." And instead, have a piece where you can remove tracking calories, steps, or whatever it is. If we can remove those pieces, it's kind of like having an airbag, right? We can still have features like heart rate and those things that are so beneficial. And if you do intersect with an eating disorder, and that happens to be an experience in your life, at least you're not slamming through the windshield—you've got an airbag. You don't have these other pieces that are just aggravating that situation.

MP: That is an excellent thought.

E5: As you were talking about the companies being altruistic, I think that also comes from a place where, for a long time, there's been this messaging that a lot of people in North America have difficulties with their weight and have different ailments related to their weight, and there is this narrative of helping people in that area of things. So, if you look at the lifetime prevalence of OSFED [other specified feeding or eating disorder], it's like 10% of people—that's like the highest number of people who are going to experience a diagnosed eating disorder. It's like, "What do the companies focus on? The 60-70% of people in which the data is spreading the message that being "overweight" is a health concern? Or do you focus on taking care of the 1-10% of people who experience eating disorders that are diagnosed?"

MP: Yes, I really understand where you're going with that. There was a recent study [Impacts of Risks Over Benefits in the Adoption of Self-Tracking Technologies] that concluded "The perceived benefits outweigh the risks," or something like that. So, they were viewing wearable health devices as tools to help the majority of people. But there needs to be nuance, because the populations we are not serving are still people, right? But I'll leave it there because I'm not being neutral. (laughs)

E5: (laughs) But, "Is it going to make us money?" is the problem. And, "It's not going to make us money, so we don't care."

MP: (laughs) Yes. (pause) I would like to ask you a question regarding health data in general. Wherever it's coming from, or however it's being collected, I wanted to learn your thoughts regarding the complexity of health data. For example, do you find that

there is misinformation about the data that's coming in? Or do you find that the data in isolation is potentially causing some difficulty for your clients? And this could be in terms of contextualizing the data, understanding the relevance of the data, or maybe a hyperfixation on the data. Or maybe it's all positive? I just want to learn your thoughts regarding health data in general.

E5: Let me clarify this, "Are we portraying and using health data in a way that is accurate and portraying that to society well?"

MP: That is a very good distinction. So, "public health data and stats," that is not what I'm talking about. Let's say a person buys a new device, and it's tracking their sleep, their steps, their walking asymmetry, their menstruation cycle, etc. Simultaneously, we're also living in a kind of optimization culture where there's a lot of messaging like, "Eat more of this" and "Do more of that." So, that is the setup, and with that base foundation, I wanted to get your general thoughts on the complexity of health data that's available to a person living in 2023 versus 2003.

E5: So, "Is having your individual data available to you through monitoring apps helpful?"

MP: It can be anything. Again, I don't want to lead the question too much. (pause) A person could be like, "All this data in the hands of the individual is empowering, and you can make a lot of choices." Another person could say, "The complexity is getting pretty high, and it's potentially creating a disconnect between someone's lived experiences and their internal senses."

E5: Okay. One difficulty is that there are some inaccuracies with tracking monitors. For us as researchers, you go in and you see the validation studies, and you look across monitors and see the shortcomings of something like, "The Fitbit Charge 2 isn't great at high intensity activity," right? There's some knowledge that some of the health data might not be as accurate as it could be. So, that's one component to consider, "Is it bang on?" But, you know what? It's not too far off, really. But, "Is having this information helpful for people?" For some, absolutely. I've heard of people who have been like, "My Fitbit monitor told me my heart rate was irregular, and I went to see my physician." So, I think there are even some health promotion and prevention pieces that can happen through these monitors that can be helpful. It can be very empowering, as you said, for people. It can be empowering and

powerful, and it can play into what health promotion has tried to do forever, which is the prevention of health ailments. I think that can be really helpful. Again, bringing awareness to different behaviours is a psychological intervention. So, it brings awareness and can help you change behaviours that can be lifestyle interventions without having to be told by your family doctor to take a sedentary break and get up every 15 minutes. So, I think having the information or the notifications can be helpful to you. But again, I think it can also play into some darker tendencies. And depending on who you are and how things have changed in your life, having that information can also facilitate comparison and competition. Especially when you can share your stats with other people. So, having that information—not only your own health data but other people's health data—can introduce some interesting paradigms that might not have been there. But again, I think there's no definitive "yes" or "no." It can have some benefits, and it can have some drawbacks.

MP: That balanced perspective is a common theme in this conversation. (pause) I believe some of your current work is about trying to better connect with the body?

E5: Yes.

MP: Some treatment programs are very explicit about trying to reestablish things like internal hunger cues. For example, "What does the sensation of hunger feel like?" and things like this. And I wanted to get your perspective on whether you feel like these devices or applications can be helpful to increase bodily or sensory awareness? Or if you feel there are any technological interventions that are helpful for this, like biofeedback or something?

E5: For me, this is one where there's a pretty clear cut answer, and it's no. In eating disorders, some of the core pathology is that you become very disconnected and dissociated from the body. I'll talk to patients and say, "Do you kind of feel like you're floating above your body and looking down on it?" And they'll be like, "Yeah. Yeah." So, I think this disconnection from the body is something that has to be found again in a way that removes noise. And I think part of that is having this almost moderator variable of, "Okay, should I be hungry? I've done all these steps." So, remove this sort of checkpoint [the device or application] from the individual so that they can begin to connect more with themselves and become more mindful through awareness of the present moment. That's the key underlying principle of mindfulness interventions, is awareness of the present

moment. And a lot of that is connecting with the body—it's not connecting with your fitness monitor. So, if you're talking about it in terms of "bringing awareness back to the body," I really don't think that it has a place there.

MP: In your treatment protocols, if you're trying to help establish a connection to the body, are there any predominant techniques that you use?

E5: Mindfulness in the broader sense. Not "CBT for Mindfulness" or anything like that. Just practicing and educating about mindfulness—for example, how to be mindful, how to be mindful of your body sensations, how to be mindful of your thoughts, how to engage with one thought or let it go—and doing that sort of practice is really helpful in reestablishing awareness with your body.

MP: Very good. Thank you. (pause) Are there any key design considerations for these products that you feel could mitigate disordered eating or body dissatisfaction?

E5: There is something that I've really been advocating for in my work. Currently, we focus a lot on body weight in eating disorder treatment. Like, "Your weight is too low. Let's get you to the right BMI." We touched on this earlier, but it would be nice if these monitors did not have anything to do with weight, calories, or anything like that but still had these features like heart rate, etc. Really coming across to patients that "it is also about what's going on in your body." If you tell a patient, "Your heart rate is this low, and this is what's going on with you," having that monitored as pieces of progression for them rather than weight could be interesting. And it's not well researched to frame eating disorder treatment and progression other than through this focus on body weight, which is very prominent. So, I wonder if that could be helpful? But then again, there is the risk of pathologizing that too. Like, "Oh, my heart rate is going up, and that means that XYZ is going on with my body, and now I feel uncomfortable." You could create a relationship with the heart rate, or whatever it is, that could be unhelpful to you. Because there are lots of people with eating disorders who have a fear of gaining weight, they don't want to gain weight. So they know, "My heart rate is going up and stabilizing—that means I'm gaining weight." (pause) I don't necessarily know if introducing more things to monitor on a day-to-day basis, as an individual, is going to be helpful. But I do think there may be a place for looking at physiological function and helping someone progress through an eating disorder

by focusing more on their physiological function, or their functional fitness, rather than on their weight. That could be an interesting way to go.

MP: That is really interesting. To clarify, when people are very underweight, their heart rate becomes dangerously low as well? Is that correct?

E5: Yes.

MP: Then that is one of the metrics you're checking as they're progressing through treatment? Because cardiac disease is one of the leading causes of death? Is that correct?

E5: Yes.

MP: To elaborate on that, are you checking their breathing as well? Are there any other things that you're working with?

E5: I can tell you specifically—I'll go to my table. (refers to table) All your biomarkers, like your calcium and potassium, and all of those things that are part of your regular blood work. You get an ECG [electrocardiogram]. All of your cardiac markers, like your QT interval, heart rate, systolic and diastolic blood pressure, and different arrhythmias—all of those get regularly checked.

MP: This has got me thinking. Steps, and some other metrics like this, are indirect measures of health. Meaning, you could be getting your 10,000 steps each day, but you could also be very unhealthy. For example, you could be dangerously underweight or you could be compensating with a lot of food. Or there could be other lifestyle factors that are impacting a person's health that cannot be measured. So, potentially looking at holistic health markers, or more direct health markers, and contextualizing those could be an interesting pathway.

E5: The other thing that we have been focusing on in this conversation is, "The health data that is being collected is being tracked by the individual." Whereas, there could also be the consideration of, "Can you collect the data and not have the individual be the one who gets it?"

MP: So, if you're a clinician and you're treating patients, and the device was passive for the user—maybe there was no display, or it just presented the time, or something like that—but it was sending you and your team detailed health information, would that be beneficial?

E5: Yes, that's what we use in research. We get blinded Fitbits where we get the information, but they don't get anything—I think it just says the time. Research-wise, I think that's been something that's been used beneficially because understanding the type of activity has become something that's become more important in the eating disorder world. There's been this real focus on strenuous exercise as being "the bad guy of the group." Whereas, there's more evidence coming out now that it might actually be more indicative of pathology to be engaging in incidental physical activity after discharge. And it's generally the first thing you have patients do, like, "We'll take everyone for a walk around the block." There's a paper by Solfrid Bratland-Sanda titled, "I'm not physically active—I only go for walks," and it's this whole narrative around patients not understanding that, "You're still going for 35,000 steps a day, and you might not be doing high intensity exercise, but you still have a dysfunctional relationship with movement—it's not even just exercise anymore." Getting data and understanding of not just "What's your exercise?" but "What's your incidental activity?" and different health markers—heart rate, blood pressure, etc.—and having that data come back to the clinicians or researchers, blinded to the participant, could have a lot more use than having data collected by the participant where they can see it when they're in the context of treatment.

MP: That is very interesting, and there are a lot of things to unpack. (pause) We're onto the last core question. What are your thoughts on the future of wearable health tracking devices and applications? Artificial intelligence is becoming really sophisticated and very accessible. Additionally, the prevalence of these devices is increasing. In five to ten years, what could this area look like? What could be some interesting things that might be exciting to you?

E5: I'm quite curious to see what else it's going to be able to track. Even the Oura Ring I'm using in my research right now—to just see the evolution. I was a kid who had the iPod Shuffle and the original iPods, and I remember going to school and being like, "They're going to turn these into a phone?" To have an Apple Watch now where you can get calls and do these things, it is just so fascinating to watch people's minds and these technologies be developed. I'm hopeful that as they're developed further, they'll be able to be considerate of people and their needs. And just having the monitors be able to be tailored for people. Things

like being able to remove the activity rings displayed on the Apple Watch. If someone wants that off, let them be able to remove it from what they monitor. Let's be able to tailor it so the people who are at risk—at least they can have the choice to not facilitate that risk further—at least give them that choice. Are we going to be able to make the choice for them? No. Can we also promote awareness and education about it? Sure.

MP: That is excellent, and a great place to end. (pause) Based on the nature of the conversation and the types of topics brought up, are there any research studies or individuals that come to mind that you feel are in alignment?

E5: I'll go into my folder, and I'll send them to you.

MP: Okay, great. Thank you. Before we conclude, are there any other topics you would like to discuss?

E5: There is one last thing that I think is important to mention. Whether it's with athletes or the eating disorder population who are not athletes—if you're a clinician and you're working with these individuals, you can't control what they're going to do. You can encourage them to not wear their Fitbit. You can encourage them to not track. But at some point, there's also a piece of meeting that person where they're at. And if they don't want to take it off and they're going to keep doing it, then also introduce some flexibility as a clinician. Maybe reassessing and looking at, "How can I use this to my advantage? How can I try and keep someone safe by saying that I'm going to check how many steps they took that day?" It's not me telling and encouraging clinicians that they should be doing this. But if you get those patients that are just stuck, and you're just stuck, and they're going to wear it, and you're not going to physically take it off them—just recognizing that instead of it being a piece of contention, where you see their watch, and you're just frustrated every time you see it—instead, being able to have an open conversation with them about it. And if they're still not willing to take it off, and if you think that's what would be beneficial for their treatment at that point, figure out how you can work with them to keep them safe and use it as a tool to your advantage. Because it is still something that's pretty taboo. It is still something that has a lot of contention around it, despite its widespread use in the general population.

MP: Yes, that is a great point. Again, another really balanced perspective. Before we end, is there anything else you would like to discuss? Or any questions?

E5 + MP: [Off the record discussion regarding transcript processing and thesis documentation]

E5: In terms of additions to these tracking devices, I think the public could do with more awareness. If we're going to give them the option to decide whether or not they want to track one health marker or another, we need to help them make informed decisions. For example, "What information does the public need to have about these monitors, which is sound information and is not coming from a company, like Apple or whoever, who wants to make money?" Just like the Physical Activity Guideline in Canada, "What kind of information and guidelines can we give people about these monitors that is sound and comes from an overarching body that doesn't have a financial stake, that can help people make better decisions?"

MP: That is really cool. Something external from the marketing of the product. I can see a real benefit to that. Do you think delivering that information through the device would be beneficial? For example, if there was something like a Government of Canada recommendation that popped up in the app. (pause) What do you feel is the most effective way to spread the message? Or provide a sense of authority? Is it from the governing bodies?

E5: I think the fitness and health apps have been marketed in such a way that they tie into the fitness world. So, they could even be from sporting bodies like ACSM [American College of Sports Medicine], CSEP [Canadian Society for Exercise Physiology], the Physicians of Canada, and the Government of Canada. All of them, the recommendations are unanimous—it's "150 minutes..." So, having unison amongst these guidelines from these different bodies and then putting them in the same place that they would put your sedentary guidelines, your screen time guidelines, etc. That could be an up and coming health promotion initiative that could be really beneficial in terms of helping people make decisions around these devices.

MP: Absolutely. You're right, and it's potentially a perfect time for that.

E5 + MP: [Off the record discussion regarding current thesis project and future research opportunities]

MP: Okay, I'll let you go. I see the time and you've been gracious. Thank you again. I really appreciate it.

E5: No problem. My pleasure. Talk soon. Good luck.

MP: Yes. Have a great weekend.

E5: You too. Bye. [Interview Duration: 01:23:30]

Expert 6, September 26, 2023

Michael Peel (MP): Before we begin, there are a few mandatory items that I must take care of. This will take approximately two minutes to complete, and then we can begin the interview. I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated.

Expert 6 (E6): Okay, amazing.

MP: The scheduled duration for this interview is 50 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

E6: I don't have any questions right now, but if they come up, I will let you know.

MP: Wonderful, thank you. (pause) While I am familiar with some of your work, would you mind telling me a bit about your academic, professional, and research background in your own words?

E6: Definitely. My background is in both mental health counselling and sport and performance psychology. I have a master's degree in mental health counselling and additional training to meet the requirements for the Applied Association of Sports Psychology [AASP]. I serve as a consultant in that realm. My training is with [National Collegiate Athletic Association (NCAA)] Division I athletes in performance and mental health. I have ongoing experience in the eating disorder space working with the general

eating disorder population, as well as the athlete population, and what I call "the fitness-oriented population." These are people who wouldn't meet the criteria to be admitted into an athlete track in an eating disorder program but do identify as athletic.

MP: Do you mind speaking a bit more about your connection with athletes and eating disorders? Was that a purposeful decision? Or did that come about organically through a need in your research?

E6: A little bit of both. I had worked in the eating disorder field, developing continuing education programs for treatment centres, for four years. I went to school with the intention of seeing sport specific clients because of my own athletic background and an interest in pursuing the subject. But then I had a very organic opportunity to work in the eating disorder space again. And I will say, when I was working exclusively in the sports space, eating disorders inevitably came up—a lot. So, I started thinking more about the connection that would inevitably occur there.

MP: Do you mind elaborating on that inevitable connection between athletics, the fitness industry, and eating disorders?

E6: Definitely. I think that athletes, in some ways, have a lot of protective factors in the treatment of their eating disorder and their prognosis. They typically have high resilience and experience overcoming challenges. They tend to be more naturally regulated in their bodies. But they are definitely not immune to some of the general sociocultural influences of eating disorders and sport specific ones as well. The tension around an athletic and high performing body versus, what might be considered, a socially idealized body. Especially now, as athletes have this dual role of performing in their sport and creating visibility for themselves through social platforms.

MP: Absolutely. That is such a unique and contemporary scenario. (pause) I would love to hear your thoughts on body dissatisfaction and the fitness athlete, or the individual who is interested in fitness, and how that comes up in your work?

E6: Do you mean more for the general fitness oriented person who is not necessarily competing?

MP: I think so. I know that those lines can sometimes blur. You can toggle between that population, the athlete population, and the general population. My core question is about body dissatisfaction and people who are interested in fitness.

E6: It seems like a focus on appearance really tends to derail—not just performance outcomes, because I think that's more relevant in strictly competing athlete populations, although other populations place importance on it as well—but it tends to derail goals related to performance and then related to the other outcomes of fitness, which might be increased regulation, improved mood, and overall health indicators. I think that body image dissatisfaction is like a distraction. The reason that somebody started pursuing an activity could have been motivated by body image. But body image definitely seems to be a derailing or distracting factor in the process.

MP: Do you find that body image is a derailing factor in the treatment process for eating disorders as well?

E6: Definitely. Historically, in eating disorder treatment, the recommendations have been focused around movement abstinence, which creates all sorts of issues. I think it almost provides space for the dissatisfaction to fester. Because if you're constantly putting off movement exposure and the reintroduction of exercise, or making it a failed treatment outcome if the client is exercising, then it just gives more space for body image dissatisfaction to be the centre focus.

MP: That is really interesting. What types of problems can occur in eating disorder treatment if we're promoting a movement abstinence model?

E6: On one hand, I think it just sets a person up to fail if, realistically, they're not going to engage in movement abstinence. I think a lot of times it isn't necessarily indicated. Certainly, in some cases, movement reduction and temporary abstinence for restorative rest make sense. But a lot of the time it's just a catch-all, where people who don't even demonstrate symptoms of compulsive exercise are being told that they're doing something wrong by engaging in even light exercise. I think it creates this weird tension in the treatment team. Beyond that, I think it also becomes difficult when a person is done with the treatment process. They haven't had any tools for integrating movement and exercise into their lives. I

don't think it should be treated any differently than food. Everybody has to eat, and whether it's intentional or not, everybody has to move around the world. I don't think it makes sense. And of course, so many eating disorder clients struggle with all types of physical symptoms during treatment that would benefit from some amount of exercise. This includes motility issues and even mood improvement. I think there are just so many reasons to incorporate it.

MP: I really appreciate learning your thoughts on that. (pause) I would like to switch topics and move directly into a conversation about wearable technology. Starting off, what are your general thoughts regarding current wearable health tracking devices and associated digital applications for athlete use?

E6: I think it's mixed because there's so much use, potential, and benefit. But I haven't seen one that I think is good and comprehensive. For example, I think of the Oura Ring, which has a big focus on rest and recovery—it's focusing on sleep and HRV [heart rate variability], and I love that. But it still doesn't really give you the option to mute all the things that are going to trigger the mind of someone who is very numbers oriented and compulsive with their movement. I wish that there was a way to better mute that information.

MP: Absolutely. (pause) Have you observed any common motivations regarding the use of these products? For example, "to change body composition, to track performance and health markers, or to understand the body." Are there any common themes that you hear?

E6: I have heard an increase in people mentioning their wearables for sleep. I think sleep is definitely getting a lot of attention in a lot of different fields, which is great. Sleep, rest, and recovery—but also exercise. I definitely hear people just say plainly, "I want to track my steps, my exertion, and my calories burned."

MP: Thank you. Do you find that your clients are using these products? And if so, do you find them beneficial, neutral, or harmful during treatment? Do you have any thoughts on this?

E6: I do have a couple of people coming in wearing them. My non-compulsive, non-disordered athletes—or at least the ones who it's not affecting in a clinical sense—I find most of them have some sort of wearable device. And it's great—it's a really good resource for them. Even if people don't have wearables, I am noticing more of the conversations that

they have around the tracking apps on their phones. So, even if it's not intentional, I think people are still gathering information.

MP: What types of conversations are you hearing? Is it general things like steps and sleep? Or is there anything particularly noteworthy?

E6: Steps are such a big one—steps and calories burned from all of the Apple devices. And I think it's interesting that even though I think most people can recognize that the calories burned metric is a very rough estimate and that it's not really the best measure, they still find themselves fixated on that number.

MP: Absolutely. Building on this, I would love to hear your thoughts on wearable health tracking devices and any connections to body dissatisfaction and disordered eating behaviours. Have you witnessed a connection between these products and applications and these conditions?

E6: I would definitely say there is some sort of parallel connection. I don't know if it's necessarily the devices on their own. (pause) For the people who present what I would consider "high compulsive movement and an unhealthy preoccupation with exercise," I would say that across the board, most of them do track—as opposed to the people where exercise has been a part of their eating disorder, but it is not necessarily the main behaviour or symptom.

MP: So you do see a connection between people who are prone to compulsive exercise and the use of these devices to track?

E6: Yes, definitely. And I think that people who particularly rely a lot on external validation—I mean, maybe you could say that across the board with people engaging in compulsive exercise, there is always an external measure when it comes to exercise that is really far removed from internal signalling.

MP: Building on this, there seem to be some common and observable traits that may indicate a person could be susceptible to compulsive exercise, as well as the negative consequences these products could have. In addition to things like a reliance on external validation, are there any other observable traits that you feel might indicate a person could be at risk with these devices?

E6: I've noticed that there is usually something like a deficiency threshold. For example, when somebody reaches a certain point of low energy availability, there's definitely a cognitive shift that you see across the board in treatment, where they're not able to connect the dots as much and are less able to apply restraint around behaviours. And I think at that point it feels like all bets are off with the wearables. For some of the people that I've seen through a few rounds of weight restoration, I have noticed that once they're above that threshold, they might think about it, but they can restrain from checking it and acknowledge, "This is not something that's good for me."

MP: That is fascinating.

E6: Yes, it is.

MP: It makes so much sense—when a person is so depleted for such a long period of time. (pause) Moving onto the general concept of self-tracking for athlete use, are there any health metrics that you feel are beneficial to track? Are there any health metrics that you feel might be problematic to track? Or do you feel it's a case-by-case question? I would love to hear your thoughts on self-tracking, which is a growing phenomenon now.

E6: Yes. I feel it depends so much on the temperament of the person. I think that even outside of eating disorder populations, there are people who will have the device and check it every once in a while—and then there are people who are checking seven times a day even if they don't have a problem with it. So, I think it is temperament driven. Obviously, there are so many benefits to tracking recovery oriented measures like sleep and HRV. I think it provides a lot of information, but it can also have this effect where the person is then preoccupied with any dip in those metrics that might happen naturally or might happen from some sort of event. It's just interesting. I think that somebody who has that temperament can be critical of the metrics, no matter what they are. But it's an interesting question. It would be a cool research question to nail down, "How do you specify someone with that temperament? And what are good interventions? Is there a benefit to short-term interventions to learn about your body? Or would those tendencies even out over a period of time?"

MP: That is a really interesting and balanced perspective. You mentioned temperament, and I was curious about any connection to the topics of health anxiety, unhealthy social

comparison, rigidity in behaviours, and things like this. Do you find there is a connection between these topics and people who are potentially having difficulties with eating disorders, self-tracking, their sport, or their body image?

E6: Was the question about people who have health anxiety?

MP: Generally, yes. Are you observing health anxiety, health comparisons, social comparisons, and things like this?

E6: Interesting. I guess I haven't noticed much of that. When you say health anxiety, what exactly do you mean?

MP: Yes, thank you for seeking clarification. I know it was a bit of a confusing question. I'll give you some context. For some people I have spoken to, the reason for such rigidity with tracking, compulsive exercise, and things like this could be to offset or prevent future disease or health conditions. But then the preventive behaviours, the rigidity, and the potential eating disorder itself can impact their immediate quality of life. So, I was curious if you have seen that connection, where larger health anxiety is causing more immediate health consequences?

E6: That's so interesting. I think that I've observed this more in my experiences as a coach, particularly working with male populations. I work with a lot of men, and this is outside of the eating disorder and athlete space, but I've worked with a lot of men in their mid 30s to mid 60s. And I feel like there's this arc that happens where, all of a sudden, there's this really strong fixation on longevity and aging, and I don't necessarily know where it comes from. And obviously, that happens with women too. But I just see it so much, and I don't know why it feels so obvious with the men. And I think there's a path it takes because there's an acute fixation that cues the stress and anxiety responses of overfixation. But from that, I've noticed people almost evening out and learning, "Okay, I can think about these things, but long-term, the extent to which I'm fixating on anything is going to have an impact on my health and wellbeing." Does that make sense, the way I said that?

MP: Absolutely. And maybe I can shed some light on the messaging and marketing directed towards men. Currently, there is a lot of social media content focused on things like

longevity, lower testosterone levels, enhancing performance, etc. And maybe there's some initial noble pursuit, but at the same time, there's also a lot of avenues to capitalize on that fear by selling supplements, programs, coaching, and things like this. There's definitely a surplus of information being pushed at people.

E6: Yes, that makes sense.

MP: Your biography mentions that you utilize EMDR [eye movement desensitization and reprocessing] and breathwork, in addition to CBT [cognitive behavioural therapy] and ACT [acceptance and commitment therapy]. Additionally, I was interested in another statement that said that you "help guide individuals to deepen their mind-body connection." With this in mind, I was curious what your thoughts are regarding the impact of wearable health tracking devices and digital applications on the embedded bodily awareness, or senses, of the individual. Meaning, do you feel that tracking, these devices, and these applications are helping people to create or enhance this mind-to-body, or mind-to-muscle, or mind-to-sensation connection? Or do you feel that it may abstract it, create a disconnect, and potentially cause it to feel like isolated data that is removed from their body? I would love to hear your perspective.

E6: I definitely go back and forth on it. I feel like I mostly lean to, "It's not my favourite way to cultivate a mind-body connection." But it does have its intervention purposes. Maybe the answer is, "That both, in parallel to each other, are great?" But it's hard to say. For example, going back to the fitness and eating disorder populations, I think that helping someone practice differentiating between "I am tired and I need to exercise" versus "I am too tired to exercise" is important. It's just so hard because if you have a machine that's giving you feedback, it may or may not line up very well with what you're actually feeling. Again, just thinking of the Oura Ring and their "Readiness Score," I know from my own experience that it's often off. It's valuable sometimes, but I'm not the biggest fan. I think that ideally, you should be feeling what those zones are for you and for yourself. You should be tapping into, "Was this good sleep for me?" And of course it provides information—if someone is trying to walk more, it is useful to know, "This is about how long this walk feels." But to always be relying on, "Did I get 10,000 steps? Am I satisfied?" just doesn't seem sustainable. Or it doesn't seem that there is really anything to build and deepen there.

MP: I really appreciate that you shared that. Within your practice, what techniques do you utilize to develop the mind-body connection? What are the core pillars of your approach?

E6: I have a background in yoga, and in recent years, more specifically in breathwork. And with that, using cold water immersion ice baths. And that is sort of where the male coaching comes in a lot—I just feel like a lot of men gravitate towards that. Out of all those things, I like using breath work specifically to help people build a better understanding of the connection between physiological responses and developing emotional awareness. Just simple things like, "Okay, the shortness of my breath—what am I feeling? Is this related to anxiety? Even if I'm not feeling or identifying as anxious, my body is giving me feedback that I'm having this anxiety right now." And then meeting yourself with really simple tools for what you're feeling in that moment. I almost laugh because I think that sometimes we want, or I find that people want, a big, complicated solution. But I think that when you understand the upregulating and downregulating purposes of the breath, it becomes really easy to meet yourself where you're at physiologically.

MP: I am smiling because I really agree with what you said. While it may be difficult to cultivate, the tools for self-regulation are embedded within us. It is a really interesting thing that I keep coming back to myself. I appreciate that you shared that.

E6: Yes, absolutely.

MP: What are your thoughts regarding positive technological interventions to treat body image disturbances and disordered eating behaviours? Are there any that you feel are viable? Maybe biofeedback or other technologies?

E6: That's a great question. Technology for body image—I haven't thought about that at all. But I wonder, "Who is thinking about it, and what is out there?" Because the nature of my work in the past few years has been so remote, I haven't been able to share my HRV tools with people, but I would definitely like to use them more. I currently use HeartMath technology, and I think it's very useful for making the connection. In my own experience and with the clients I have used it with, it's amazing to see the way a thought will change the output. Just one simple thought deviating from the focus of the exercise to, "Oh my God, I forgot to pick up my dry cleaning," and the effect that will have. I think that's such a

powerful connection for people to make. I've wondered what it would look like in some of my more acute cases. I wonder if they would be able to regulate and get positive feedback from the machine? And if they were not able to, what kinds of effects would that have? I think that there is a lot of great potential there, but it would be great if there was a more accessible way to use that remotely.

MP: To clarify, when you were speaking about the patient making the connection, was that visual biofeedback? Are they seeing, almost instantaneously, their heart rate change based on new thoughts?

E6: Yes, it's giving you a live HRV stream. It oscillates between, "You're good, and you're in the green. You're yellow. You're red." And then it gives you cues for how to bring it back to the green. It also has different difficulty settings. (pause) But I don't know—I just wonder about some of my really dysregulated clients. I've thought about recommending it, but I don't want them to feel disheartened.

MP: Could you elaborate on that final point? Disheartened in which way?

E6: If they're not able to regulate and get the "good, green, thumbs up," they might be disappointed or lose their willingness to try.

MP: I suppose that implies the inherent challenge of developing that regulation. Is that correct to assume?

E6: Yes, definitely. Especially in eating disorder populations. That's why I say, "The benefit of working with athletes," because they tend to just be more regulated by the nature of their jobs. But you often have the combination of malnutrition and, a lot of times, acute PTSD [post-traumatic stress disorder] symptoms that are really dysregulating the whole system. And sometimes just getting the person regulated during a session is a challenge.

MP: Yes, that is very understandable. (pause) Thinking about future improvements, from your perspective, are there any design considerations or recommendations for these products that you feel could mitigate instances of body dissatisfaction and disordered eating behaviours?

E6: Yes, absolutely. I think it would be great if you could self-select what kind of output you're getting. For example, if you just want strictly recovery-oriented measures, being able to mute the others. I think that alone would be a huge improvement.

MP: Wonderful, thank you. Continuing on that theme, what are your thoughts on the future of wearable health tracking devices and applications? They have improved so much over the last few years, and I am curious what you think these could look like in five to ten years?

E6: Mmm. Maybe not for these purposes, but in general, if you could more accurately measure calorie output, I think it would be so interesting if you could get a better read on metabolism—or a read on metabolism. I know that metabolic testing is really complex and expensive right now. But like you said, technology has come so far, and I don't think it's unreasonable to imagine it making that next step.

MP: Yes, for sure. (pause) I have a question based on what you just said. Let's say we have more accurate data on caloric expenditure. In a treatment setting, do you feel it could be beneficial if that data was shown to the treatment team but not to the user? Do you feel there should be transparency for the user? Or could it be useful if it was only shown to the treatment team? What are your thoughts?

E6: I think that would be so interesting for so many reasons in the eating disorder space. We actually looked into that at one point—whether we could order Oura Rings for our clients but not give them access to the data. But it doesn't seem reasonable right now. But I think that would be interesting, and I think it would also improve the quality of care and understanding. I think it would really advance understanding in general. I think there is a lot to be learned around metabolic health. I recently read "Brain Energy" by Christopher Palmer. It was really interesting. His whole theory is about how metabolism is the underlying factor in mental health. He's a psychiatrist, and he started treating severe mental health with a ketogenic diet —and now with basically anything that improves metabolism. I think it would provide the opportunity for more real conversations in the eating disorder space, because I don't think that is a conversation providers like to have, but it's there nonetheless.

MP: I really appreciate that you shared your perspective. As an aside, I also have an interest in the connection between metabolic health and mental health. (pause) I see we're at time. I

wanted to thank you for this interview, as it was very beneficial. Before we conclude, are there any topics that you would like to discuss? Or do you have any questions for me?

E6: I don't have any questions. I just hope to stay up to date on your research. I thought that this was a great conversation, so I hope to stay in touch about it.

MP: Absolutely. As noted in the participant consent form, I will start the transcription process once all of the interviews are complete. Once completed, I will send a copy of the transcript to you, and you will have 14 days to review it and make any revisions. Afterwards, the transcript will become part of the data set. Obviously, I will keep you in the loop regarding how things progress. I will contact you if I have any questions or if anything in the conversation requires clarification. At the same time, I would love to keep the dialogue open. So, if you have any questions or anything, please feel free to contact me.

E6: Amazing.

MP: I will send you a follow-up email right away with a few points. But I think we're good for now. I really appreciate your time and energy. Thank you very much.

E6: Of course. Thank you. [Interview Duration: 00:48:15]

Elizabeth Lampe, October 2, 2023

Michael Peel (MP): Before we begin, there are a few mandatory items that I must take care of. This will take approximately two minutes to complete, and then we can begin the interview.

Elizabeth Lampe (EL): All good.

MP: I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. You may request that anything you share be off the record or not disseminated. The scheduled duration for this interview is approximately 60 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

EL: I don't.

MP: Okay, wonderful. We can begin. (pause) Your research is very impressive, and your articles with Olivia Wons and Emily Presseller were particularly influential for this research project. While I am familiar with some of your work, I would like to give you the opportunity to describe your academic, professional, and research background in your own words. Could you please share your thoughts?

EL: I'm really interested in understanding the complexities of exercise engagement in the context of eating disorders. Knowing that for some people, that behaviour can become really maladaptive and harmful over time and just reinforce the eating disorder. But for others, exercise seems like it can actually be a helpful tool for recovery. So, I've sort of built this

program of research trying to understand, "When is it helpful and when is it harmful? And for whom is it helpful and harmful at different times?" To try to figure out how we can target maladaptive exercise engagement and help people reduce that behaviour while still promoting and allowing adaptive exercise engagement in the name of recovery.

MP: That is really interesting. I read your article titled, "Affective profiles of exercise episodes are associated with maladaptive and adaptive motivations for exercise." The article mentions a dual nature [adaptive and maladaptive] that can occur within the context of an individual exercise episode, and this is something I have witnessed too. I feel your work is on the leading edge of this topic. How did you become interested in these research areas?

EL: I grew up in the ballet world. I was a dancer and came at eating disorders from that perspective. As you might imagine, there was a lot of it in that world. I became interested in eating disorders and wanted to do something to help improve eating behaviour among dancers as an early graduate student. And that was a really niche population, so my advisor was like, "You have got to do something that's a little more applicable to most people who are not ballet dancers." Then I started thinking, "What is it about ballet that lends itself to eating disorders?" And exercise was a really big piece that stood out to me. I heard a lot of people in that space talking about "working off calories" and "I can eat this cupcake because I have six hours of rehearsal tomorrow, and I'll work off what I eat." That really got me thinking about the relationship between exercise and eating and how that can function differently for different people. From there, I was also interested in treatment research and developing new treatments. So, I kind of combined the two to get to where I am today.

MP: And you're currently working on your clinical psychology doctorate, correct?

EL: Yes.

MP: In this clinical setting, are you more research-based? Or are you working in counselling and treating people?

EL: Both. (laughs) Doctoral programs in the U.S. are particularly odd, and I think the setting that I'm in is more clinical than others might be, where I'm doing my own research, and I'm pursuing that line of research that I talked about, but I'm also working in my advisor's lab,

who is doing her own treatment research. So, I'm serving as a clinician on a lot of her clinical trials that she's running and treating patients through those. And I'm getting simultaneous eating disorder treatment experience, as well as the research side of things.

MP: Are you currently working directly with athlete populations? Or do you have a history with those populations?

EL: Yes. Not specifically for any studies, but I have worked with several patients who were athletes or were continuing to be athletes.

MP: Okay, that leads well into the next question. Generally, what are your thoughts regarding current wearable health tracking devices and associated digital applications for athlete use?

EL: Yes, lots of thoughts. (laughs) Just like any tool, I think that they can be used in ways that are helpful, and they can be used in ways that reinforce the eating pathology if it is present. One thing I've noticed, particularly with my athletes, is that they're really concerned with the data. They want to know, "What is my sleep doing to my performance? What is my eating doing to my performance?" It's all about using that data to fine-tune their performance in sports and to make sure that they're making the progress that they want to see. Which is cool, and as a scientist, I'm all for using the data to inform the decision-making that we're taking. But I think having access to so much of that data sometimes leads us to this place where we are trying to over-control what our bodies are doing and how our bodies are functioning. And I think that's the trap that I see a lot of athletes falling into with fitness trackers. They have access to so much specific information about their bodily functions—that may or may not be as accurate as they think it is—and they're like, "I know this thing, so I should be able to control this—I should be able to do this." And when they can't—when they can't restrict their eating without resorting to binge eating—then they're feeling frustrated, discouraged, and guilty, and it brings up this host of negative emotions, which then reinforces that whole cycle over again. So, I think they can be really useful, but I think they're a double-edged sword.

MP: That makes a lot of sense. Have you observed any common motivations regarding the use of these products? Or even a common progress path?

EL: So, I might go a little bit off topic here. With the athletes specifically that I've worked with, by the time they get to me, they have been using these trackers for so long that I have a sense of their current motivations for continuing to use them, but I don't necessarily know why they started. I don't know why they first picked up a tracker. I think they're generally continuing to use it for that sense of being in control of their performance and their growth and making sure that they're doing what they want to be doing. And I think there is an intermittent reinforcement part at play, where every so often you are successful. Or when your Fitbit buzzes when you get your 10,000 steps for that day, that feels good for people, and that sort of keeps them going, almost in an addictive kind of way. The place where I've seen more of "the reasons for picking up these kinds of trackers" is in the patients that I've treated that are not elite athletes, but they're exercisers and exercising frequently, but not in the context of a specific sport where they're necessarily competing. And for those individuals, I think it usually has more to do with weight loss and weight control. So, they're picking up that tracker as a way to manage their weight and make sure that they're seeing the progress that they want to see. Again, back to control. I think for those individuals, I really see the positive reinforcement of tracker use kicking in, where they start to get those rewards, and they start to get those little buzzes. When you get a really good sleep score, it feels really cool to be like, "Yes, I got 98 out of 100 sleep last night!" So, I think it transitions from, "I'm really doing this in order to control my weight, my performance, and my body in some way and fine-tune inputs and outputs and see what I want," to, "This is actually kind of fun, to try and keep controlling this system." And once those detrimental effects kick in, you've got enough of the reward history that it keeps you going, even if you're feeling discouraged much of the time.

MP: Yes, absolutely. Do you mind speaking about some of those detrimental effects?

EL: I think the biggest one that I see are feelings of frustration with oneself when they're not able to stick to their step goal. I have had a lot of patients who really feel like they are an "unworthy person" because they didn't get 10,000 steps that day. As you might imagine, that can lead to a whole host of downstream effects. And I think that would generally be the theme. Those trackers tend to set goals—they work in a goal-oriented mindset. And we know that people with eating disorders also tend to function in a more "control what you can" goal-oriented mindset. It's part of what drives the behaviour. So, I think it just sucks them in, and when they're not achieving those goals, it feels really,

really bad. And it can reinforce maladaptive coping mechanisms and further increase someone's maladaptive exercise. Or if someone's feeling horrible about their day, they could engage in binge eating to help manage those emotions. Or they could lash out at a friend. Or they could just feel generally crappy about their day, even if they're not necessarily engaging in an eating disorder behaviour specifically.

MP: I really appreciate that you shared your thoughts on that. At the end, you were speaking about health tracking devices and instances of body dissatisfaction and disordered eating. Do you have any more thoughts on the connection between these items?

EL: Yes, I do. I think fitness trackers, and specifically the watches, make you more aware of those thoughts throughout the day. For some people—I don't think this is for everyone with an eating disorder necessarily, but for certain people with eating disorders—I think having that on your wrist can remind you every time you look down, every time you bump it on something, you're reminded of what your goal is. And that's part of how they were designed to work for healthy activity promotion. They're just sort of a goal-salience reminder. But when your goal is something that's not actually in your control—if your goal is to be skinnier—sure, you can control what you eat, but that's only 5% of the equation for your body weight. You're relentlessly pursuing this goal, and that fitness tracker becomes a reminder of the fact that your body doesn't look the way that you want it to look right now. And those frequent thoughts just become a habit over time. It's exactly the way the fitness tracker was designed to work, just not on this behaviour. I don't know if this has ever been empirically studied—this is clinical observation—but I think fitness trackers can often increase the frequency of those thoughts, at least in the first few weeks of wearing one, until you become used to it and it's just another thing that happens. And again, there's that goal achievement piece—if someone feels like they're not achieving their goals, they're more likely to find fault with their appearance. If they know they've eaten above their calorie limit, they're more likely to report feeling fat that day. Versus, if they know they've eaten below their calorie limit or they know they've done 30 minutes of intense cardio, then they might be more likely to report liking their body that day. And that reinforces, "Oh, I need to do 30 minutes of intense cardio to like my body." Which then reinforces, "Not liking your body on days when you haven't done 30 minutes of intense cardio." I think it can be this cycle where people get stuck in thinking, "I have to do this thing in order to feel okay about the way I look, about my body, about my existence." For some people, that positive

reinforcement of "I met my goal today, and that feels really good, and I'm going to keep going" can be really helpful, and the downside isn't quite as strong. I think for people with eating disorders, body shape and body weight tend to be such a central part of their identity and their value as a person that it feels really bad when they don't meet those goals, and that body dissatisfaction can just be incredibly intense.

MP: Thank you. That is great information, and I really enjoy hearing your perspective.

EL: Of course.

MP: One of the topics that you mentioned was the potential feeling of being driven or compelled to exercise through the product or through tracking. Could you speak about that and the potential negative consequences it could have for someone with the underlying traits of an eating disorder? Or for someone with an eating disorder?

EL: I think that idea of feeling compelled to exercise, or feeling like, "I have to exercise today," can often reinforce other coping strategies for managing your body shape or body weight. With athletes specifically, it's less about managing body shape and body weight and more about managing athletic performance. But the idea generally is, "I'm managing something about my body." I think that people get stuck in a cycle of, "If I don't do this thing, then I don't feel like I'm managing my body appropriately." And maybe by happenstance, they catch a look at themselves in a mirror that's distorted, and they look larger than they might actually look in real life, and their interpretation is, "Oh my God, I'm fat today." Or they place fourth in a race that they really wanted to place first in, and that interpretation is, "Oh my God, I didn't perform well today because I didn't do that thing yesterday, or last week, or whatever." We use our interpretation of our past history to inform our future behaviour. And it allows us to focus on, "I didn't do this thing, so I have to do this thing in the future if I want this outcome," when there's actually a lot of other data points that we're ignoring. So, that behaviour then becomes compulsive in that, "In order to get this outcome, I feel like I have to do this thing. And if I don't do this thing, I'm either not going to get this outcome or I'm going to feel really uncomfortable. I'm going to feel guilty, and I'm going to feel anxious because I didn't do this thing." And then that thing becomes obligatory, and it's not fun anymore. That is a phenomenon we see a lot with people with some level of disordered eating pathology. The exercise becomes a job—it becomes work. And that is a sign that I use to look for that

compulsive quality of exercise: "Do you feel like you have to do this, or are you doing this because you actually want to?" And often, if people feel like they have to do something, then the bar just keeps going up. "If I do the thing that I feel like I have to do—for example, I do my 60 minutes of cardio—but the thing I want doesn't happen—for example, I still feel fat and I still feel like I'm too big—then maybe 60 minutes wasn't enough? Maybe I need to do 90 minutes? Then I do 90 minutes for a few weeks, and it's good, and it's feeling great. Then, three weeks later, I did 90 minutes, and I still feel fat. Maybe I need to do 120 minutes?" So, it just ratchets up over time, to the point where someone is skipping hanging out with their friends or skipping family events to go exercise, and it's actually really getting in the way of their psychosocial well-being more than anything else.

MP: That is very interesting, impacting the immediate quality of life for some future reward that may never come because the goalpost keeps moving forward.

EL: Yes.

MP: Are there observable traits or things that may indicate a person would be susceptible to the negative consequences of these products? Are there certain things a person could say or do that would raise some red flags?

EL: That's a really good question. I might have to think about this one for a minute. (pause) I think that generally, the urgency of their "wanting to avoid some outcome" could be a flag for me. For example, if I'm hearing someone talk about, "I want this thing because I really need to not become fat," or "I really need to control my weight while I'm still skinny," or something like that more broadly, if they're getting the tracker to have the ability to exert control over their body in some way, I think that's a big flag for me. If they say, "I'm doing this to have control over my body," my immediate thought is, "Well, that's not going to give you enough control to make you happy with it in the long run." You're never really going to be in control of your body, so it's setting them up to fail. And setting them up to get stuck in that cycle of "feeling like they can control it for five seconds, losing control, feeling really bad, going back and grabbing on harder to control," that negative cycle. So, I think that's the biggest one. (pause) This might just be another way that shows up, but I often hear people who present for treatment seeking weight loss and maybe don't even know that they have an eating disorder or could be susceptible to that. Often, they really want it for the positive

reinforcement, "I want it to know what I'm doing." And once you dig a little bit deeper, "Why do you want to know what you're doing? Is it because you generally feel good about yourself when you achieve your goals?" Yes, that is probably part of it—these trackers are not entirely, 100% maladaptive for all people with eating disorders. But if that's the only way that you're achieving your goals, then it can become maladaptive. Whereas, if they have other pursuits or other pieces of their self-evaluation that allow them to feel good about themselves besides their body shape and weight, I think that there's just less pressure on it. There's less centrality, so it's less likely to become detrimental.

MP: That makes a lot of sense. Do you feel that there is a connection between personality traits like perfectionism and high achievement within education, career, athletics, etc., and then susceptibility to disordered eating or body image issues?

EL: I think there is. And that's not to say that everyone who is Type A, perfectionistic, and goal-oriented is going to have an eating disorder—I think there's a lot more that goes into it than that. And not everyone with an eating disorder is Type A, perfectionistic, and goal-oriented. I think that there is definitely a subgroup, and maybe even a large subgroup of people who fit into both. And I will say, in my own clinical experience, not based on any research, that this most applies to athletes. It applies to athletes, and I think it also applies to a lot of people who undertake exercise as a main form of weight control. That sort of goal-orientation, goal achievement, just works really well in athletics. And it gets people what they want. They perform well, they get a college scholarship, they make the national team, and they do whatever they want to do in that area. So, they're like, "Oh wow, this really works. I need to do it more, I need to do it further, and I need to apply this." Maybe, "That worked for running, but I want to lose weight now that I'm 40 and not running anymore, so I'll just use the same skills that helped me succeed in running." It's one of those things where perfectionism and goal-orientation are really adaptive qualities—it's something that gets people what they want. And when it's applied to an area where you can't just work harder and succeed, then it becomes frustrating and sort of cyclical.

MP: Yes, that makes a lot of sense. The marketing around these devices leads one to believe that you can control your health. Yes, you can influence it. You can do things and see results. But there is a lot that is outside of your control. And after a certain amount of time, your body reaches homeostasis or rebels against your behaviour.

EL: The marketing is really just a reflection of our deeper societal values. Marketing is a mirror for what we, as humans, want and desire. And we want to control our bodies. I think that is true for almost every person on this planet in some way, shape, or form. And for a lot of people, that comes in the form of wanting to control their weight, because we're sold this message from society—of which marketing is a big part—that "We can control our body. We have the ability. And if you can't control your body, you're just not working hard enough, or you're just not doing the right things, or you have willpower." That kind of stuff.

MP: I agree. Or, "The solution is just around the corner, in the next Instagram post, or in the next special workout program. Everything you've been doing up until now is wrong."

EL: Yes. (laughs)

MP: I would like to change topics. A lot of your published work relates to sensor technology and devices. I would love to hear your thoughts on positive technological interventions to treat body image disturbances and disordered eating behaviours. Are there any things that you feel are most viable or most promising in this area?

EL: I love that question. Yes, I think there are some really promising things. I think that we are building this knowledge base of more and more advanced computational modelling that allows us to actually predict human behaviour in more and more accurate ways, and I think that holds a lot of promise for eating disorder intervention and recovery. A short history of momentary intervention: in about the 1980s and 1990s, people started coming up with this idea of intensive longitudinal data collection, where they'd have people carry around PalmPilots, or pieces of paper and pencils, and write down the answers to surveys four or five times a day. So, we started getting more momentary information about what was actually going on day-to-day for these people. Eating disorder behaviours are so tied in with the biological processes in our bodies that a therapy session once a week just isn't going to cut it. Someone can't take what they learn in therapy and immediately apply it successfully in their day-to-day life when they're experiencing really intense negative affect and they haven't eaten for six hours. Their body is really hungry—of course they're going to binge—what else would we expect? So, we're building these models where we can actually predict human behaviour and say, "Oh, this person is likely experiencing really intense negative affect, and they haven't eaten for a few hours." We can do all this based on

sensors, and I think that's where this world of fitness trackers and passive data collection meets "how we can benefit patients." And we really need to figure out how these people can use these sensors in a way that doesn't get them stuck in that negative reinforcement cycle, because they have so much promise. Emily Presseller—you mentioned her earlier—her dissertation, which is happening right now, is trying to build up an algorithm that can identify negative affect and when that might predict binge eating for these people. For my dissertation, I'm trying to identify and predict when people are likely to engage in exercise that might be maladaptive versus exercise that might be more adaptive in nature. So, we're slowly taking steps toward having this integrated system where people don't have to answer questions six times a day on a PalmPilot anymore. They just wear a watch, and then we can ping them and say, "It looks like you're at risk for this behaviour—why don't you use XYZ treatment strategy?" So, I think that's a really promising area, and there are certainly a lot of people working on this, building algorithms that can identify different risk factors and predict different behaviours. And once we can put all of that together into one system, and once we identify which interventions are the most effective on that small time scale, I think it's going to change the game for eating disorder treatment, honestly. I think it's going to change the game for how people use these devices to actually help them in recovery, rather than getting them into that negative reinforcement cycle.

MP: Absolutely. I read your protocol study [Using Wearable Passive Sensing to Predict Binge Eating in Response to Negative Affect Among Individuals With Transdiagnostic Binge Eating: Protocol for an Observational Study], and I think that framing the conditions around disordered eating episodes by collecting sensor data and data input by the user and using this to predict future episodes is an extremely interesting and viable pathway. When I was reading that article, as a designer, I was thinking, "Okay, how could we implement that in the future?" And I am curious about your thoughts on the complexity of the data that is currently presented to the user. One of my thoughts is that we're potentially giving the user too many fragmented data points, which we try to frame by saying, "This is your sleep score. This is your recovery score. Here are your steps." But I still feel that they are disjointed data points, and they are unable to actually communicate to the user a holistic understanding of "health." In this context, my question is: with the potential viability of the work that you and your colleagues are doing right now, how would you present data to the user? Would it look like a traditional health tracking device, or would it be something

different? Would the data be sent to the clinician only, and the device is more passive for the user? What are your thoughts regarding how this could look?

EL: I think we're trying to figure some of that out right now in some of the research that we're doing and thinking through some of that. From my own observation, the times that I've seen these systems be the most successful are when you do have a clinician on board who can help the patient interpret their data, interpret what all of this means, and help put it all together. Because I totally agree with you, especially with commercial fitness trackers, people have access to so much data, but really no help integrating that, and no help contextualizing that to their specific lives. Like, "Why are these numbers the way they are? Based on the fact that I was travelling last weekend, I probably didn't get as good sleep as I otherwise might have." Unless you are the kind of user who takes the time to research that stuff and sits down and thinks it through, you don't really make those connections very easily, and you don't know that those connections are there to be made. I think some sort of system that is helping people do that is necessary in order for us to see the benefit that we want to be seeing from these interventions. Whether that be a human person you sit down with once a week who helps you contextualize the data—I think that can be one of the more tailored and personalized approaches because you have the person that you can talk through and really have a conversation with. And that's mostly what we're doing right now with these types of interventions—they're used adjunctively with a weekly therapy appointment. I do see potential for a standalone—if we could build an app that helps people do that a little bit better and maybe present them with some data, but it's tailored, curated, and helps them contextualize all the data together—I think it could be really helpful. I do think that if you're not presenting any data, people get really frustrated. They're like, "Why am I wearing this tracker?" The field has done a lot of studies where we've given people trackers that don't have screens, and they don't have access to their data. Which is great because they can't then make erroneous interpretations of their data. It totally takes human error out of that end of things. But the reason people wear those trackers—the reason they keep wearing those trackers—is because the data is reinforcing. People want to see their data. A lot of individuals with eating disorders really want to see the data. They want to see what's working and why it's working. It's helpful to know things about yourself. I think seeing the data can have really beneficial impacts for progress in recovery as well. "If I can see with data that when I feel upset, I'm more likely to binge," that can help someone integrate treatment skills between

sessions. But I think we need to be careful about what kind of data we're showing and how we're showing it. I do think we need the data just to get people in the door.

MP: That makes sense. (pause) In your opinion, what are some beneficial or critical health metrics to track? Maybe it's a collection of a few health metrics that create a health index? Are there things that you feel are beneficial to track? Or are there things that you feel are detrimental to track?

EL: I don't know that I've really thought about that explicitly before. (pause) I think the more we can show people our—like back in grade school when you had to do algebra and show your math—show people how we're getting to the conclusions that we're getting to. I think the responsibility for disordered eating treatment, or just for making these applications more usable for someone who is not even in treatment but might be likely to have disordered eating behaviours, is that we need to be able to teach people how to think in this way on their own, without the app. If we're just spitting out a sort of summary score—I don't even know what that score might be—we're not really showing them how we got there, and the second they take that watch off and they're not tracking anymore, they don't really know how to interpret and contextualize their behaviour without that tool. One of the green flags is that people become less and less dependent on the tool. I think with these kinds of tools, we'll be able to tell that they're working when people actually get more sporadic about wearing the watch, or get more sporadic about using the app, or whatever they're doing, and they're actually less dependent on it. It goes against all business strategy ever, right? "You want to keep people addicted to your thing," but we actually want the user to be able to walk away—that is going to tell us that we have succeeded. And to be able to opt in and opt out flexibly. I think "showing our math" is going to be one way that we can help people gain independence in this process and manage it without needing to know exactly how many calories they ate or something like that. And I do think showing our math is going to be more than just, "Here's this number plus this number plus this number, and that's how we got this overall score." I think we have to contextualize it in the evidence that we have for how stress affects your body and under what conditions. And be really careful about crafting a story that allows people to see that stress is not always bad. There are situations where stress can be helpful and situations where stress can be detrimental, and there are a myriad of factors that affect that equation. So, finding a way that is understandable and approachable for people to teach them that kind of complexity, I think,

is a really big task. It's going to be really hard to make a tool that can do that. But I think that is going to be the best tool that we have—something to really help people critically evaluate, "What's going on in my life and how is that affecting my behaviour?"

MP: Absolutely. It is fairly naive for us to present these health metrics in isolation, with very little in-app or in-device training or contextualization, to the general public upon startup. It is truly relying on the individual to have some basic understanding or to develop that understanding over time through passive learning. But to think, "Every individual has the same amount of base knowledge regarding these variables," is incorrect. I think some type of in-app or in-device training or education component could be a really promising avenue. And I love this idea of "showing the work." But I also agree with this idea of "discontinuing use when you no longer need it." (pause) I would love to hear your thoughts on the impact of wearable health tracking devices and associated digital applications on the embedded bodily awareness or senses of the user. Do you feel these products help to enhance, reduce, or abstract these sensations? Do you feel it can help someone get in better touch with their body, their sensations of hunger, or their sensations of fatigue? Or do you feel the reliance on data creates a disconnect with the body? What are your thoughts?

EL: I think it goes both ways for different people. In the eating disorders world, we've had this conversation in the literature where oftentimes individuals with eating disorders over-interpret interoceptive cues, for example, "If I feel slightly bloated, I'm fat today." Where normative body cues become this catastrophic thing. And that starts to get people into this cycle of paying too much attention to their body cues and misinterpreting their body cues. There are other people, or maybe the same people, who cycle in and out over time, where that over-interpretation becomes too much to bear, and then they just ignore all body cues. "If I don't eat for a day, then I just ignore the hunger, and I don't relate it to my body cues," and over time that begets less attention to body cues. Often, people can miss hunger and satiety cues because they are just totally out of whack. And when we don't eat, our hormone regulation is all off, so our body doesn't even send us the same cues at the same level and at the same times that it normally would. I think our interoceptive system just gets totally thrown out of whack when you're engaging in disordered eating behaviours. Same thing with exercise—if you're overexercising, often people will exercise past internal body cues that suggest maybe they should stop now—their legs are hurting, they're shaking—that kind of thing. Or people will pay even more attention to certain body cues, like, "My ankle hurts a

little bit. What if that means I can't exercise?" Then the tiniest twinge in their ankle becomes this horrible idea of, "Oh my God, I won't be able to exercise tomorrow. That would be awful." I think the fitness trackers and having that reminder on your wrist could reinforce the more attentive people. If it's reminding you that you're doing this thing, then you might be more likely to pay attention to those body cues. And we almost need a way to help those people disengage from that information and say, "Yes, my ankle twinged. Maybe I just stepped on a rock weird? That might have been all that happened." Help them more objectively interpret the information without jumping to a catastrophic conclusion. (pause) For the people who are just not paying attention, I think the sensors could be more helpful. Especially if they're cued as part of whatever intervention, whatever total score to rate how their body feels in some way. This is the thing that gets me—I don't know if other sensors have it, but I know Garmin has this recovery score that indicates how your body is doing overall, but to my knowledge, that score doesn't take into account any subjective data at all. It's based on your heart rate variability, your sleep score, and whatever else. But you, as a person, also know how your body is feeling. I think giving people that power can be really helpful. To say, "Yes, my heart rate variability was low, and yes, I didn't sleep great, but actually, my body feels really good today," and allowing that to influence the algorithm can also be really helpful.

MP: That is a really balanced perspective. I really appreciate hearing your thoughts on that subject. Related to your last point, something that came to mind was the distress this could cause. Where the user could feel they're in a battle with the data or the messaging that comes from the device. Especially since these products are viewed as sophisticated, aesthetic, highly ubiquitous, and created by well-respected companies. So, to say, "The device is wrong—I feel fine," could feel like going against the grain.

EL: Yes, it could be hard. And then you get the placebo effect of, "If the device says I feel bad, then I must feel horrible. Then I over interpret my current state feeling of 'just fine,' as 'this is bad,' and in the future, when I feel this way, 'it's bad.'"

MP: That is very interesting. (pause) Regarding design improvements, have you identified some key design considerations for these products that you feel could mitigate instances of body dissatisfaction and disordered eating behaviours?

EL: It's a good question. (pause) I think devices or systems that promote adaptive skill use are really important. The more that we can incorporate lessons for people on how to handle these scenarios in the future and cue them to use skills that are helpful for them at any given point, I think, is helpful. I've heard from a lot of patients, "Sure, it's great to know that maybe I'm at risk for an eating disorder behaviour," or, "It's great to know that exercise I just did might have been maladaptive. But I don't know what to do with that information. I don't really know how to change my behaviour in the future." I think giving people skills, opportunities, and optimism to know that they can change their behaviour in the future helps them to engage with it more and feel less stuck in the cycle. I think this would be partly design and partly function and form, but building in this sense of "I am the user of the device" and giving the user autonomy over their decision-making and how they use the device so that the device doesn't become the final arbiter of "My success in treatment," or "My success in managing my weight," or whatever it is. Keeping the device in that space of "This is a tool that I'm using —this is not a thing that controls me" is really helpful because it's really hard to not engage in these behaviours. Building in that empowerment can be really, really important for people.

MP: What could that look like to you? Is it more personalization? Is it more product options in the marketplace? Is it a collective understanding within our culture that maybe these products are more transient? Like, "You wear them when you need to, but not all the time." Do you have any thoughts on what that could look like?

EL: I think it could be all of those things. The first thing that came to mind was actually something that cues the user to critically evaluate the information they're given. Having the user write down a few thoughts about, "What is my interpretation of this data and information?" And potentially building some sort of chat bot that helps people interpret the information. For example, "Here are my thoughts about my sleep score." And then the chatbot could take that information and help them contextualize it. Like, "You also logged having a few drinks last night, so it makes sense that your sleep score was a little bit lower—that's normal." Having some sort of interpretive component to help people think through these things, I think, is a big part of that. And that could be a sociocultural shift, or it could be part of the device, or it could be both. I think we could do it at a lot of levels.

MP: That is really cool. (pause) Some of the apps have a social component where you can connect with other users and share and compare progress. I know the social component is

important for eating disorder treatment. How do you feel about the social component of these apps and devices?

EL: I think, more often than not, it leads people to make upward comparisons where they're feeling like, "Someone else is making more progress or doing better than I am," in some way. My feelings are not particularly positive towards the social piece of things. That's something I've actually been wanting to study for a while because we've never empirically evaluated the effect of that. That's just my own personal reaction as well as clinical observations of the patients that I've treated. With some scaffolding, the social piece can be done really well. And certainly, when the social piece comes into play in the context of treatment, we're actually putting a lot of thought and effort into curating how that social piece can be helpful and really positioning the social milieu to be a helpful scenario for people. I think we can't just say, "We'll build a chat room or a leaderboard," and just let people have at it. I think we need to build some scaffolding to help that actually function appropriately and be helpful for people, because I don't think that's something we can do by ourselves in our own heads.

MP: Yes, our health and our treatment protocols are so complex, so nuanced, and so interdependent, and it's almost funny that in our tech-focused society, we believe the device or the health metrics in isolation are sufficient for a person.

EL: We want it to be that simple, right? The people who are designing these devices want it to be that simple. These people are designing these devices because they see a need for them in their lives, to some extent. We have these ideas like, "Wouldn't it be so cool if I could just have this watch that would make me healthy? It would be so much easier than having to interpret this immense amount of data and contextualize it." And the reality is, I just don't think we can.

MP: What are your thoughts on the future of wearable health tracking devices and digital applications? In five to ten years, do you think these products will still exist? Do you think we will still be interested in this stuff? And if so, considering all of the technological advancements, what do you think these products could look like?

EL: My cynicism says, "Yes, they will absolutely still exist because marketing and business will do whatever they can to stay relevant and keep selling products." My cynicism again, like

the Debbie Downer perspective, is that, "To stay relevant, we have to give people what is immediately reinforcing to them." I think that without regulation and without putting more thought into it, like you are, the trend and the easiest path towards profit is going to be to capitalize on that addictive nature and to capitalize on that sense of reward gained from the device. That's the path of least resistance for where I could see this going in five to ten years —where these devices actually become really detrimental because we're just capturing people's desire to control their bodies in some way and really keeping people addicted to that cycle of, "I felt good; I controlled it. I felt good; I controlled it—oh no, I didn't. I felt good; I controlled it. I felt good; I controlled it—oh no, I didn't." I think we have to be really purposeful moving forward to make sure that we don't take that path. To make sure that we can present evidence and really build reasons and conscious technology—it sounds like an oxymoron, but we need socioculturally conscious development of technology and making sure that it is actually helpful for people. And I don't think they're going away. I think that it is too much of a pipe dream for humanity to have this technology that just tells them what to do. "We don't have to put a lot of effort into our lives anymore. We can spend our time doing what we love to do rather than figuring out how to feed ourselves." That's the evolution of humanity to date —I think this is just the next phase in that evolution. So, I think they will be around, but I think we will have to put a lot of effort into making sure that they are around in a way that is helpful to us in the grand scheme of things.

MP: I appreciate hearing your thoughts, and I agree with your perspective. Within the design field, there are some prominent thinkers who were trained in psychology and used that understanding of people to teach designers how to build very addictive and desirable products. And recently, there has been a moral shift where some authors, such as Don Norman, are saying, "Design must now change from being unintentionally destructive to being intentionally constructive" and address the intended and unintended consequences of these decisions. So, I love hearing your perspective on this, as you are someone who has to work with the implications of these decisions. You are on the front lines.

EL: Absolutely.

MP: You mentioned regulation, and I wanted to ask you about this. As these devices become more sophisticated, what are your thoughts on increased clinical trials and medical device classification?

EL: The researcher in me is like, "Yes, more studies are better." Absolutely, we need to understand how and why these things are working. But I don't know if that's realistic in the world we live in. That's expensive, and that takes a lot of time. (pause) Maybe there's a happy medium. Maybe we can do some of this work without needing "a fully powered randomized clinical trial to establish the safety of a heart rate sensor" or something like that, given that thousands of people are already using these devices and not necessarily dying from them. But I do think that we need more public awareness of the harmful implications of these devices. In terms of "classifying something like a drug where it needs a study to be deemed safe," people know that there are inherent risks to taking drugs, but I don't think people in the world, going about their business, know that there are inherent risks to wearing a Garmin, a Fitbit, or something like that. So, coming at it from a public awareness perspective might be more realistic in terms of "what could actually have the benefit that we want it to have?" Or both—we could always do both. We can do the randomized control trials and also increase public awareness.

MP: That is a great point. The analogy I have used to describe this work is, "Humans developed and introduced the automobile, and it was successful, but then there were extreme unintended consequences, such as greenhouse gas emissions and increased safety concerns. We then need to pause, look at the automobile, and propose changes. It doesn't mean automobile production stops and we outlaw the automobile. But now there is increased awareness, and now we have all these different groups developing technologies for improved environmental protection and safety." (pause) If we're purely looking at the health and wellbeing of our population, is the promotion of these health tracking devices the best option? Maybe, maybe not. Simultaneously understanding the economic system that we live in and questioning whether these products will just go away? Probably not. So, the dilemma is that increased public awareness about the current dangers is required, and we also need to make these products less harmful. We need to understand and play the game.

EL: Yes. And I think we have to work with and inside the beast in a lot of ways. Sure, we have to build public awareness, but we also have to work from the inside out and figure out how to make marketable devices that will sell and are also not harmful.

MP: Yes, and then making sure the message and marketing do not get manipulated again.

EL: Right.

MP: In a recent commercial for Samsung's Galaxy Watch5, the tagline was "See how your body improves every day." It implies that improvement is the goal or is necessary.

EL: Yes, "If the body is not improving, you're not healthy."

MP: Exactly. (pause) Maybe I'll leave it there. This has been a really great conversation, and I think we can conclude. Based on the nature of this conversation, are there any key research studies or topics that you feel are relevant and something I should look into?

EL: I can't really think of anything. It sounds like you're very well versed in the literature in this area. If you haven't come across Adrienne Juarascio's work yet, she is someone who is not necessarily doing work with athletes specifically, but she has been a really big influence on my work. She is really interested in, "How can we use different kinds of sensors in this direction?" She is someone who has some ideas about novel ways sensors could be applied to actually improve eating pathology. So, she is someone I would say, "If you haven't heard her name, give her a look." I'm not really sure how relevant a lot of her stuff will be, but she's doing some really cool stuff.

MP: I appreciate that. I believe you have collaborated with her—is that correct?

EL: Yes, a lot. I've been able to use a lot of her data for my papers.

MP: Okay, cool. (pause) Before we conclude it, I would like to give you the opportunity to address or discuss any other topics, if you are interested.

EL: I don't have anything else that I feel we haven't touched on. I am curious—can I ask you a question? Where do you see this line of inquiry going for you? And what's your end goal from this research?

MP: Yes, of course. Originally, I was interested in developing a product that was inspired by Nada Pop-Jordanova's work on biofeedback as a treatment for disordered eating. Consider a hypothetical scenario where your research is complete and we could collect all of the

situational data around a disordered eating episode or a binge-and-purge cycle. If the device could detect that the person was very susceptible to these conditions, it would provide biofeedback in some form. Whether it's a series of pulses from a wrist-mounted wearable—or even rethinking where the device is worn, potentially moving it closer to the stomach to help reestablish sensation connections for hunger cues. In the beginning, it was about applying biofeedback to help the user understand when they may be at risk for disordered eating—that was my thesis proposal. And once I started to dive deeper into the literature, I realized the scope of this topic was quite vast. I learned there are a lot of people in the medical and psychology professions discussing the implications of this technology. But in the design, tech, human-computer interaction, and sensor development areas, there was little discussion about the negative effects. It was just about advancement. So, I realized that I needed to bring my audience up to speed, and this includes myself. That would be the first thing. Because in order to have a good product, a really well-informed project brief that contains a lot of contextual information and data is required. Right now, my immediate goal is to take primary and secondary research and coalesce that into a design brief and design recommendations for an eventual next phase. I may create visual prototypes to illustrate what these solutions could be like. For example, if there are ten major themes, what could those look like? That could spark people's imagination. And then further research would make those concepts more tangible. For example, something that we talked about today was, "How to add more subjective data into the app?" The first step would be to simply visualize that theme to make it understandable. And later, in terms of implementation, determining, "What is the workflow? What is a good user experience? What is realistic considering they have just completed their workout? Is it numeral or text-based?" So, I hope I addressed your question and didn't go too far off topic.

EL: That's fantastic. I'm getting chills as you're talking through this because I am so glad that someone is doing this work. Like you mentioned earlier, for a long time, I've personally felt that we, as eating disorder professionals, are pushing back against this really big monolith that is sensors. And as you noted, it does feel like when the sensors are sold, "They're just amazing. They're perfect. There's nothing wrong with them." And there can be things wrong with them. They can be hugely helpful, but they can also be detrimental. It's just so gratifying to hear that this world is seeing that and taking that into account in your design. And that someone is doing this thinking and this talking. I'm so glad that you are.

MP: Thank you very much. I sincerely appreciate hearing your encouraging words. Sometimes I feel like I am going against the grain in my field.

EL: Yes, I am sure. (laughs)

MP: (laughs) Yes. Thank you again. (pause) Perhaps one more related anecdote before we end. Tony Fadell, one of the developers of the Apple iPod, wrote a book in 2022. In a press interview, he described his time in the Silicon Valley tech industry and how different teams would work to develop independent pieces of technology. Afterwards, they would try to jam all of these technologies together and then say, "It can do all these things—it's so cool." But then the marketing department would have to determine, "Okay, how do we make this interesting? How do we sell this?" It was really fascinating to explicitly hear that it wasn't necessarily driven by consumer need but rather by finding applications for novel technology.

EL: That's super interesting to hear. It goes back to your point that we find applications for these things without fully thinking through what that application is going to do in reality, in people's lives. And then we're having to look at the car again and say, "Hey, this may be unintentionally harmful in these ways—how can we mitigate that? How can we make it better so that it can still exist and can still be helpful to people?"

MP: Absolutely.

EL: I'm super excited that this is going to be out there and that you're thinking in this way. I can't wait to see where this goes long-term.

MP: Thank you again. I really appreciate it. And I am really excited to see where your work goes. I am following your study. I saw that May 2024 is potentially when some data will be out, and I am really excited to see that data. Thank you for agreeing to participate. I appreciate this interview. There is some amazing content here.

EL: Of course, I'm happy to. And feel free to reach out in the future. If there's more opportunity for collaboration, I would definitely be open to it as well.

MP: Wonderful. That is great news. (pause) Finally, as noted in the Participant Consent Form, I will start the transcription process once all of the interviews are complete. Once completed, I will send a copy of the transcript to you, and you will have 14 days to review it and make any revisions. Afterwards, the transcript will become part of the data set. I will contact you if I have any questions or if anything in the conversation requires clarification. At the same time, please contact me if you have any questions. Finally, I would like to thank you once again. I really appreciate your interest and your contribution.

EL: Of course, thank you so much. It was a great conversation. It helped me think through a lot of this stuff, too. (laughs)

MP: Oh, good. I'm glad it could be useful for you too, not just one-sided. (laughs) Okay, have a wonderful day. Thank you.

EL: You as well. Thanks. [Interview Duration: 01:24:04]

Dylan Scott, October 4, 2023

Michael Peel (MP): Before we begin, there are a few mandatory items that I must cover. This will take approximately two minutes to complete, and then we can begin the interview. I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. And you may request that anything you share be off the record or not disseminated. The scheduled duration for this interview is approximately 60 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

Dylan Scott (DS): Nope.

MP: Okay, now we can begin. (pause) I have familiarized myself with your LinkedIn page, some of your published research studies, and some of the press content related to True Angle Medical and Mobili-T. With this said, I would like to give you the opportunity to describe your academic, professional, and research background in your own words. Could you please share your thoughts?

DS: Yes, for sure. I am sure you noticed that my LinkedIn page is pretty minimal. I think it says, "Coming soon," or something like that, and has a picture of me surfing. So, probably not too much to glean from that. I can give you a brief rundown of my educational background—where I came from, how I got to where I am—if that makes sense for your interview.

MP: Yes, it does. Establishing that context is really helpful. This research study features purposeful sampling, where I contacted experts based on their expertise within their field.

Therefore, it is helpful if you state your background, your experience, and things like this for the research documentation.

DS: Excellent. I am an engineer by trade. I went through the University of Alberta's Mechanical Engineering program for my bachelor's degree. After that, I worked as an engineer in the alternative energy space. I decided I didn't like it, and I went back to pursue a master's degree, again in mechanical engineering, this time through Dalhousie University in Halifax. My thesis was on distributed robotics, and more specifically, on insect-style collaboration between robotics. Following graduation there, I came back to Edmonton and found a job with an organization where I actually met Ben [King], called the Institute for Reconstructive Sciences in Medicine [iRsm], which is run out of the Misericordia Hospital here in Edmonton. My role was as a research engineer, working primarily on two projects. One project was dealing with bone-anchored hearing aids and the design and development of new algorithms for processing the signals from these bone-anchored hearing aids. The other project was the development of a novel surgically implantable device for the treatment of hydrocephalus. I worked there for about four to five years. Following that, I moved to the University of Alberta within the Communications Sciences and Disorders Faculty, formerly Rehab Med. I worked there as a research engineer. I continued work with the bone-anchored hearing aids—the design and development of novel algorithms for characterizing the hearing aids themselves. This resulted in one or two patents from that work, a few presentations, and whatnot. Also during my time at the university, we started conceptualizing the idea behind True Angle's primary product, which is the Mobili-T, which is a medical wearable device. My role in that was the complete design and development of the hardware, and at least for the early stage, the electrical and software design as well. So, kind of a "soup to nuts" type of thing, where I was involved in the very early stages of product conceptualization, all the way through to what we now have as an on-market prototype, or product, for this mobile wearable piece of health tech. In 2018, I transitioned from the University of Alberta to True Angle Medical as the chief technical officer. Again, my role here is primarily on the technical side, supporting the Mobili-T product and our other product development activities.

MP: That is very interesting. Do you specialize in particular technologies or products, either as an individual or with True Angle? Do you feel you have an area of expertise?

DS: I would consider myself more of a jack of all trades than an expert in any one thing. But my professional experience has all been in small electromechanical systems for the measurement of human activities. Always electromechanical, where I'm building actual hardware that specializes in measuring or monitoring some human condition or signal. So, my specialty, from a professional background, would be in that domain. Hopefully, that is helpful.

MP: Yes, that is helpful, and I appreciate the clarification. (pause) Do you work with any athletes, or have you worked with any athletes? And if so, what type of athletes?

DS: Not specifically athletes. My focus has been primarily on dysfunctional conditions. For example, hearing loss and, with the Mobili-T, swallowing difficulty. So, I haven't had any in-depth personal experience with athletics.

MP: That is no problem at all. Tying into the previous question—and again, you may not have any experience with this—but do you encounter any body image concerns or disordered eating behaviours with your clients or research?

DS: Yes, body image, for sure. Working on the hearing aid side of things, with pediatrics all the way through to adults, from that one device type or that one specific area, there's definitely a body image component. I'm not sure if you're aware, but bone-anchored hearing aids are not the standard in-the-ear hearing aids. These are people who have an ear missing or have had a traumatic incident where they had reconstruction and now the ear is no longer there or viable. So, definitely body image concerns with these people, where they don't want to be seen with this "Frankenstein post" sticking out of their head—very concerned from that side. From the head and neck cancer side, obviously, it comes up as well. Depending on the severity and type, if any, of the resection, there is a massive amount of concern around appearance. Where you've had huge resections and your jaw has been rebuilt, or part of your face has been resected and now is replaced with prosthetics—huge body image concerns there. And massive effects on a person's psyche, I'd say. Eating disorders are kind of part and parcel with head and neck cancer. Maybe not the disorder itself—it's more of a fact, right? You now have a modified structure that doesn't allow you to eat in the same way or the same foods that you used to enjoy. So, while I don't specifically deal with the psychological impacts of this and how it may translate into disordered eating, it definitely happens with head and neck cancer. And specifically, dysphagia—which is what the Mobili-T product actually

supports—is an eating and swallowing disorder that can lead to disordered eating. So, I don't directly deal with this, but I have witnessed it.

MP: I really appreciate that. It is very interesting to understand where you're coming from and how you're experiencing these conditions within your world. Leading into more direct questions about wearable devices and their associated applications, could you please describe your experience with wearable technology? This could be from personal use, or it could be from your professional design practice. I know Mobili-T is a wearable, and I am curious about your experience developing other wearables. Finally, do you personally use any wearables?

DS: For sure. Mobili-T is a wearable I've developed. I've assisted and worked on the development of hearing aids, which I would consider wearables. Now they're called "hearables," I think, but another wearable that's in the medical space. Personally, I have owned a number of health wearables—I'm wearing one right now—and have used them for a number of years, more than I care to admit. So, I have experience from a professional perspective and from a personal perspective. Sorry, I think my rambling made me forget the original question. Can you restate it?

MP: You were not rambling at all, and you did address the question. The question was about your general experience with wearable technology—what types of products have you developed, whether or not you use them, etc. (pause) Now the next question is, as a user and as a developer, what are your general thoughts regarding the current state of wearable health tracking devices and applications? For example, have you observed any positive or negative effects in terms of behavioural, health, or performance factors? I am looking for your general thoughts regarding the current state of the field.

DS: I think it's a great question and probably something that you could spend a lot of time on, which is probably why your thesis is in this area. It's a cheesy way of saying it, but I think it's like the Spider-Man quote, "With great power comes great responsibility." This is from a personal perspective, and it is something that I continue to struggle with—I'm quite a competitive person, and when you have something that can very accurately measure your own personal health stats and also allows you to easily publish these to online forums where anyone can witness them, or not, and you can just look at your own performance against

yourself, it's a very powerful thing, and it can either be very motivating or demotivating. For me, it's something where I'm getting older and because I've worn these things for so long—and I'll use Strava as an example where I have wearables that directly link to Strava and they push the data into the application—I've had that for countless years and all that data has been sitting there. So, when I was 20, I was significantly better at certain activities than I am now. But there's no contextual awareness within those platforms or within the device that says, "Hey, you don't have to be as good as you used to be." It is very demotivating to me, where I'm like, "Ah, I'm not as good as I used to be," or "I'm not as fast as I used to be," or "I'm not as strong as I used to be." And I think it's detrimental to the product itself—it makes me not want to use it as much. There have been points where I've taken it off because it's like, "I can't take this. I can't take another, 'You should train harder,' or 'You should do this.'" Again, from a personal perspective, I think there's a lot of power that these companies have over what they can make you feel and what they can do for you. And it can be used really intelligently to make you feel very good about yourself or your activities, or it could be quite demotivating. It's a very fine balance between what you're collecting and how you're presenting it, and how that can really impact a person. Personally, I have had both really good experiences with these things and quite negative experiences, like it's made me not want to do an activity because I'm tired of comparing myself against others or against myself. From a professional standpoint, the devices that I had a hand in building or have been involved with—again, I have seen both the positive and negative sides of these things. Body image comes into play when you have an assistive device. We're very focused on providing that initial mitigation. Hearing aids are a great example where it's like, "The problem is you can't hear. The solution is that we will give you a hearing aid." Traditionally, there hasn't been much thought into, "What's the quality of life implications of adding this assistive device?" Like, "It's great that you can hear again, but if you have this [holds up a large object] attached to your ear, maybe you don't want to hear?" There's some negative side effects, or there's some side effects—I won't say negative or positive—that don't really get thought of very often. Especially when you're developing medical assistive devices where the problem is some medical condition that you're trying to mitigate, you don't go into some of those nuanced side effects based on the design of the device or the interaction of it with the external world. So, I've had great experiences where we've developed things like the Mobili-T, which is this very small wearable thing. And clinicians love it because it's small, it's affordable, their patients can wear it, it's easy to attach, and it has benefits. From a patient's side, it's like, "I would never wear this in public. I will never do my exercises in public. I will do them at home because who

wants this thing hanging from my chin with blinking lights? I already have something going on with my face—I don't need any more attention drawn to me." So, you see both sides of the coin. The benefits are here, and people are aware of them, but there's also this negative thing that people perceive or feel about wearable devices. Hopefully, I answered the question.

MP: Absolutely. There is so much information there to unpack. I really appreciate that you shared both your personal and professional experience. I am really interested in the unintended consequences of design. Like you said, a design team can address the immediate needs with a technological solution, but there could also be cascading effects. The duality of these devices is also really interesting. Again, like you said, as a long-term user, you're able to compare your progress to a previous stage of life. And that awareness can potentially cause distress, despite these changes being normal and natural. But it's potentially the first time in history that so many people have access to this longitudinal data. But I digress. (pause) Are there particular devices, applications, or companies that you feel are doing this really well—providing excellent products and user experiences and potentially avoiding some of the problems that you alluded to?

DS: The best wearable that I've ever owned was the Nike+ FuelBand. It was very minimalistic, but it was fun, and it was engaging. It didn't give you an alert that, "Hey, you should get moving right now because you've been sitting for this long." It was very direct in what it did, and it was a very engaging thing. It wasn't around long enough to have a lot of longitudinal data. Nor did it have great integration with anything else. It used a proprietary measurement system like Nike Fuel Points and whatnot. But I wore it every day, I loved it, and I used it all the time. It was what I benchmarked myself against all of the time. And I really feel like it was the right balance of monitoring, engagement, and intentful usefulness. More and more, it feels like we're now at the stage where "We can collect it, so we do collect it. And because we do collect it, we're going to show it to you in some way that we feel is necessary." Gramin is terrible for this—and I'm a Garmin user, so I obviously haven't jumped out—but they collect so much information, and they try to present it in meaningful ways, but I don't think that they have it right. So, that's the opposite of your question. But the Nike+ FuelBand, for me, was something where they had it right. I've never owned an Apple Watch—I'm an Android user—but I think, in general, Apple obviously puts a lot of effort behind their user experience. From what I have seen, they do provide a more thoughtful presentation of the user metrics or stats,

but I haven't personally used it in any great detail. From what I have seen, it feels a little more thought out compared to some of the things that I have used or that I do use.

MP: That is awesome. I was not aware of the Nike+ FuelBand, so I will look into it. I am searching for ideal products and design criteria. Therefore, for my understanding, could you please speak a bit more about the primary highlights of that device?

DS: This is a product that I haven't used, but the older Fitbits, where some of them didn't even have a display—or Whoop, Whoop is a good example of this—there's nothing to distract you. There's nothing to provide you with instantaneous, on your wrist, "Hey, you did this" or "You need to do that," just in your face with what I find to be the overly pervasive use and presentation of your information. I don't need to know every second, "This is my heart rate," or that "I should get moving because you didn't detect motion." That's what, I think, the FuelBand did really well. They abstracted away whatever data they were collecting, and they just put it to you in a very simplified and useful form factor. Whether or not it was ultra-accurate or whatnot doesn't really matter. I found it engaging and useful from a relative perspective, if that makes sense. Knowing my heart rate every second of every minute of every day isn't as important as knowing, "Hey, you did this much more activity today than you did yesterday," or whatever. That's what I really enjoyed about it. And I think Whoop took it a step further—they took out the display all together. So, if you don't want information, you don't get information. There's no way for you to get it unless you're fully engaged with your phone, which I really like. I think that's probably a good analogy. That would be the primary reason why I liked the FuelBand—the abstraction from the complex data and only displaying what is pertinent and important to me.

MP: Thank you for sharing your thoughts on that. This leads into the next question about the complexity of health data presented to the user. I read a few of the Mobili-T studies regarding the journey to develop the app and the different ways of visualizing the mind-to-muscle connection. In some of the interviews, the users spoke about the complexity of the data visualization and things like this. You also brought up Garmin and how it presents a lot of data, and then you contrasted this with the Whoop and the Nike+ FuelBand. Could you please tell me your general thoughts on the complexity of health data? What are your thoughts about contextualizing health data so that it makes sense for the user? Do you have any thoughts on things like this?

DS: With respect to the complexity of health data, most data from one sensor is complex, and something that we have now is that it's not just the complexity of one source of data. With respect to health data, it's like, "More is better," right? You have heart rate monitors, SpO2 monitors, motion monitors—everything is just packed into this little thing. There's machine learning on these devices. It's insanity. The amount of information we have is insane—it's crazy. There are now more sources of data for your physical health in your watch than there were in the hospital room, like, five years ago, it's not that long ago. You now have medical-grade ECGs [electrocardiograms] coming out on devices that cost a couple hundred bucks. It's insane. The data itself from a single source is complex, but you have tons of stuff plus all this other processing, and a lot of it is "black box," so we don't know what it is. And it's so new —these are just my opinions—but it's so new that we don't really know how to present it to users. It's not something that's been out there. Within the context of using this for your personal well-being, this is super new. Like you alluded to, this hasn't been around for a long time. This went from hospital to home, so we're still figuring out how to display it in a meaningful, useful, engaging, and not overwhelming way. I don't think we're there yet—it's quite difficult. And we, as professionals in the industry, misinterpret certain things, and then people get attached to them. I'll use gamification because one of the articles that you probably read was about Mobili-T and gamification, and this can extend to any other health tech. A misconception you hear all the time is that gamification makes apps, data, and this and that more engaging. But we, as professionals, perceive gamification when we're developing it as "a game." So, you're like, "I'm going to make a heart rate monitor that's Flappy Bird because that's gamification," when you've really gotten away from the principles of what gamification is. It's not necessarily that it looks like a game or behaves like a game. It's that you have game-like elements in there, meaning there are rewards based on specific activities—that's gamification. But in the industry, if you don't talk to enough people with prototypes or physical assets to show them, "Here's what we're intending to do," then you won't find out that the presentation is just garbage. Like we did with Mobili-T, "Maybe it's a fishing game?" I think that was one of the ones in the article. And people were like, "I'm doing swallowing exercises because I had head and neck cancer and I can't swallow. I don't want to fish. That's not at all what I want to do. I don't care. I want to see the simplest thing that I can." And for them, gamification was a target line that you achieve, and it's like, "Hey, you got it." That was the element that they needed. So, long rant aside, I think there is a massive amount of complexity in a single data source, and now that's compounded by the number of data sources that we have via sensors, algorithms, and whatnot. And we don't have a great

understanding of how to present that to users because it's really new. We don't have a good or unified understanding as to how to present that to users.

MP: That makes a lot of sense, and I appreciate learning your perspective. What you have articulated is what I feel as both a user of these products and as a researcher in this field. It is moving very quickly—new features come out with each iteration, and best practices haven't really been established. Simultaneously, we exist in a social culture of optimization. We are conscious of and tracking all of these health metrics, which we were potentially unaware of before. It is easy to get caught up in it all, and we may need to question our individual motivations for using these products. (pause) A common goal in the treatment of eating disorders, the treatment of body image concerns, and athletic training is to reestablish a connection with the person's embedded bodily sensations. For example, to reestablish true feelings of hunger or satiety—or if a person believes they are overweight but in reality they're dangerously underweight—to reestablish an accurate body image. With this said, I was curious if you have any thoughts regarding the impact of wearable devices and associated applications on the embedded bodily sensations and bodily awareness of the user? Do you feel these products can heighten or reduce those sensations? Do you feel these products can abstract bodily sensations to a point where people are strictly focused on the data and are potentially viewing themselves through the data? What are your thoughts?

DS: I'm not sure how to best answer this question. (pause) I feel like the wearables, the data they collect, and the processing they do could be used to provide some of the beneficial things that you mentioned, like actually reinforcing an appropriate body image. They could be used like that, but I don't think that they necessarily are. However, I also don't think that, in and of themselves, they're the opposite either. If wearables were to exist in a vacuum where the associated social media and community platforms like Strava didn't exist, I don't know if these wearables would drive a negative sense of body image. I think it's a coordination of all of these external factors plus the fact that you're able to measure what this other person is measuring. You're seeing them, and it's like, "Oh shit, they're doing that, and I don't look like that, and that sucks."

MP: Because you have long-term experience with these devices and applications, like Strava, I would like to hear your thoughts on the general concept of self-tracking for athlete use.

Additionally, are there any health or performance metrics that you feel are beneficial to track? Or any that you feel are potentially problematic to track?

DS: I think the tracking of metrics for athletic performance, in that context, is very important. If you're coming at this from a performance athletic perspective—not like a weekend warrior, "Hey, I'm out for a bike ride" kind of thing—but performance athletics, tracking of metrics could be extremely important. What the important metrics are is probably highly dependent on the activity. But at the end of the day, I think any metric has to be actionable. Let's take resting heart rate as an example—if that's something you're tracking over time, is that something that is actionable? If it's not actionable, then it's a useless metric that you're collecting for no reason. And in the best case, it could be confounding—it's just putting extra data where it doesn't need to be. Or again, it could be one of those demotivating factors where it's like, "It doesn't matter where it is, but now I'm highly reactive to this data point because I feel as though it should be something else." Body weight and BMI are other examples. There are BMI calculators that are all over the map, and tons of people can have an awful BMI but are crazy fit. It's not a good indicator in most cases, so that's a piece of information that's probably just confounding in the best case and demotivating or dangerous in the worst case. I think collecting the metrics is very useful from a performance athlete perspective, as long as the metrics are actionable. What the metrics specifically are would be highly dependent on the activity itself.

MP: That is a balanced perspective, and it ties into some of the things that you mentioned before. The ideas of tracking metrics that are actionable and making that data understandable for the user are certainly tied together. For example, if a user has a need or purpose to track a metric, you would ideally present that data in an understandable manner and with context. And if they need to make a change, you would ideally provide them with information on how to modify or adjust that. Do you feel there are opportunities for an educational component within the design of these devices or applications? To contextualize this, one of the primary design criteria for the user experience of these products is that you can essentially start to use them immediately—that there is a very low barrier to get them up and running. But what might be sacrificed is an opportunity for rich learning regarding "why you're tracking each metric, what the metric means, and how to change it." Do you think there are opportunities for more education within the apps or the user interface?

DS: Yes, definitely. I think we're at the stage where the technology is advancing so fast—we're just pushing more and more and more tech into these products—that thoughtful design just can't keep pace. The pace of technical development is significantly faster because there is no "human-centredness" about it, right? I can develop a new heart rate sensor and a new heart rate algorithm independent of "how it makes this person feel or what it provides to them." It doesn't matter. I don't need to do interviews like this to make a piece of tech work. Now, whether it works for the intended user, for the intended purpose, and provides contextual information that is important? That's a whole different thing—that's where design comes in. "Here is the tool that I gave you—now you find out how to make it useful." That is, at least where I think, design and technical engineering play, right? In my opinion, there is a massive amount of room to really push that design forward, from a hardware perspective all the way to the application side of things. And those are UI and UX elements—that doesn't even include informational design. For example, "How do I present this complex thing to the user in a manner that makes them educated about it and in a manner where the information is actionable?" Like, "Here's what you can do, and here's why we're presenting this to you." That is missing in a lot of this right now. So, I think there's a massive landscape for design right now, all the way from the hardware to the software or the application.

MP: That is really cool to hear. With that in mind, what does the path forward look like to you? Is it getting more users involved in a co-design process? Is it having researchers interview more people? Is it developing uniform standards for data presentation? Is it performing more clinical trials and treating these products as medical devices rather than consumer electronics? Are there other techniques or processes that you think could help this situation move forward?

DS: Definitely. But "whether or not I know what their official term is?" That is a different question. But just as a side note, going down the route of clinical trials and medical device classification is not the way to get a good user experience. If you look at actual medical electrical devices that are in a hospital, they have the worst user interface. They're hard to use, they're outdated, and they don't employ any of the new techniques because it's such a hard industry to change within. You don't get to make rapid adaptations based on user feedback. It's a hard space to be in, and I would hate to see all consumer-facing health tech have to go through that same thing because it really is a bottleneck with respect to user friendliness. (pause) I think we need more of this type of discussion, and I'm trying to think

of areas where it's really taken off. Even user interface design, from the software side of things—look how far that's come. Not that long ago, back when your first mobile phone was a flip phone, texting was a nightmare. And look at how far it's come—it's crazy. There are a lot of technological advancements right at the start, and then design catches up. I think more conversations like this are needed. One of the biggest things—and I don't think the universities that I've been a part of do a great job of this—is collaboration across departments. I don't know if it's changed, but a lot of developers and startups are very young, coming out of university, and they have their group, and that's who they start the company with, and that kind of trickles into everywhere. If you don't have engineers that get to talk to industrial designers and even know that industrial design exists, or vice versa, it's hard to implement it down the road. I'm always going to develop like an engineer. I'm not going to think, "Hey, maybe we should do user interviews to find out what the actual optimal user experience is?" So, starting early on at the university education level and fostering cross-disciplined collaboration would be huge in the ongoing development of these things. Also, just open discussions with customers. And maybe slowing down a little bit on the deployment of technology, but I don't think that's going to happen. (laughs)

MP: (laughs) I really appreciate that you shared those thoughts. There are lots of great things to unpack. And I agree—it just doesn't seem to be slowing down anytime soon. (pause) Have you identified any design considerations for wearable technologies or digital health applications that could improve these products? Are there any features that you feel are particularly problematic?

DS: This is a personal opinion, and this is not from a professional side of things, but I think "less pervasiveness." Again, I think the Nike+ FuelBand and Whoop have done this right. I feel they're collecting relevant information. Or what they feel is relevant. Whether or not it's important, I don't know because I don't use the product. They're collecting relevant information, but they're not overly pervasive about it. They're useful only when you need them to be useful, or only when you want them to be useful. I think that's a huge thing, and not enough companies are taking advantage of that. Garmin, the company that I've chosen to hitch my wagon to, is the absolute worst at it. They are way overly pervasive in what they do, and I find it annoying. It's a huge space where you could provide a lot more value by being a lot less invasive with what you're trying to present to the user. Users are a lot more likely to respond when you're targeted and thoughtful about what you're presenting

to them, not when you're like, "Hey, did you get this? Look at this!" I think that's an easy one, and you're starting to see it. Whoop has taken off massively, and the same with the Oura Ring. These products are displayless—they don't get in your way while you're using them. But if you had said that five years ago, when Garmin and the Apple Watch were coming out, I would have been like, "Oh God, no display? How am I supposed to use this stupid thing?" I think that's an area where big benefits can be had. Also contextualizing information for the specific user. And I think you touched on it too—another big area is providing education within context. Like, "We're collecting this information, and this is why we're collecting it." And not making it something where you get that notice right when you turn it on and then never again. Somehow educating the user as you go through long-term use of the device, "This is what, this is why, and this is how to make some targeted changes to improve something." I think those are good starting points.

MP: Thank you very much for sharing those points. When you were speaking about the Whoop, the Oura Ring, and other displayless devices, I started to think about a potential development arc. Perhaps the product that most accurately mirrors the natural lived experience could become the most ubiquitous? For example, we don't actually want to go to the doctor every day, and we don't actually want to test our blood pressure every day. But when people are approaching a health journey, or they want to change their body composition, or their doctor has indicated that "they need to get into shape," perhaps all of those invasive notifications and reminders are useful for initial adherence. But at a certain point, you have to ask, "What is the long-term plan? Are you going to wear this for your whole life? And if so, do you want to be nagged all the time? Or do you want this to be a little bit more holistic and less invasive in your life?" It is something to think about. And I think the phone analogy is really interesting as well. We can conceptualize what would be an ideal scenario. And in that context, it would have been a full keyboard, but we didn't have the technology yet. I suppose that is an example of hardware needing to catch up. (pause) I was curious if you had any major learning outcomes after developing several wearable hardware products for people? As you have progressed through your career, were there moments that were like, "Wow, that was important, and I'll never like that mistake again" or anything like that?

DS: (laughs) Yes, and I'll get to that. I just wanted to pose a question. I certainly don't know the answer, but you made me think about it while you were talking about "the pervasiveness of

the technology" and "the doctor found, 'Hey, you may need to lose a couple pounds, so maybe get one of these.'" I don't know the answer, but I'm curious to know—we've had these watches and all of this health tracking for a long time—has the general populace gotten healthier over this time? My gut says no, but I don't know. Are these just a shiny thing that allows a specific portion of the population to improve something that they are already good at, or are they truly positioned and designed for better overall health? I don't know the actual answer, but it doesn't feel like they're there for overall health.

MP: It is an excellent question. (pause) All of the information on how to be "healthy" already exists, right? There are books you could read and podcasts you could listen to, and none of this information is groundbreaking. However, despite all of this information, our population still faces major health challenges. So, are these products following the same path? The information and the tools are out there, and adoption of the tools is potentially the highest it has ever been, but is it actually creating long-term positive change? It would be really interesting to research this. There are certain populations who are promoting a concept where essentially everybody wears a health tracker of some sort, and I would be interested to learn what their actual goal or perceived outcome would be.

DS: Yes, it's a very interesting area. What is "true quality of life" versus "doctor-perceived health?" There is definitely a difference. (laughs)

MP: For sure, 100%. This is becoming clear with some of the body image and disordered eating literature, with the people I have spoken to, and even with my personal experience. I'll take competitive bodybuilders as an example. Prior to competition, they have deliberately gained muscle and body fat for a predetermined amount of time, and then they deliberately cut down to an extremely low body fat percentage. At the time of the competition, they will look "excellent" in terms of our society's current body image standards. But it will truly be a period of time when they feel the worst they have ever felt. And they might achieve an emotional high if they are successful in the competition, but as soon as the competition is over, their bodies often fight back. And if they don't enter into a period of thoughtful eating, they could be at a severe risk of overeating, binge eating, rapid weight gain, and developing a distorted body image. All of this to say, I don't believe that "health tracking" and "quality of life" are synonymous right now—not at all. (pause) That

was a great discussion, and I appreciate that you brought that up. Circling back to the question about lessons learned through the development of wearables…

DS: Yes, a few. Hardware is very hard to do for a number of reasons. Wearables also have their own struggles. I'll give you some of the hard points and then some of the lessons learned. Developing a coaster is hardware—it's not all that hard, it has a very specific set of requirements, and it's fixed. Yes, you can do a bunch of fun things with it, but it's not overly complex because it's holding something standardized on something standardized to do a single job. When developing a wearable, it has to fit on something that is fully non-standard. Look at how many holes there are in your watch strap, and sometimes they still do not fit, or they're not right for everyone, and they don't position it in the right spot. It is difficult. You're working with a population that is not at all the same from a physical standpoint. Another insane point is, "What are they going to do with it?" Like, "Who knows?" So, it's hard when you're designing hardware, and the biggest thing with it is your test cycles. Software is also very hard—I'll throw that out there as well. But your hardware iteration cycles are glacially slow compared to software—it is crazy. "You want to get 10 users to try this?" It is hard to find 10 people to use your product. But you can throw a piece of software on the internet, and it doesn't matter if you advertise it—someone is going to find it and use it. Hardware—that part is really, really difficult. Now, "Lessons learned from developing wearables?" Don't do it. (laughs) Something that I've learned that I don't hope to repeat is going down the medical route. I know you mentioned the clinical trials—medical is slow for a reason, and it's very slow with advanced technical products. The heart rate monitor that's in a watch—that's not a crazy complex product, but getting it through medical is difficult. It is very difficult, and it is a hard thing to do. (pause) Find development partners, like manufacturers, early. Don't underestimate the time that it's going to take to ramp up for production—it's crazy. Another thing is understanding your supply chain and protecting yourself against it. This was more evident than ever in history during COVID. It almost bankrupted so many companies, and it did bankrupt so many, where you couldn't get parts because you didn't manage your supply chain. It is very difficult to do, and it is super important. That was a huge learning experience for us where it's, "Understand very early on what your bomb-critical components are, and make sure you can supply or source them." That's something we do now—we identify bomb-critical components and will stockpile them so that we don't have to worry about a lack of supply.

MP: Yes, that makes a lot of sense. Are you doing the manufacturing or assembly [for Mobili-T] in Edmonton?

DS: Yes, we do. Believe it or not, most of our product development was done down here [in Dylan's personal workshop]. All manufacturing is done at our office here in Edmonton. It's a small office, and we do all the manufacturing. Most medical products like this are not coming from what you would call "mass manufacturers," in terms of an iPhone, where you're making 200 million of them, or whatever. We do all of our assembly here. We have vendors that do the circuit board assembly and whatnot. But we do all unit part testing, full device testing, and full device assembly here in Edmonton. So, it's a lot. (laughs)

MP: (laughs) Yes, absolutely. (pause) What are your thoughts for the future of wearable health tracking devices? What do you think these products could look like in five to ten years, considering the pace at which we're progressing? Alternatively, do you have any preferences for future products?

DS: I think they will get a lot less wearable. This is just an opinion. I think machine vision and vision algorithms are getting so good and so cheap. For instance, with sleep tracking, I think that'll get a lot less wearable. The Oura Ring and Whoop are monitors that specialize in sleep and recovery. Maybe not in five years, but in the future, I think, wearables will get a lot less wearable and turn out to be just vision-based systems. That would be my guess.

MP: For my understanding, could you please elaborate on what you mean by "vision-based" and what you think implementation of that could look like?

DS: Yes, for sure. Again, this is just an opinion—it's not founded on anything. (laughs) So, continuous heart rate monitoring maybe isn't so important, but point-in-time heart rate monitoring might be important for certain things. "Can that be done with the camera on your phone?" Yes, it can be. "Body temperature, can it be done with the camera in your phone?" Yes, it can be. "Stress and alertness—can those be monitored with vision?" Absolutely. So, I think a lot of these contact physiological signals that we have now could be, and will be, replaced with vision. For sleep tracking, the Oura Ring and the Whoop are not sensing EEG [electroencephalogram], but people use them and they love them. The Oura Ring has actually been clinically validated against sleep labs—it's been clinically

validated to be able to monitor your sleep almost as well as a clinical sleep lab by using just motion and heart rate sensors. If I put a camera that has the right parameters, "Can it measure motion, temperature, and a bunch of other things?" Absolutely, it can. The Oura Ring could be replaced with a non-contact thing. You don't have to wear it—it's just there, and this could be throughout your house. I think it's a big space, and it will hopefully make an appearance for predictive medical analysis or ongoing disease progression. Alzheimer's disease, for instance, is something where we don't have a cure, there are not really good treatments, and there is not a great wearable that does anything. But there are markers in the way that you act and the way that you speak that could be used to mark the progression of the disease, which could then be alerted, "Hey, maybe you should go see a doctor," or whatever it is. I just think vision is a lot less invasive and a lot easier to deploy for a mass amount of monitoring. So, I think some of this will go the way of vision.

MP: That is fascinating. I had not thought about that before, but I agree that the possibilities are quite incredible. It also raises an enormous number of design and user questions.

DS: Yes, I think it's quite interesting, but that is my solo opinion. (laughs)

MP: Yes, but it links back to something we discussed earlier. If we can envision it, it will likely hit the market at some point, in some form. Then we, as consumers, have to determine whether we will use it and whether it will fit into our lives. Things are moving so quickly—if you can think of it, there may be people working on it already. I really appreciate that you shared your thoughts on that. (pause) Just wrapping up here, based on the nature of this conversation, are there any key research studies that you feel I should look into?

DS: Nothing comes to mind other than the questions earlier about "What is the actual impact of wearables on health and wellness? Is this actually something that we should be pushing forward? Has it had a noticeable impact on general health?" I think that is a huge question.

MP: I agree. I think that is a very important thing to look into. I have identified a few studies that try to tackle that, and I will look for more. (pause) We know that holistic health is this very complex, interwoven network of factors and things. For example, if you go on a substantial health journey and become super fit, but through that process you're not eating meals with family members, you're not seeing your friends, you're losing social connection,

maybe even your work goes on the back burner—eventually all of that stuff catches up, and then your overall health, how you actually feel when you interact with the world, is potentially lacking. There is no shortage of people who are very healthy and unhappy, and conversely, the opposite is also true.

DS: Yes, I think that's a good point. The general public's notion of health is pretty restricted right now—it's not the holistic health that you're talking about. "Looking good and eating well" is considered healthy, right? And "looking good" is so subjective, it's ridiculous. (laughs) But yes, it's very interesting. I'm super happy that I got the chance to speak with you. If there's anything else that I can do or anything like that, let me know. This was great. Hopefully, it was somewhat helpful. I really appreciate the time.

MP: I really appreciate it as well. It was an excellent conversation, and you presented a lot of great knowledge. I appreciate your perspectives as an actual developer of wearable products and also as a user. Thank you very much. (pause) Finally, as noted in the Participant Consent Form, once I have completed all of the interviews, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. For example, you can let me know if you would like anything taken off the record. After that, the transcript will become part of the dataset.

DS + MP: [Off the record discussion regarding transcript processing, thesis documentation, and current thesis project]

DS: Very cool. Thanks again.

MP: Thank you very much. I'll let you know if I have any questions. And feel free to keep the lines of communication open.

DS: Right on. Awesome. Bye.

MP: Take care. Bye. [Interview Duration: 01:26:48]

Gabriela Constantinescu, October 6, 2023

Michael Peel (MP): I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. And you may request that anything you share be off the record or not disseminated. The scheduled duration for this interview is approximately 50 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. Finally, I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

Gabriela Constantinescu (GC): No.

MP: Okay, now we can begin. (pause) I have familiarized myself with your LinkedIn page, some of your published research studies, and some of the press content related to True Angle Medical and Mobili-T. With this said, I would like to give you the opportunity to describe your academic, professional, and research background in your own words. I know that you have recently made a career change, and I was hoping that you could share your thoughts.

GC: Way in the beginning, I started off as a clinician. I completed the Speech Language Pathology program—that's an Allied Health program—here at the University of Alberta. After that, I worked in schools for about a year. Then I worked primarily with head and neck cancer patients for about 10 years. That was in an outpatient setting where they would come to you after having had their surgery, radiation, etc. Because I was in an institute that highlighted research and had university professors working as clinicians, I would say I caught the PhD bug more than I had before. I then pursued a PhD. I had two supervisors coming out of there. That's where I met Ben [King] as well. And then, throughout my PhD, we created a minimum viable product for Mobili-T. Out of that, we had some advisors

around us who said, "If you don't commercialize this, it's just going to end up in a drawer," so we started a company. One of my supervisors at the time, myself, and Dylan Scott, who was the engineer, spent about five to six years with True Angle Medical. And now I am with the government of Alberta. I've been here for two months, and we are essentially trying to make the "commercialization of research" pathway easier for other folks.

MP: That is really interesting. I noticed that you're doing a postdoc as well—is that true?

GC: Yes, on paper, it was a postdoc. It was still very much research with Mobili-T as well, and it was with someone in the School of Public Health.

MP: Thank you for providing that background information. Regarding the types of clients and populations that you work with, do you work with any athletes? And if so, what type of athletes?

GC: Right now, I don't work with athletes. And no, I've never worked with athletes.

MP: Okay, that is no problem at all. These questions are just to situate your perspective. The next question is about body image concerns and disordered eating behaviours with your clients or in your research. Do you have any experience with these topics? I presume that some of the individuals with head and neck cancer could potentially encounter body image concerns or disordered eating as a result of the treatment and surgeries. Do you have any general thoughts or experience with this?

GC: For sure, a lot of them did, and I would imagine that all of them would. If you think about you and me, even if we had a pimple on our faces, we would probably feel a lot different. But the trauma to the face is so big that I don't even know how to describe what these folks go through. I think, by virtue of my profession, we probably didn't go into that topic as much. I'm sure they had some kind of, I don't know what the word would be, "out-of-body experience." You're not you. So, I guess my answer to that would be mostly assumptions and projections. Some folks have shared how they felt, but because of who I was and my profession, they mainly talked about how they sounded and not being able to eat. That's where the conversations focus. Mind you, we were in a clinic—and Ben [King] may have shared this with you already—and we worked with a profession called anaplastologists. They created facial prosthetics for anybody who had missing parts of their face, either due to cancer or due to

being born without an ear, an eye, or whatever. I would imagine that they would have probably heard more of these conversations than I did. And I'm happy to put you in touch with them. One of them is doing her PhD at the moment, so she would totally be in this mindset. The worst I've ever had was somebody who had no face—nothing. From here to here [forehead to chin], just a flap of skin with holes for breathing. I would say that person didn't seem impacted by it at all because he had no idea what he looked like. But other folks, I would imagine, struggled with identity. And this was something I wanted to research personally because I would imagine there's some kind of mess up that happens when you look different and you also sound different—your identity is probably so shifted at that point.

MP: Thank you for sharing that. I agree that those compounding factors of "how you look" and "how you sound" could drastically impact a person's identity. (pause) I'll switch topics and move into a discussion about wearable technology. I would love to hear your general thoughts and experience with wearable technology, and this could be from your professional practice with Mobili-T or your personal use.

GC: A decade ago, I was in love with wearable technology, and my brain went to, "Oh my God, you could collect so much data, and you could marry this data with this data, and you could get so much insight." And now, I guess this is more of a personal view, but I feel like there's just so much noise around us that I'm personally fatigued by wearables. I'm not a minimalist or anything, but I don't have any wearables—I have my own insights into my own behaviour. So, personally speaking, I have stepped back from wearables. I think my experience with Mobili-T has shown that it opens doors to clinicians to have some insights into what folks are doing at home above and beyond, "I checked it on my piece of paper—I did it." But when I was with True Angle, I still found a lot of apprehension from folks. It was "too expensive, too new," or they didn't understand it. So, that lack of awareness of "How does this thing know?" or "The insights aren't quite matching what I did, so now I'll throw it out the window." (pause) I initially loved it. When I went to market, I found there was some apprehension. Some people loved it. Some were early tech adopters. Some were quite averse to it or didn't have time for it. Personally, I prefer just the bare minimum right now. Maybe when I'm 60 to 80, I will have these wearables because they'll help me get on with things. But right now, I don't need to know how many hours I sleep. I don't need to know whether I've eaten a perfect diet. I just think it's just too much right now.

MP: I appreciate your balanced perspective, and it is really interesting to hear your progression. You brought up complexity and potentially feeling bombarded with data. If possible, I would love for you to dive into that a bit more. This could be from your personal perspective or the apprehension you described from some of the early technology adopters. Was the complexity of the data, or the ability to understand the data, part of the apprehension?

GC: For me, or for Mobili-T?

MP: It could be either. I would love to hear both your personal perspective and some of the things that you could infer from your practice.

GC: From my perspective, I'll give you a top-of-mind example: when I look at one of my friends who uses the Oura Ring to track her sleep, part of me feels like, "Is she more anxious because now she's looking at this data that might not actually be all that real and accurate?" She's going into the app, and it's like, "I didn't get the amount of sleep that I should have, and it wasn't at this peak, and now I'm going to be freaked out for the rest of the day because it wasn't perfect." To me, that is now "data driving behaviour." And data that might not even be all that accurate. To some extent, I'm a little bit like, "Who cares what your sleep score is? If you feel good that day, why do you need this data to tell you whether you feel good or not?" So, that's part of it. I personally use fitness trackers, and I would say I'm at a point now where it's really just about going out and doing the fitness part. I'm not an athlete—I don't care if I shaved a minute off my mile or ran for longer. It's all about, "Did you get out there?" And if I don't get out there, I know I didn't because I can track it. So, that's more in the personal realm. For patients who use Mobili-T, from what they shared, some of them liked having something that tracked what they did. So, it was almost like a pat on the back, like, "Hey, you did it." How long is that sustainable? I don't know. They were doing this with us for six weeks —could they do that for years? I'm skeptical. There's also a novelty effect that comes with these wearables, right? You feel like, "Technology has advanced, and I'm doing a little bit better because of it." Some patients really liked it. Some people were like, "Meh." I would say that for the most part, the ones who liked it found that they did their exercises more and adhered to the treatment program more because there was a physical unit that you had to put on and interact with. I always thought it was because they knew I was checking in on them, but it actually wasn't that. (laughs) From a clinician perspective, when I was still with True Angle, most clinicians weren't even using that feature. That feature, to me, was the

golden thing because you had visibility into what your patients were doing, and then you could decide if this treatment worked or didn't work. But if you don't know what they're doing, how can you even really say that? They could just be doing nothing. So, I was surprised. Maybe they were just not there in the product-use ladder, but a lot of them didn't even use that feature—it was mostly in clinic use to show them biofeedback.

MP: Very interesting. I have a few questions related to these topics, but first I would like to circle back to an earlier statement. You said that you don't wear a wearable device but that you do use fitness trackers—what do you use?

GC: My phone and Strava. Like, "Did I take my 10,000 steps today?" (laughs)

MP: (laughs) Okay, got you. (pause) My understanding of Mobili-T is that it uses visual biofeedback to help develop a mind-to-muscle connection to strengthen the swallowing muscles. Since you have a lot of experience with biofeedback and wearables, I would love to hear your thoughts regarding the impact of wearable health tracking and biofeedback on the embedded bodily sensations of the user. My presumption is that biofeedback could help to heighten the patient's sensory awareness, but I would love to hear from you. Over time, did that prove to be true? Or did it abstract and create a disconnect between their bodily sensations? Did it do what it was intended to do?

GC: I don't know that it was that deep. (laughs) I understand what you're getting at, but it was mainly trying to elicit more effort during a contraction. Essentially, think about when you go to the gym and you're like, "Today I'm going to lift 5 pounds, but in five weeks maybe I'm going to lift 20 pounds." You have visibility into your progress. Whereas, if I told you, "Swallow hard" or "Swallow weak," what does that even mean? So, for them, it was a way to understand, "Did I do the exercise?" and then, "Did I give it as much oomph as I thought I did?" And for a lot of them, I think it did elicit more effort than they were putting in before without the biofeedback. And that's just the intrinsic nature of biofeedback. The other thing we had with the software was—let's bring it back to something more relatable—let's say your trainer is like, "Please do the plank five times." And, on average, all five times, you held it for around 30 seconds. So, when you go home and do your exercises, they say, "I want you to try 31 seconds. Your comfort level is 30 seconds. But I'm going to push you just a little bit." So, it's kind of like that. Other than being able to stay on track with their exercises and complete

them more, I don't know if they would even really see progression with effort expended because that was tailored to where they were in that session. All they're seeing is, "Yes, I did do 110% of my calibration effort." Does that make sense?

MP: Yes, it does. I think the muscle contraction idea is a great example. You could ask different people to do a bicep curl. One person performs a partial range of motion, another person performs a full range of motion, and another person performs a full range of motion plus a slow eccentric. You could consider each example as the same general exercise, but each will require a different amount of effort, provide a different stimulus for the muscle, and provide different potential for growth and progression. So, I agree that people may not have an understanding of their baseline or the amount of effort that they are applying during an exercise, especially in the beginning. So, what you described was helpful, and I think that general concept can be applied to a lot of things. (pause) I have a question related to the clinician-facing data that you were speaking about. In the treatment of eating disorders, there are clinicians who see benefit in a one-way device that collects data from the patient, sends this data directly to the clinician, but does not show this data to the patient directly. The clinician can see what's actually occurring, deliver precision treatment, and potentially relieve the user of some of the issues associated with contextualizing the data. I would like to hear your thoughts on this topic since you have experience implementing similar systems. Was this clinician-facing data approach effective? Were there any lessons learned, best practices, or important things to consider?

GC: I could write a book. (laughs) When you talk about precision, yes, absolutely, that was my dream. And maybe it will still go there with the team—who knows? As a clinician, when I have more visibility into what you're doing at home, our conversations can be much richer. For instance, if all you're telling your trainer is, "Yep, I did my work," and they're like, "Okay, continue doing it," that is currently the gold standard of swallowing therapy in clinics right now. Versus me being able to see what you're doing. Like, "Michael did this one exercise really well, and he's telling me that he actually feels quite good doing it. Maybe I could increase that? In this other exercise, he's not even meeting the target, and he's dropping off at half of what it is. I'm going to check in with him and see if he feels beat up by that exercise or something? And then, in this one exercise, he's not meeting any of the targets. I wonder if he remembers how to do this exercise correctly?" Now, at a glance, I can see what the heck you're doing. And when we have a conversation—you don't even have to come into the clinic—when we have a conversation, I can

be like, "Michael, first, walk me through how you feel you're doing? Next, can you show me how you do that exercise? Okay, let's try it again, and you might have more success." Do you know what I mean? It's just a little bit more of a rich conversation than just, "Cool. Well, keep at it. You're doing great." So, personalized care is, to me, where the money is, essentially. When it comes to clinicians in my field, I felt like maybe they saw that, but there were so many other steps to get there that I don't think they either had the resources or the patience. Or maybe they didn't quite see the big picture? I'm not quite sure, but they never really got there. Some of them got there, maybe the academic ones, but the ones who were putting out fires on the ground every day didn't see it. I don't know if it was just my field? I feel like it was really just my field. (laughs) Maybe other fields will have more success? But honestly, I remember saying to myself when I was with True Angle that it felt like speech pathologists, in particular, were tech laggards. Some of them didn't believe in the technology. Some of them preferred pens and paper. Some of them were very averse to any technology not working correctly. For example, when I connected for this interview, for some reason, the internet wasn't working, and I stumbled for a minute before I logged in. If that happened with the new technology, because they don't want to feel like they don't know what they're doing in front of their patient, they just blame the technology, put it aside, and go back to pens and paper. "I can see it—I'm a good clinician." That was one of the challenges with Mobili-T. But yes, I think the data would have really helped out. And I think if we had either more clinicians out there to pull the 1% tech adopters or if we had a higher percentage of our clinicians be tech-minded, we would have been able to show the value faster for that field. So, don't let my field and my answers sway from whatever it is you're trying to do. (laughs)

MP: (laughs) Thank you for sharing these thoughts. (pause) While they are different fields, I think that when any psychological distress related to disordered eating and body image progresses to a point where it requires clinical treatment, it enters a similar environment. It moves within the walls of the medical field. Therefore, I think you could potentially generalize some of the perceptions about technology use, trustworthiness, and things like that within the medical field. And these perceptions could be much different than those of the consumer tech world.

GC: Yes, that's a good point. I remember when I was doing these types of interviews for my PhD, there were patients who were saying, "We want the design of this mobile technology to not be medical-looking. I have been going through treatment for so long, wearing gauze and

having little tubes come out of me. I want to be able to wear something that everyone else would wear. I don't want to wear this and then feel like I'm still on my cancer care pathway." But then, when we flipped into the clinical world, it was almost like people didn't trust something that was very consumery-looking because it didn't have the monstrosity and presence that a medical device does. So, there is something to dig into there—the trust related to how something looks.

MP: That is fascinating. (pause) If you have identified that this technology is viable and has been documented to help people, but the adoption and adherence rates are low due to clinician or user perception, then the product is not succeeding or failing based on the effectiveness of the technology, but rather on its perception, which is unfortunate. (pause) As a designer, my focus for this project is to collect different perspectives on this subject matter and use these perspectives to help inform the creation of improved devices that try to mitigate some of the issues that we are currently facing. With this said, are there any other key findings that you have discovered along the way that would help future product designers as they enter the world of wearable technology? For example, "We learned this great lesson with colour, texture, form, etc." Have you identified any obvious improvements to the design of existing wearables? Do you have any thoughts on this?

GC: I have lots. I love your field very, very much—I miss it here in government, actually. The sad part about it all, at least from my experience and my perceptions—lots of caveats there—was that, for me, it felt like you could have the best design, but if the product didn't solve a problem that was a fire for the market, none of that mattered. They would be like, "Wow, this looks so cool! This looks so good!" But then, they still don't use it. These questions, when I was doing them, I did them wrong. You should read [The Mom Test: How to talk to customers & learn if your business is a good idea when everyone is lying to you]. It's really good. It's about trying to frame these types of questions that you're asking right now in such a way that no one will lie to you. It's like, "Not even your mom would lie to you because she loves you and doesn't want to hurt your feelings." So, because we had set out to create a product—we already had in our minds what we were going to do—we were like, "This is going to be the product, and here are some design ideas we are working on." And people were picking designs, but I had never gone one step back to figure out, "Clinicians, what is your biggest fire right now? Tell me about your day—what's going on?" I had just assumed, because I had experience with the problem and we had a super sexy solution for

it, that it would just go in that direction. But when we went to market, they were like, "This is 1% of what I do. It might be super sexy, but I have to pay $50,000 for this other thing that does way more than what your thing does." So, that was one challenge. The other thing, because we just mentioned it, was trying to find not just the product-market fit but also the right business models. Like, "How much do we charge for this thing?" And I would say, as a consumer, when I see something tiny, like something I would purchase from Best Buy, I'm thinking, "This should be $200." Now, as a clinician, if you're charging me $2,000 for it, my expectations are through the roof. Like, "This thing should basically do my job for me." But there's a disconnect because in the clinic I had a cart that didn't do anything—it was just like a piece of plastic on wheels—that was $7,000. However, because it looked like a medical product and not a consumer product, there was a shift in my mind—and I'm sure I'm not the only one—where I was like, "Yes, it makes sense that this is $7,000." "But why are you charging me $2,000 for this, albeit sexy, thing? It looks like something I would buy from Best Buy, and it's $200 there." So, there's a lot there to unpack. (laughs) But all this to say, I think the design [form, aesthetics, etc.] in the medical sphere attracts, gets you noticed, and gives you a step up from the competition. But ultimately, the other pieces of the puzzle need to be there as well. For example, the perception around price, and more importantly, it has to solve a fire that's real for that market.

MP: That is very interesting. There is so much great information to unpack there. I agree that addressing a true need is very important. We often encounter a type of altruistic thinking where it's like, "We can do this—we can help." But you're right—if there are all these other issues in the medical system, in the patient's life, or in their treatment journey, and that small component could provide an improvement, but it is not the most immediate issue, it is difficult to prioritize. I think your analogy of putting out fires is really appropriate and excellent design advice.

GC: The other thing with design that I've noticed is that "who your buyer will be" also makes a difference. When we set out with Mobili-T, we were asking patients, "What's important to you?" And their response was, "Not having it look medical." And when we were looking at the interface, they were like, "There's so much going on in my life, and I'm on so many drugs—just make it simple. I don't want to have the anxiety of a character dying." Or, "I don't want it to have colours—I'm already high. Just make it simple—I just need to know, 'Did I do it right or not?'" But when we went to sell to clinicians, they were dazzled by other things. They were

like, "Well, your app is just a line going up and down, and this one has balloons and flowers—so, this one is better." (laughs) It's been a super interesting journey because it's not as straightforward as, "I want fancy furniture, so I'm going to pay for super cool design," and, "Wow, that's so slick and amazing—if I lift this thing, now it's another piece of furniture." Because in that example, my money goes to the design. Here it's like, "What is important to that end user?" And it might be at complete odds with something amazing and artistic that you and I would be like, "Yes, this is the thing." And they're like, "No, I want a fish eating another fish." And you're like, "No." (laughs)

MP: (laughs) Yes, I read your 2017 study [Designing a Mobile Health App for Patients With Dysphagia Following Head and Neck Cancer: A Qualitative Study] exploring the different styles of visual representation for biofeedback, and the user feedback was really interesting. (pause) When you were speaking about the different levels of need, or the competing needs of the patients and the clinicians, it reminded me of my earlier question regarding the different types of data presented to the patient and the clinician for my population. And I would love to hear your thoughts on the idea of increased personalization. It feels like there are so many competing needs, and perhaps increased personalization could help address this. Because I totally understand what you mean. I've been in design meetings where we could have a 98% excellent product, and one stakeholder sees the 2% that they just don't like. But instead of a conversation on how to improve the product, it's like, "No, the conversation is over, and we will look at a different vendor." Because they can, there are so many options in the marketplace. So, I would love to hear your thoughts on increased personalization, different levels of configuration, or the ability to turn features on and off. Do you feel that could be a path forward?

GC: Potentially, but I think people are so fatigued these days. Fatigued, first of all, with data and having to enter data, especially at the patient level. If you shadow a patient these days and see how many times they have to fill in their personal information, sometimes within the same clinical visit, they're like, "Oh my God, don't you guys have this figured out yet?" And then the other thing is, people are so used to technology just working at a push-button level that you have to get there quickly. I honestly don't know how you do it, Michael. I think the perfect solution would be, "I want to be able to get in there and start playing with the app or mobile device right away." I don't like these apps where you're like, "I am a female—I am this old... Oh my God, just get me to the app! I'm done—delete." (laughs) I'm sure you've

had that experience. But at the same time, you want this thing to learn about you over time and provide you with personalized recommendations, sometimes without you even having that insight. There are some mood apps where you put your phone up to your face and it says, "Oh, you're sad today." And you're like, "What? My face must read that?" (laughs) I guess there is this mismatch of, "Yes, technology has advanced, but it hasn't quite advanced to the level of expectations of the user." I think users just want, "Poof. Now it knows everything. And it tells me what to do. And it works perfectly. And there are 20 papers published about it." So, it's hard, but I think things are moving in the direction of increased personalization—it's just that you need a lot of data for that.

MP: Yes, that makes a lot of sense. I think the concept of data fatigue is really interesting. The larger companies like Apple and Google, who are creating their wearable devices within the larger ecosystems of their existing product lines, obviously have to wrestle with this too. But they have an advantage because the design language that they use for their health apps and devices will be adaptations of what is already used for their other products. For example, there is a clear and understandable workflow from your iMac to your iPad to your iPhone to your Apple Watch—there is similarity for the user. But now there are so many brands creating wearable devices, each with different features, price points, and design languages. They will try to mirror the design language of the big players, but they can't replicate it exactly for several reasons. Additionally, I feel the combination of all our digital interactions contributes to this data fatigue. Keeping up your text messages, your emails, your social media, your personal data, your interests—you are just bombarded from all angles on any device. Treating our phones or our watches as a technical device, a social device, and a health care device can really add a lot of complexity to life.

GC: The thought I had when you were talking about this is that, personally speaking, I feel these tracking products and data presented without much insight are like, "Another way that I'm failing." It's like, "I don't need to know that I got five hours of restful sleep instead of eight. I already feel like I need more coffee today. I don't need my phone to tell me that as well. It's enough. My boss will tell me how I'm falling short." It's just another app where you didn't do as well as you needed to. "You need to do 10,000 steps today, but you only did 8,000." And you're like, "Well, one more reason to feel shitty." (laughs) I don't know—if you were to spin it in a positive sense, maybe? But sometimes it does feel like that with all this data that is thrown at you, with probably positive intent by somebody to get you to go out

there, but sometimes you just can't. "Things get in the way, and now you have seven apps yelling at you with little red dots that you didn't do it." That's what your comments triggered in my mind. Like, "Yeah, too much."

MP: Thank you for sharing those thoughts. (pause) I am aware of the time, and we have five minutes left. I will pose one more question, and then we can get into the closing remarks. This question relates to your last point. What are your thoughts regarding these wearables and applications in relation to health anxiety and overall quality of life? They are marketed to improve health, and mental health is a major component of overall health. Do you have any thoughts to share on this topic?

GC: I think we just don't know enough to know where all of this will go. It could, probably, go in a positive direction. All of this information about us might not help an anxious person, but it might help someone who's data-driven. And that might be more than half of the population. And then, ultimately, we will learn so much about ourselves that we can help everybody. That could be a very utopian view of where all this is going. But the flip side could be, "Wearables are the fad of this decade, and in the next decade it will be something else." So, who knows where all of this is going—it's hard to say.

MP: I think that may be a perfect way to close. (pause) Based on the nature of this conversation, is there anything else you would like to discuss or bring up before we end?

GC: No. I just wanted to say you did a really good job interviewing. It's hard to be on that side. I don't do such a good job of shutting up and letting the person speak. So, you did really well.

MP: Thank you very much. I really appreciate it. That means a lot to me because you don't know how it actually went, right?

GC: Yes. If you need anything else, let me know. All the best with your research and studies.

MP: Thank you very much. Just to wrap up here, as noted in the Participant Consent Form, once I have completed all of the interviews, I will send you a copy of the interview transcript for review. You will have 14 days to review it, and you can let me know if you would like to make any revisions. Afterwards, the transcript will become part of the data set. In the

meantime, you can email me if you have any questions. Finally, I would like to thank you once again. I really appreciate that you took the time to talk with me.

GC: My pleasure. Thanks, Michael. Have a good Thanksgiving. Bye.

MP: Yes! Thank you. Bye. [Interview Duration: 00:50:43]

Rachael Flatt, October 10, 2023

Michael Peel (MP): Okay, I appreciate your patience with these technical issues. Before we begin, there are a few mandatory items that I need to cover. This will take approximately two minutes, and then we can begin. I would like to restate the purpose of this research study, which is to better understand the relationship between wearable health tracking devices and their associated digital applications and instances of body dissatisfaction and disordered eating behaviours within fitness athlete populations. This interview session will include the potentially sensitive topics of body dissatisfaction and disordered eating behaviours. I would like to remind you that you do not have to answer any questions that you are not comfortable answering. You may stop the interview session at any time without consequence. And you may request that anything you share be off the record or not disseminated. The scheduled duration for this interview is approximately 60 minutes. This interview will follow a topic guide, which includes a selection of open-ended questions. With this said, the purpose of this interview is to facilitate a rich and organic conversation. Therefore, you are free to explore topics as you wish. I will try to remain as neutral as possible during our conversation. I would like to thank you for reading and signing the Participant Consent Form. Before we begin the actual interview, do you have any questions regarding this research study?

Rachael Flatt (RF): No. Sounds good.

MP: Okay, perfect. We will begin. I want to thank you for agreeing to this interview. Your research and background are very impressive, and a few of your articles, specifically [The Binge Eating Genetics Initiative (BEGIN): Study Protocol], were particularly influential for this research project. While I am familiar with some of your work, I would like to give you the opportunity to describe your academic, professional, and research background in your own words. Could you please share your thoughts?

RF: Sure. I just wrapped up my clinical psychology PhD at the University of North Carolina at Chapel Hill. I have primarily focused on eating disorder research under two umbrellas. One is digital mental health tools, and the second is more related to eating disorders and athlete mental health, more broadly. I have definitely taken an interest in eating disorders and athletes, given my own athletic background. I was an Olympic figure skater for Team USA, but I'm happily retired. (laughs) That was part of the reason why I wanted to pursue those two

areas of research—just knowing that athletes don't typically get a lot of help for their mental health. There is a lot of increased stigma and reduced treatment-seeking in that population. I felt like using digital tools would be a really good opportunity to reach folks who are maybe more skeptical or do not necessarily have access to as many evidence-based treatment resources. So, that's a little bit of my professional background.

MP: Wonderful, thank you very much. Can you explain your affiliation with both Duke University and UNC-Chapel Hill?

RF: Yes, it's complicated. (laughs) As part of the Clinical Psychology PhD, you go to graduate school for four to five years, and then you complete what's called a clinical internship for a year—it's just straight clinical work for a year, even though I already have almost five years of clinical training. So, both of those things are associated with actually getting your PhD. I did my graduate school training at UNC-Chapel Hill, and then I'm doing my clinical internship at Duke. It's complicated. (laughs)

MP: Okay, that makes sense. It's all so interesting. (pause) In your clinical practice, are you working primarily with athletes, or do you also work with the general population? Or is it a mix?

RF: It's a mix. Definitely, my area of interest and priority would be to work with athletes. But I also have a lot of experience—in fact, most of my experience is working with folks who do not have an elite athlete background. But I did a full year of training, specifically working with UNC-Chapel Hill student athletes last year.

MP: When you do work with athletes, what types of athletes do you work with? Is it a broad range of disciplines? Are there any commonalities that you find?

RF: I've mostly worked with collegiate student athletes, but I've also seen folks who are in middle school, high school, and also up to professional athletes who are not affiliated with an NCAA [National Collegiate Athletic Association] school. I've kind of seen the gamut and a wide variety of sports, too. It's been a pretty diverse set of folks that I've seen—it's not been a specific sport or a specific demographic.

MP: Thank you. Relating this to body image concerns and disordered eating behaviours, are these topics coming up in both your general population and your athlete population? And if so, could you please describe that?

RF: I'd say that even outside of the eating disorder clinics that I've worked in, it feels pretty common for folks to bring up body image concerns or disordered eating behaviours. Just generally speaking, we know that those types of behaviours are pretty underreported within the general population, and especially within athlete populations where binge-eating or purging behaviours, or any forms of compensatory behaviours, tend to be pretty normalized. Now, that is changing, especially with more education getting out there. And I think the culture related to athlete mental health and sports, generally, is starting to change and improve. But with that said, if you think about a lot of wrestlers, for instance, I've seen a number of folks who have come in who engage in a lot of disordered eating behaviours to cut weight, and then that turns into a full-fledged eating disorder. And it seems like most athletes who come in now have at least some concerns related to their body image. Whether that's from engaging in social media and being in the limelight—especially with folks within the United States with all the name, image, and likeness [NIL] deals that are occurring—there's just a tremendous emphasis on social media and your own marketing and branding. And it seems like poor body image often goes hand in hand with that. All of that to say—I think it's very common. It seems like it comes up with most people that I've seen and spoken with—both in the existing research and in my clinical work. It's pretty pervasive.

MP: Thank you for sharing that and for laying the foundation. I would like to transition into questions directly related to wearable health tracking devices. Generally, what are your thoughts regarding current wearable health tracking devices and associated digital applications for athlete use? Do you have any thoughts, preferences, or feelings towards these?

RF: I think there are pros and cons, as there are with most digital tech applications. For the pros, I think it can be transformative for a lot of people, where they're getting better insight into their sleep or their mood changes over time. It's very easy and accessible to track and gather that information. There are still some issues with accuracy, especially if you're looking at physiological markers—some of those are not quite up to par yet but are still in development. In that respect, I think it can be really helpful for a lot of folks to just see that data, acquire the data, and be able to understand how things are changing more quickly. So, I

think, from that perspective, it's beneficial. And on the opposite end of this spectrum, I've seen this happen often as well, where athletes will use some of these step counters or will use some of these mood trackers that are associated with some of the wearables, and they've taken that to the extreme. And that has facilitated, for instance, an eating disorder where they get really stuck on getting a certain number of steps in a day or exercising a certain amount. And that has facilitated concerns with body image, compulsive exercise, and then drifting into a full-fledged eating disorder. So, I see both sides of it. I think there are some really positive potential applications. With the dissertation study that I just defended, we were using steps and heart rate collected from a wearable to predict when people were going to engage in compulsive exercise—which we were able to do, which is pretty cool—and being able to send people interventions in the moment is where we're heading with that. That would be very transformative for a lot of people who have a variety of mental health concerns. If we're able to detect these high-risk periods for engaging in harmful behaviours and send them interventions in real time just based on the data we're gathering from a wearable, that's pretty freaking cool, if you ask me. (laughs) But at the same time, I think wearables are not the most equitably accessible form of technology. For athletes in particular, if you have folks who are coming from low-income backgrounds, these are not necessarily going to be tools that they're going to be able to access easily. Whereas, for the athletes who are making a lot of money, have a lot of sponsorships, and have access to those types of tools, I think it's another opportunity to increase that gap between folks who have access to certain types of resources and those who don't. I think there are a lot of pros and cons. All of that to say, I think it's complicated. (laughs) I don't think there's a good answer to that, but I do think there's a lot of room for improvement.

MP: There are so many things to unpack there.

RF: Yes, sorry, that was a lot. (laughs)

MP: No, it's good—it's what we want. To clarify, your dissertation is collecting user data to predict whether individuals are at risk for compulsive exercise. Is that correct?

RF: Yes.

MP: Does that differ from the BEGIN study, which is, I believe, to predict episodes of binge eating?

RF: Yes. It was part of the same parent study. We were using the same methodologies to apply that to a different eating disorder behaviour. We are also in the process of writing up the binge eating paper, and similarly, we are able to detect differences between these low-risk control periods and these high-risk windows leading up to a binge. There were differences in the system related to heart rate and steps and how they changed over time between those two windows. We are basically able to detect when people are at risk for a binge. So, it was the same thing.

MP: That type of data is absolutely fascinating. In terms of the user interface for current consumer wearables, a lot of the data—such as step count, calories, and energy expenditure—is presented to the user objectively but is potentially lacking some broader context regarding how those values might impact other bodily systems or behaviours. With the two studies that you just mentioned, you were able to use this data to predict future behaviours. And thinking about future devices, do you believe the complexity of the data presented to the user could be decreased? And instead, more direct prompts and information could be presented to the user? For example, rather than having the user decipher their data and create these connections themselves, present direct prompts like "You're potentially susceptible to a binge" or "You're potentially susceptible to engaging in compulsive exercise." (pause) I know this is a really roundabout question. But in terms of data complexity for the user, I see so much benefit for the clinician and the researcher to have this data, but what about the data that is presented to the user? Do you have any thoughts on what I have just spoken about?

RF: I'm following you. I'll start with the vision that we had behind the two studies that I just shared, and I'll dovetail into some additional thoughts. With those two studies, the vision was to basically house all of the data acquisition and visualizations behind the scenes. So, users wouldn't necessarily see those algorithms or predictive models coming up on their screen because they're very complex. The idea is basically that we would get continuous data, and as soon as it looks like they're entering that high-risk window, they would then get a notification like, "Hey, it seems like you might be at risk for engaging in this behaviour." That was kind of the vision behind it. I think the data and the modelling for those types of interventions are very complex and wouldn't really be useful for folks outside of the research team—even the clinicians, that would be pretty complex. So, that's on one end of the spectrum. On the other end of the spectrum, I think there's a lot of utility

in folks being able to, for example, look at the night sleep that they had and see whether it was pretty consistent or if they had sleep disruptions that they didn't necessarily recognize. Being able to see that type of data on the screen—whether that's a graph or some form of visualization that makes it easy, or even if it's just a very quick report of that information—I think that type of data presentation can be very useful. I don't know if all of the types of data that are presented, or the visualizations for a lot of the applications that currently exist, are useful and, more importantly, are actionable. I think one of the things that is really lacking in a lot of these apps is that they're really just geared towards self-monitoring. So, it's getting the data, and then it's not actually telling you or giving you information as to "what you can change or improve upon so that you can get a better night's sleep" or "decrease your risk of engaging in XYZ behaviours." But again, that also requires a lot of personalized and tailored information to come in, and in most instances, doing that alongside a clinician or a researcher who has that background and expertise. I just don't think that we're there yet for a lot of apps and a lot of the wearables that exist. I think, more often than not, it's really just a function of "collecting data and then presenting it," and I think there's a lot of room and opportunity to take that to the next step. Whether that's moving towards more data interpretation and recommendations and moving away from these visualizations or report-outs of that information, that might be a way to go. But I think there are also a lot of other alternatives. I don't think that the current use of data, and then that presentation to users, is where it could be.

MP: You mentioned that there could be more alternatives. And as a designer, part of this research study is thinking about future possibilities for how these devices and applications could look, how they could work, and how we could interact with them. And I am also interested in the idea of not just providing raw scores that the user has to interpret or knit together on their own. Do you have any more thoughts on what future possibilities could look like?

RF: I think one of the things that we consistently talk about with a lot of these apps is that the data is not dynamic in any way. What I mean is that oftentimes it's just a stationary presentation of what you're looking at. Even if you just go to the Apple Health app, one of the only dynamic pieces to that is the rings that you're filling in over time. And this goes back to the actionable piece—when you have these types of recommendations or these types of indications for improvement or growth, they would allow people to understand how to change their behaviour over time. Also, from a consumer perspective, if there's more ability

to engage with this app—rather than it just being a stationary checkpoint for what's going on during the day—I think that would be very helpful. I'm the furthest person from a designer, so I'm definitely not the best in terms of articulating "what would be really helpful to see." But in terms of what we do in therapy and what we do in clinical work, there are huge discrepancies between the types of things that we're discussing and the data that we're looking at versus what's presented on an app screen or on a wearable. I'll leave it there. I don't know if that was helpful, but those were additional thoughts. (laughs)

MP: I really appreciate it. As we progress, there will be more opportunities to discuss these things. (pause) Are you finding that your clients or your patients are currently using these products?

RF: To some extent, yes. (pause) I would guess that at least half of the folks that I see in my clinical work are using some form of wearable or app to try and track some of this information. With that said, I think the relationships that they have with it are very different. (laughs) With eating disorders in particular, there's an app that we just tested with BEGIN. It's an adapted version of Recovery Record, which is one of the most widely used eating disorder apps out there. And that one is by far the most functional and useful out of pretty much any of the eating disorder apps that currently exist. We adapted it for a wearable and tried to understand the differences in the interface and what can be presented on the phone versus what can be presented on the watch. For example, meal tracking is a big component of that app, and it's very difficult to log that on an Apple Watch face—it's much easier to do that with your phone. Just understanding some of the differences in usability and function was really important for us. And then taking that to more clinical populations and understanding how they use and like it. Finding the differences in functionality and utility was really helpful for making sure that the next iteration makes a lot more sense in terms of what's offered on those two interfaces. All of that to say, I think folks do use them—it's often—and there is a reason why engagement and drop-off are so significant for a lot of these types of tools. I think some of that can be attributed to design—I think a lot of that is related to functionality and usability. A lot of what is designed in the research sphere is very much oriented towards "We're trying to look at these specific targets and then testing the evidence base." Whereas a lot of the apps that are developed, especially for mental health concerns in athletes, are much more oriented towards "the beauty" and "the style." They're not necessarily bringing in

the more important evidence-based components that we actually need to see change. So, it's trying to find that balance that I think will be really beneficial in the long term.

MP: That is very interesting. You mentioned Recovery Record, which is an application for treating people with eating disorders. But in general, do you feel there are any other devices or applications that are leading the field or doing this better than others? Do you have any thoughts on this?

RF: When you say "more broadly," do you mean not just specific to body image and eating disorders?

MP: I suppose I am thinking about anything within the realm of health and fitness devices or applications. Anything that is logging things like calories or activity. We could speculate that any of these products could be used by athlete populations. Therefore, they could potentially be used by people who are strictly trying to control their body size and shape, caloric intake, energy expenditure, and things like this.

RF: Gotcha. I think one of the go-tos that I see a lot of people use is MyFitnessPal. Which is tough because I think it does facilitate a lot of body image concerns and then calorie tracking in a way that is much more about weight loss or compensating. Basically, being able to use their exercise and their physical activity to compensate for their caloric intake that they're tracking through something like MyFitnessPal. (pause) I think that is probably one of the only other ones that I think is decent, but I also feel like I'm relatively picky about it. (laughs) Again, I'm coming from the space that is seeing how a lot of folks use these tools in more negative, malicious, or disordered ways. I'm seeing those folks on that end of the spectrum. I'm not seeing as many folks, just in my clinical practice, who are using these tools effectively in a way that is not harmful. I'm sure there are more tools out there that folks use effectively, but I'd say MyFitnessPal is probably the only other one that I see used most often that holds more of those evidence-based tenets, if that makes sense.

MP: Yes, it does. (pause) Something that you mentioned, which I am particularly interested in, relates to extreme users. I believe some of the issues that we are facing could be due to the unintended consequences of these designs and our inability to predict how far users could push these products and what they could do with them. Obviously, there is freedom

of choice with all of this. (pause) I would like to ask—what are your thoughts regarding wearable health tracking devices and instances of body dissatisfaction and eating disorders? Do you feel these products have potentially increased or decreased instances of these concerns? Do you have any thoughts on this?

RF: There's pretty strong evidence for the fact that these types of wearables, devices, and apps can increase the risk and eventual onset of body dissatisfaction, poor body image, disordered eating, and all of that stuff. The evidence is pretty clear about that. And at the same time, I think one of the things that we have to be very thoughtful of is, "What are the stopgap measures that are implemented within the design of these tools to capture when someone is only logging 800 calories in a day?" Almost none of these apps will provide a notification, like, "Hey, it doesn't seem like you're consuming enough." Or if it is able to detect certain types of physical activity that are sustained for a long time—for instance, there tend to be core components of compulsive exercise, which are typically prolonged periods of cardio-based activity, that people will use to compensate for their caloric intake and use in a disordered way—these apps may be able to pick up on that and be able to recommend or just identify, "Hey, this might be something that you're tracking, and we just want to make sure you're getting some support, or you're getting someone to check in with you on this?" There are just not a lot of measures that are implemented in these types of tools to catch those types of extremes. The same thing applies to social media platforms when they're recommending all those "thinspiration" types of posts and videos. Those are their algorithms —they can very easily identify that content might be contributing to poor body image. I think being able to use that same type of logic and apply that to these different metrics that are acquired through wearables would be very actionable and provide very targeted opportunities to prevent some of the poor body image, or some of these disordered eating behaviours, from coming up in the first place. But that doesn't really happen right now.

MP: I agree. It is important to understand all of the other external influences. For example, you brought up social media, and a lot of these health and fitness apps interface through a phone. But this is also how most social media is accessed. A person could be on Instagram and potentially viewing photos or content that could cause mental distress or body image issues. And then move directly into their health and fitness app to check their physical activity or their calories for the day. The pathway is so quick.

RF: Yes. And you can capture that information through APIs [application programming interfaces]. There's a lot of opportunity to act on that, but it hasn't necessarily been done yet. I think it's a really cool space. But from a design and functionality perspective, I'm sure it's way more difficult than I'm anticipating it might be. (laughs).

MP: But even just awareness of these topics is really important. The major players, like Apple and Google, are huge companies, and they have extremely intelligent people working for them. If the consumer demanded it, the companies could certainly implement it. And that consumer demand would come through greater awareness. I think the wheels of change are slow and gradual. But I do see improvements, even over the last five to ten years, regarding the general literacy of these topics. (pause) Some researchers believe that there are biological and observable traits that may indicate a person could be susceptible to these concerns. I know that within your more recent studies, you were looking at several of these biological factors as well. Do you feel there are any common factors that may indicate a person could be susceptible to the negative consequences of these products? For example, things like excessive tracking, excessive checking, or using the tool for compulsive exercise. Are there any common or observable traits that would raise some red flags for you?

RF: I think so. The folks that we see who are on that end of the spectrum, where there's poor body image or disordered eating behaviours, oftentimes have a high rate of perfectionism, are very compliant and adherent, tend to be people-pleasers, and there tends to be a lot of rigidity. I'm generalizing, but these are some of the things we've gotten from the research. And I think all of those types of characteristics can very much align with folks who would then use these types of tools in a harmful way that would support or maintain some of the poor body image or disorder eating behaviours. If you think of someone who is very perfectionistic and rigid, if they have those personality traits and characteristics, that can very easily apply to the way that they would use their wearable tracking device. There's a lot of rigidity, there's not a lot of flexibility, and there may end up being a pretty negative association with it. If they're tracking their calories or their steps and that becomes very rigid, then it's very easy to see how that can facilitate some of the compulsive or poor body image concerns that might come up with this overarching psychopathology. So, those are some of the things—that's definitely not an exhaustive list, but those are some of the initial characteristics that come to mind.

MP: Thank you for sharing. The next question is regarding the general concept of self-tracking for athletes. You have indicated that there are many excellent performance-based reasons to track. And I agree, as I have experience with self-tracking and I feel it can be beneficial in some situations. With this said, does self-tracking always remain beneficial or neutral? Or does it potentially possess a problematic undertone? Is there a possible progression path? Do you have any general thoughts about the concept of self-tracking for athletes?

RF: It's a good question. (pause) I am of the opinion that people's relationships with these types of tracking devices will most likely change over time, but I don't necessarily think that they always go down this harmful trajectory. I'm trying to remember the exact context, but at one point we were talking with some athletes about daily self-monitoring of mood, sleep, nutrition, and a couple other things. It was a series of 10 questions. Initially, a lot of them started out feeling very positive about that type of tracking, and by the end of it, some people felt like it was very beneficial, and some people, even on a day-to-day basis, would be like, "This is annoying as crap," and the next day would be like, "Actually, this is fine." I think that over time, there are probably trajectories. And even within days, weeks, months, or whatever your time frame is, I think there are probably incidental changes that are dependent on a lot of different things. So, I'll have to say, I think it changes over time. I'm not sure if it tends to fall, on average, in a harmful direction. I don't know if we have enough data to support that, but I think for a lot of people, it does tend to happen. I just don't know what the percentage is.

MP: Yes, I understand and appreciate your balanced perspective. From the literature and from what others have said, it really does seem to have this complex nature, where sometimes it can be positive, sometimes it can be negative, and it can even be both positive and negative within a single session.

RF: Yes. I just don't think we have an understanding of what contributes to that and why people feel a certain way about some of these tracking devices. I think there is some qualitative information out there, but not a lot. (laughs) On the developer and the design side, especially when it's IP [intellectual property], there's just not a lot of information out there publicly related to, "Why and what contributes to the way people feel about some of these tools?"

MP: Yes, I agree. (pause) I have familiarized myself with about a dozen of your studies, and one of your articles from 2018 discussed positive technological interventions to treat disordered eating [Adapting a Technology-Based Eating Disorder Model for Athletes]. Based on this article, I can sense where you stand on this topic. And I really appreciate that I have the opportunity to speak with you directly, because a lot of the clinicians that I have spoken to are not necessarily aware of any technological interventions to treat these conditions, or they have predominantly negative opinions about them. And I believe that could be due to a lack of awareness about the existing tools that are potentially very helpful. So, I would love to give you an opportunity to share your thoughts about any positive technological interventions to treat body image disturbances and disordered eating behaviours. And this could be your work, others, or anything.

RF: Yes, I think you're hitting the nail on the head—a lot of clinicians have a lot of skepticism around digital mental health tools, more broadly. And there are good reasons for that. If people were able to fully solve their mental health concerns with digital tools, that would put a lot of clinicians out of a job. At the same time, I think there's so much benefit and utility to them. With one of the first studies that I worked on [Screening and offering online programs for eating disorders: Reach, pathology, and differences across eating disorder status groups at 28 U.S. universities], we delivered a comprehensive eating disorder psychoeducation, prevention, and intervention tool to low, medium, and high-risk folks across almost 30 colleges nationally, and we reached close to 5,000 people just with our screening and saw a huge improvement in eating disorder symptoms and depression. For the most part, these were folks who had never received treatment and were fearful of getting treatment, whether it was due to stigma or because there were a lot of barriers to accessing treatment. Sometimes their schools didn't necessarily have easily accessible treatment for eating disorders or body image concerns, or they didn't have clinicians who were trained in those areas. Unfortunately, there are a lot of barriers to finding appropriately trained clinicians who have a background in body image and eating disorders. It's a pretty niche area. And yet, full-threshold disorders impact at least 5–6% of the population that we know of, and up to 50% of people will experience poor body image in their lives. It's pretty pervasive, and it's clear that a lot of people need help. Yet they are not able to access those services with the clinicians that are available. All of that to say, I think digital tools can really help bridge that gap. I've seen it firsthand, and I've talked to a number of participants over the years from my research and also folks who I've seen in my

clinical work who have used digital tools in combination with in-person services and have found it to be very effective. So, that's my soapbox. (laughs) I certainly understand the concerns and the potential negatives, which we have talked a lot about already, but I think there's also some pretty dramatic upsides to using these types of technologies.

MP: Thank you for sharing that. In the same 2018 article [Adapting a Technology-Based Eating Disorder Model for Athletes], you outlined several design recommendations for improved technology-based interventions and the inclusion of screening tools. In the years since publication in 2018, do you know if any of these recommendations have been put into practice?

RF: Oh gosh. To be honest, I don't even remember what I have in there. (laughs) It's been a minute. Honestly, I would have to go back and look at the paper and tell you. I can see if I can pull it up quickly. If I remember correctly, I think some of it was related to improving privacy and being able to really ensure that the screening and intervention tools are adapted specifically for athletes. There are a lot of specific considerations within athlete populations that are not necessarily prevalent within non-athlete populations. For instance, designing things based on the sport, or the seasonality of their sport, or considering the impact that coaching has on an athlete's mental health. I think those were some of the considerations that we put in there. To my knowledge, I don't think much of that has occurred. Again, there are very, very few athlete-specific tools out there. But I'm not as up to speed as I would like to be in terms of the specific developments there. I feel like it's a non-answer, so I apologize.

MP: No, it's perfectly fine. I think it indicates how busy this research field is. Even for people who have their finger on the pulse, it's difficult to keep track of everything. One of the recommendations that I thought was particularly interesting was about increased personalization and customization. For example, to be more sport-specific, or to be very detailed in addressing people, their sport, and their conditions. Now that artificial intelligence and machine learning are becoming more commonplace, what are your thoughts on the idea of increased personalization, customization, and specialization of wearable health tracking devices and digital applications? Do you have any thoughts on this?

RF: If there's one thing that I feel I've learned from being in this research space, the folks that we talk to are consistently asking for that. "I want it to feel like it understands." If it is truly coming from a prevention and intervention standpoint and not just a self-monitoring

standpoint, there's been a lot of discussion around making sure that the tool actually captures what that person is experiencing, and that requires a lot of personalization. With that said, when it's geared towards the self-monitoring side, I don't think those messages have been as resounding. And yet, there's still some level of personalization that needs to occur so that it feels like there's some level of engagement and willingness. When people feel like it's a little bit more tailored to who they are and what their experiences are, there tends to be a little bit more engagement and willingness to use it. I feel like that's been one of the main learnings that I've had. Again, I think there are a lot of different variables that can be played with that are specific to athletes. Whether it's sport, amount of training time, types of behaviours they're engaging in, or even just looking at the different types of screening tools for poor body image or disorder eating behaviours that are then specific to athletes—there's just so much in there that can be customized and tailored. It almost feels overwhelming trying to figure out what needs to be customizable to facilitate engagement, but to also feel like they're not completely overwhelmed with options and not crossing that boundary where it feels like a piece of technology knows you too well, right? There still has to be some space for people to feel like they are the ones that are understanding themselves, and it's not a tool that's doing it for them. Does that make sense?

MP: Yes, it does. (pause) For your dissertation and the BEGIN study, I believe you were using Apple Watches—is that correct?

RF: Yes. For the parent BEGIN study, we were looking at binge eating, and then what I did for my dissertation used the same data set, but we were just looking at a different behaviour. But yes, for all of those studies, they all had Apple Watches that were either their own or ones that were donated.

MP: And I believe you didn't manipulate the user interface—it was just the standard user interface, and you were collecting all of this data passively. But I believe you had some additional prompts—is that correct?

RF: Yes.

MP: I suppose what I am trying to understand is, "What should actually be presented to the user?" Is it more or less information? Is it more tailored information? And how should we

present this information?" For example, when you're working with a coach in an athletic setting, they're looking at the bigger picture. They're looking at everything you're doing, watching your performance, asking you questions, and then delivering very direct and actionable feedback. Like, "Take 10 minutes off of your cardio and cut all of your sets in half—your recovery doesn't seem very good this week." And you just listen, and you act. And like you said, with some of these devices, it feels like the data is presented to the user, but there is still a lot of interpretation required and unclear direction about what to do. So, with all of that said, what do you feel some primary areas of improvement could be? Are there any obvious targets for design improvements?

RF: Let me ask a verifying question. In terms of the Recovery Record application, which was what we used for those studies? Or in terms of wearables more generally?

MP: That is an excellent question. It was convoluted, and I apologize. More generally. Let's say the actual implementation of some of the recommendations that you have collected. Are there any obvious design improvements that could be made? Is it improvements to existing features and interfaces, the addition of new features, new visualization methods, more sensor data, or improved sensors? Maybe it's not a wearable device anymore, but another data collection method? After spending some time in this area, have you observed any things that could be improved?

RF: I think "yes" to all of the things that you just said. (laughs) I feel like it's hard to make sweeping generalizations about how some of these tools could be improved, with maybe the exception of providing more actionable steps for folks based on the data that's acquired. But that also requires a level of engagement that most people do not provide. User drop-off is tremendously fast, especially with mental health tools. I'm not as familiar with the data on wearables specifically, but my understanding is that there is still a pretty significant drop-off with engagement early on. And we don't really have a good answer for how to improve engagement. I think one of the most pervasive issues that this field faces is trying to understand "how and why that engagement drops off." And maybe there are design features associated with that? Whether it is this customizable and personalized user interface or whether it is just barriers like seeing the ridiculously long Terms and Conditions text for what is happening with your data—I think there's a lot of fear in that, too. I just don't think there's a lot of understanding, thoughtfulness, and intentionality that

goes into "What happens when folks stop engaging?" Certainly within the powerhouse tech giants, I'm sure there are thousands of people who think about that on a day-in, day-out basis. But when it comes to 99% of the other apps and interfaces, there's not necessarily that same level of thought that goes into it—which is what most people will use. All of that to say, I think engagement is a big piece, as is intentional functionality, and more intervention than just self-monitoring. Taking that step is going to be an opportunity for a lot of change for a lot of folks. I feel like it's hard to make more generalized statements, in part because I mostly know the eating disorder field more than anything. I think those are some of the initial thoughts, but I can come back to that at a later point.

MP: That is wonderful, and I think that might be a great place to end this interview. Again, I really appreciate that you took the time. Before we conclude, is there anything else you would like to discuss, or do you have any questions for me?

RF: No, not at this point. I apologize for having to go, but I hope this was at least somewhat helpful.

MP: Oh, absolutely. I really appreciate it. And truthfully, it was very beneficial. Thank you.

RF: Yes, no problem.

MP: As noted in the Participant Consent Form, once all the interviews are complete, I will send you a copy of the interview transcript, and you will have 14 days to review it and make any revisions. Afterwards, the written transcript will become part of the research study data set. If you have any questions in the meantime, please feel free to email me.

RF: Sounds good. I appreciate the time. Good luck.

MP: Thank you very much. I appreciate it too. Have a wonderful day.

RF: Thanks, you too. [Interview Duration: 00:58:42]

Appendix G: Exhibition Documentation

This research project was exhibited to the public from September 11–27, 2024. The exhibition consisted of four 30" x 50" printed foam core panels (see Figures G1–G5) mounted within a display case on the second floor of the Fine Arts Building (FAB) at the University of Alberta North Campus (see Figures G6–G7).

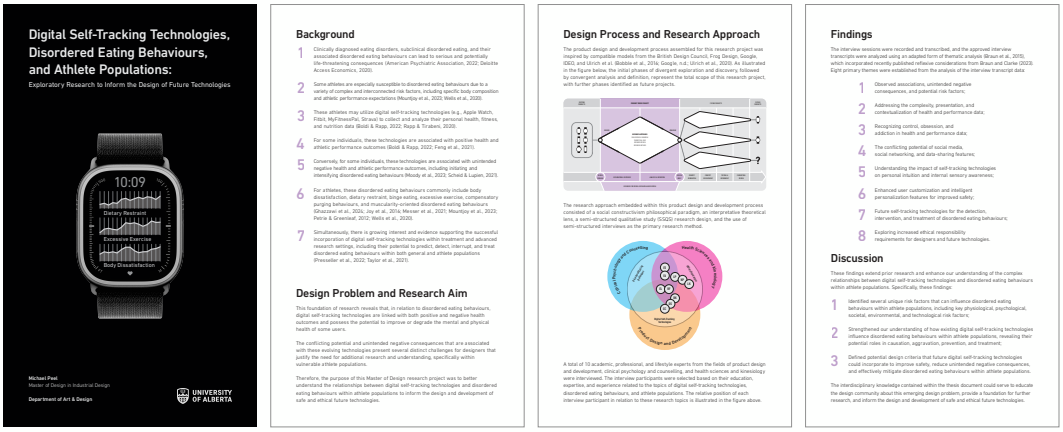


Figure G1: Exhibition panel layout

Digital Self-Tracking Technologies, Disordered Eating Behaviours, and Athlete Populations:

Exploratory Research to Inform the Design of Future Technologies

Michael Peel
Master of Design in Industrial Design

Department of Art & Design

UNIVERSITY OF ALBERTA

Figure G2: Exhibition panel A

Background

1. Clinically diagnosed eating disorders, subclinical disordered eating, and their associated disordered eating behaviours can lead to serious and potentially life-threatening consequences (American Psychiatric Association, 2022; Deloitte Access Economics, 2020).

2. Some athletes are especially susceptible to disordered eating behaviours due to a variety of complex and interconnected risk factors, including specific body composition and athletic performance expectations (Mountjoy et al., 2023; Wells et al., 2020).

3. These athletes may utilize digital self-tracking technologies (e.g., Apple Watch, Fitbit, MyFitnessPal, Strava) to collect and analyze their personal health, fitness, and nutrition data (Boldi & Rapp, 2022; Rapp & Tirabeni, 2020).

4. For some individuals, these technologies are associated with positive health and athletic performance outcomes (Boldi & Rapp, 2022; Feng et al., 2021).

5. Conversely, for some individuals, these technologies are associated with unintended negative health and athletic performance outcomes, including initiating and intensifying disordered eating behaviours (Moody et al., 2023; Scheid & Lupien, 2021).

6. For athletes, these disordered eating behaviours commonly include body dissatisfaction, dietary restraint, binge eating, excessive exercise, compensatory purging behaviours, and muscularity-oriented disordered eating behaviours (Ghazzawi et al., 2024; Joy et al., 2016; Messer et al., 2021; Mountjoy et al., 2023; Petrie & Greenleaf, 2012; Wells et al., 2020).

7. Simultaneously, there is growing interest and evidence supporting the successful incorporation of digital self-tracking technologies within treatment and advanced research settings, including their potential to predict, detect, interrupt, and treat disordered eating behaviours within both general and athlete populations (Presseller et al., 2022; Taylor et al., 2021).

Design Problem and Research Aim

This foundation of research reveals that, in relation to disordered eating behaviours, digital self-tracking technologies are linked with both positive and negative health outcomes and possess the potential to improve or degrade the mental and physical health of some users.

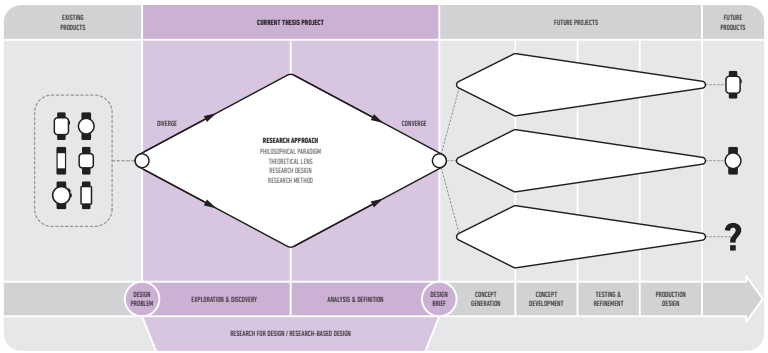
The conflicting potential and unintended negative consequences that are associated with these evolving technologies present several distinct challenges for designers that justify the need for additional research and understanding, specifically within vulnerable athlete populations.

Therefore, the purpose of this Master of Design research project was to better understand the relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations to inform the design and development of safe and ethical future technologies.

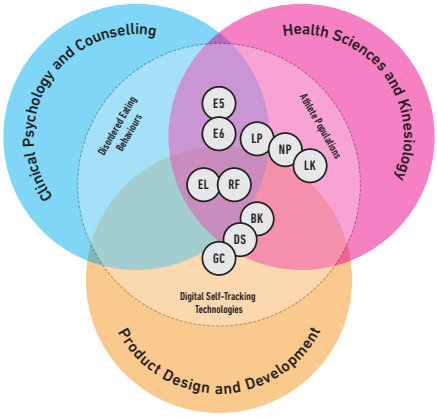
Figure G3: Exhibition panel B

Design Process and Research Approach

The product design and development process assembled for this research project was inspired by compatible models from the British Design Council, Frog Design, Google, IDEO, and Ulrich et al. (Bobble et al., 2016; Google, n.d.; Ulrich et al., 2020). As illustrated in the figure below, the initial phases of divergent exploration and discovery, followed by convergent analysis and definition, represent the total scope of this research project, with further phases identified as future projects.



The research approach embedded within this product design and development process consisted of a social constructivism philosophical paradigm, an interpretative theoretical lens, a semi-structured qualitative study (SSQS) research design, and the use of semi-structured interviews as the primary research method.



A total of 10 academic, professional, and lifestyle experts from the fields of product design and development, clinical psychology and counselling, and health sciences and kinesiology were interviewed. The interview participants were selected based on their education, expertise, and experience related to the topics of digital self-tracking technologies, disordered eating behaviours, and athlete populations. The relative position of each interview participant in relation to these research topics is illustrated in the figure above.

Figure G4: Exhibition panel C

Findings

The interview sessions were recorded and transcribed, and the approved interview transcripts were analyzed using an adapted form of thematic analysis (Braun et al., 2015), which incorporated recently published reflexive considerations from Braun and Clarke (2023). Eight primary themes were established from the analysis of the interview transcript data:

1. Observed associations, unintended negative consequences, and potential risk factors;
2. Addressing the complexity, presentation, and contextualization of health and performance data;
3. Recognizing control, obsession, and addiction in health and performance data;
4. The conflicting potential of social media, social networking, and data-sharing features;
5. Understanding the impact of self-tracking technologies on personal intuition and internal sensory awareness;
6. Enhanced user customization and intelligent personalization features for improved safety;
7. Future self-tracking technologies for the detection, intervention, and treatment of disordered eating behaviours;
8. Exploring increased ethical responsibility requirements for designers and future technologies.

Discussion

These findings extend prior research and enhance our understanding of the complex relationships between digital self-tracking technologies and disordered eating behaviours within athlete populations. Specifically, these findings:

1. Identified several unique risk factors that can influence disordered eating behaviours within athlete populations, including key physiological, psychological, societal, environmental, and technological risk factors;
2. Strengthened our understanding of how existing digital self-tracking technologies influence disordered eating behaviours within athlete populations, revealing their potential roles in causation, aggravation, prevention, and treatment;
3. Defined potential design criteria that future digital self-tracking technologies could incorporate to improve safety, reduce unintended negative consequences, and effectively mitigate disordered eating behaviours within athlete populations.

The interdisciplinary knowledge contained within the thesis document could serve to educate the design community about this emerging design problem, provide a foundation for further research, and inform the design and development of safe and ethical future technologies.

Figure G5: Exhibition panel D

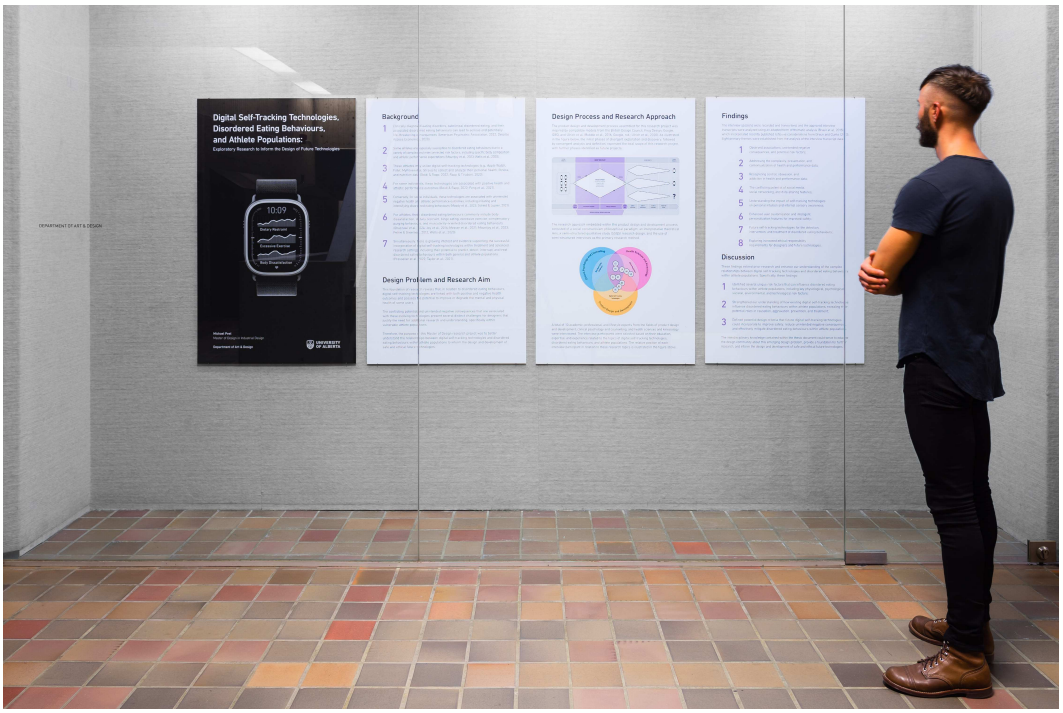


Figure G6: Exhibition in display case, view 1

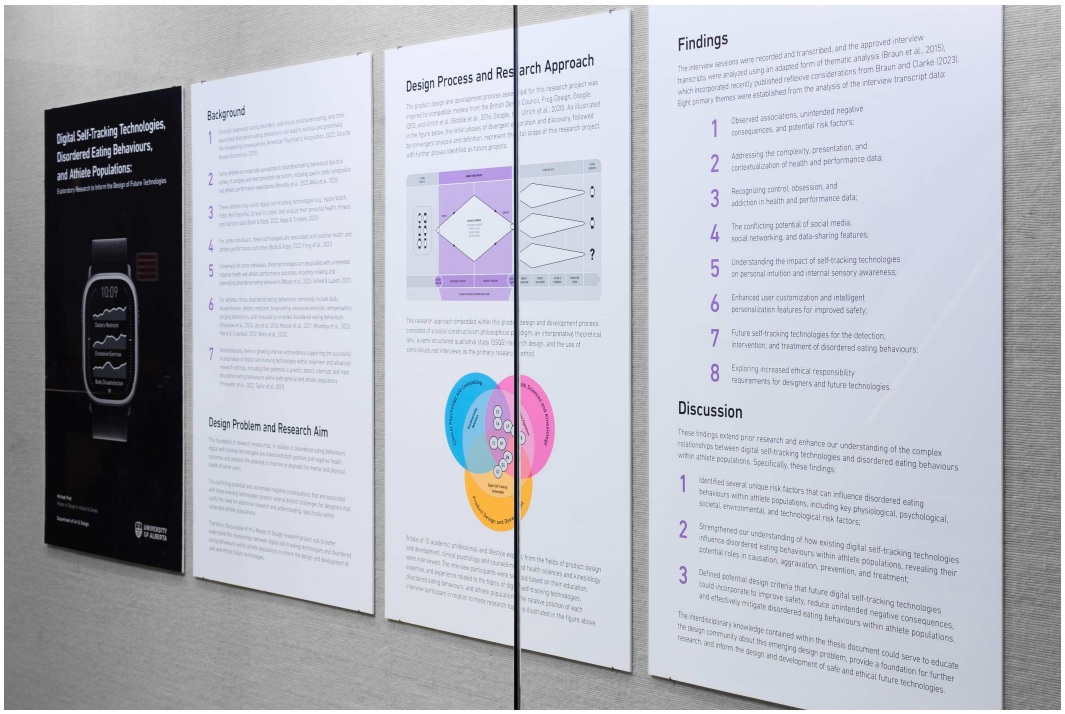


Figure G7: Exhibition in display case, view 2

Department of Art & Design
University of Alberta