Physical Activity and Student Health: A Canadian University Perspective

by

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Abstract

In 2013, a research effort at the University of Alberta combined various health-related questionnaires to form the Student Life Activity Questionnaire (SLAQ) to evaluate student health behaviour, patterns, and associations. An area for inquiry became evident when the analysis of the physical activity data appeared problematic and potentially related to the questionnaire used in the study. An evaluation of the 2013 SLAQ data suggested that future iterations of the SLAQ might benefit from an alternative approach. Therefore, this thesis sought to construct a simple physical activity questionnaire where the average of the item total would provide a general indicator of physical activity behaviour with higher scores corresponding to more frequent self-reported activity participation. Items were scored on a frequency scale from 0: Never to 6: Very often. Characterizing activity behaviours by themes resulted in a set of 14 student-focused items. Themes included bodily movement, exercise, fitness, recreation/sports, and sitting. The set of items was included in the 2014 SLAQ, which was used to a) determine whether a simple scale could be identified through factor analysis, b) evaluate convergent validity by comparing the factor-extracted questionnaire with the Global Physical Activity Questionnaire (GPAQ), and c) explore the associations between the factor-extracted physical activity scale and scores derived from questionnaires on perceived stress, nutrition, sleep, and personal wellbeing. The invitation to participate in the SLAQ was sent to 4000 University of Alberta students in May 2014. Participation was voluntary and students were provided with a $10 credit on their university identification card if they chose to participate.

The SLAQ had a 34% response rate (n = 1366) and the findings showed that a 9-item Physical Activity Questionnaire (PAQ) could be extracted from the set of 14 items. The internal consistency of the PAQ was high (α= 0.81) and the convergent validity of the PAQ to the GPAQ

activity scores was encouraging as positive Pearson ($r = 0.28$) and Spearman ($r_s = 0.44$) associations ($p < 0.01$) were observed between the PAQ and the GPAQ total activity scores. The strongest Pearson ($r = 0.49$) and Spearman ($r_s = 0.65$) associations were observed between the PAQ and GPAQ recreational activity scores. However, a direct limitation of the PAQ is that it cannot be considered a purely behavioural indicator of physical activity. When the PAQ was used to examine the associations between physical activity and indicators of health, Pearson analysis showed that the PAQ correlated significantly ($p < 0.01$) with perceived stress ($r = -0.23$), positive nutritional behaviours ($r = 0.39$), personal wellbeing ($r = 0.29$), and sleep quality ($r = 0.11$). A similar pattern of associations was observed when the Spearman coefficients were calculated between the GPAQ total activity scores to positive nutritional behaviours, and personal wellbeing except for perceived stress and sleep quality, which did not show a significant association. Physical activity is an important part of leading a healthy lifestyle and research describing the associations between physical activity and health can provide valuable insight for public health and health promotion. The important findings from this thesis include outlining steps for additional health indicator development through theme establishment and factor analysis and a depiction of the associations between physical activity and indicators of health in the Canadian university setting. As associations are open to bidirectional interpretations, future research could explore the nature of associations found in this thesis to further guide health promotion efforts focused on improving student health and wellness.

Preface

This thesis is an original work by Walie Aktary. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name “Student Life Activity Questionnaire 2014 (SLAQ 2014)”, No. Pro00046509, 26/03/2014.

Dedication

To Michelle: While I cannot fathom the array of experiences each day will bring me, I take solace in the fact that each of my days will begin and end with you.

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I would like to take the time to thank my family and friends for their love and continued support. My parents have been my most ardent supporters and I could not have progressed without them. Finally, my sincerest and deepest appreciation is owed to my fiancé, Michelle.

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List of Abbreviations

AEE: Average Energy Expenditure

BLPAQ: Brunel Lifestyle Physical Activity Questionnaire

BPAQ: Baecke Physical Activity Questionnaire

CHD: Coronary Heart Disease

CSEP: Canadian Society for Exercise Physiology

DLW: Doubly Labeled Water

FACT-G: Functional Assessment of Cancer Therapy–General Cancer

FITT: Frequency, Intensity, Type, and Time

FPACQ: Flemish Physical Activity Computerized Questionnaire

GLTEQ: Godin Leisure-Time Exercise Questionnaire

GPAQ: Global Physical Activity Questionnaire

IPAQ: International Physical Activity Questionnaire

KPAS: Kaiser Physical Activity Survey

MET: Metabolic Equivalent

METtotal: Total MET-minutes for the week

MLTAQ: Minnesota Leisure Time Activity Questionnaire

MVPA: Moderate-to-Vigorous Physical Activity

NBS: Nutritional Behaviour Scale

NPAQ: Neighborhood Physical Activity Questionnaire

NZPAQ: New Zealand Physical Activity Questionnaire

OPAQ: Occupational Physical Activity Questionnaire

OSPAQ: Occupational Sitting and Physical Activity Questionnaire

PASE: Physical Activity Scale for the Elderly

PASIPD: Physical Activity Scale for Individuals with Physical Disabilities

PAQ: Physical Activity Questionnaire

PPAQ: Paffenbarger Physical Activity Questionnaire

PSS Perceived Stress Scale

PWI Personal Wellbeing Index

PYTPAQ: Past Year Total Physical Activity Questionnaire

RAPA: Rapid Assessment of Physical Activity

REC: Total MET-minutes for all recreational activity per week

RECmod: Total MET-minutes for all moderate recreational activity per week

RECvig: Total MET-minutes for all vigorous recreational activity per week

SDAR: Seven-Day Physical Activity Recall

SHAPES: School Health Action, Planning and Evaluation System

SLAQ: Student Life Activity Questionnaire

SPSS: Statistical Package for the Social Sciences

SQS: Sleep Quality Scale

SQUASH: Short Questionnaire to Assess Health-Enhancing Physical Activity

SUM: Total MET-minutes for the week

TOPAQ: Tecumseh Occupational Physical Activity Questionnaire

TRNS: Total MET-minutes for transit activity per week

VO_2: Rate of Oxygen Consumption

WHO: World Health Organization

WORK: Total MET-minutes for all work/school activity per week

WORKmod: Total MET-minutes for all moderate work/school activity per week

WORKvig: Total MET-minutes for all vigorous work/school activity per week

YPAS: Yale Physical Activity Survey

Chapter 1: Introduction

1.1 Physical Activity and Health

1.1.1 Defining Physical Activity and Related Health Outcomes

Physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell, & Christenson, 1985). For people of all ages, regular physical activity is an important part of healthy living. The health benefits of physical activity have been documented and associations made between inactivity and an increased risk for chronic disease (Katzmarzyk, Gledhill, & Shephard, 2000). More specifically, a 2006 review on the health benefits of physical activity emphasized its role as a modifiable risk factor for diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and depression (Warburton, Nicol, & Bredin, 2006).

Given the potential dose-response relationship between physical activity and health outcomes in the general population (Kohl, 2001; Lee & Skerrett, 2001; Thune & Furberg, 2001), there is a current impetus in public health towards increasing physical activity levels among the largely inactive, ensuring that populations of interest meet recommended activity guidelines, and investigating the correlates of physical activity (Bauman, Phongsavan, Schoeppe, & Owen, 2006). Populations of interest can include school-aged children and adolescents (Kohl, Fulton, & Caspersen, 2000), young adults (Leslie, Sparling, & Owen, 2001), the physically disabled (Heath & Fentem, 1996), and seniors (Vogel et al., 2009).

This thesis will focus on the assessment of university student physical activity as well as explore what associations exist between physical activity and indicators of health and wellness. The assessment instruments of health and wellness this study will utilize include indicators of: stress, sleep, nutrition, and personal wellbeing.

1.1.2 Guidelines and Recommendations

In 2011, The Canadian Society for Exercise Physiology (CSEP), in cooperation with numerous stakeholders, and with support from the Public Health Agency of Canada, developed the new Canadian Physical Activity Guidelines for Children (aged 5–11 years), Youth (aged 12–17 years), Adults (aged 18–64 years), and Older Adults (aged ≥65 years) (Tremblay et al. 2011). The new guidelines addressed existing knowledge gaps and outlined the minimum physical activity requirements necessary to maintain a healthy lifestyle. While each age group's guidelines slightly differed, the guidelines followed the FITT (Frequency, Intensity, Type, and Time) principle of physical activity (Sallis & Patrick, 1994).

Adults, for example, are encouraged to accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more. Of the FITT model, frequency, type, and time spent being active are relatively simple conceptions to convey to the general population. Questions on frequency and duration involve familiar references (e.g. amount per week and minutes/hours per session). Questions on which activity one should perform (i.e., type) are categorical measures: running, swimming, soccer, etc. Intensity is a continuous measure referring to the level of effort required by an individual to do a certain activity. Levels of effort are typically assessed through the amount of energy a body uses per unit time of activity.

The various intensities of physical activity are primarily assessed through metabolic equivalents (METs) determined by the Compendium of Physical Activities (Ainsworth et al., 2000; Biddle, 2011). This approach quantifies intensity by comparing the energy expended during any activity to energy expenditure at rest, with one MET being equal to 3.5 mL of oxygen/kg/min or 1 kcal/kg/hr. Therefore, any activity can be described in terms of MET

multiples. Activities can be also grouped into general intensity categories, for example: light, < 3 METs; moderate, 3-6 METs; and vigorous, > 6 METs (Pate et al., 1995). In addition to aerobic physical activity, current guidelines suggest that healthy adults engage in activities designed to increase endurance and muscular strength.

1.2 Promoting Physical Activity in Canada

Despite the positive relationship between physical activity and health, the number of adults who are physically active on a regular basis remains low. Currently, an estimated 15% of Canadian adults accumulate 150 minutes of moderate-to-vigorous physical activity (MVPA) per week (Colley et al., 2011). Furthermore, the percentage of adults accumulating 150 minutes on a regular basis—at least 30 minutes on at least 5 days a week— is 5% (Colley et al., 2011). Given these statistics, the promotion of physical activity becomes important when the health benefits of being physically active are considered (Warburton, Nicol, & Bredin, 2006). Additionally, the importance of promoting physical activity also includes the potential effects of physical inactivity on health and activity correlates.

Physical inactivity is a public health concern when the relationship between physical activity to overweight and obesity is considered (Wareham, van Sluijs, & Ekelund, 2005). More specifically, current research has documented physical activity as a preventative measure against overweight and obesity in both the adult (Waxman, 2005) and youth (Baranowski et al., 2000; Sothern, 2004) populations. The relationship between physical activity and unhealthy weights adds to the importance of health promotion efforts focusing on physical activity when the economic burden of unhealthy weight is taken into consideration. A 2010 study estimating the current economic burden caused by obesity and overweight individuals in Canada emphasized the need to curb rising rates (Anis et al., 2010). Moreover, the study estimated that the total

direct costs attributable to overweight and obesity in Canada were $6.0 billion in 2006, with 66% attributable to obesity. This corresponded to 4.1% of the total health expenditures in Canada in 2006 (Anis et al., 2010). In addition, the direct and indirect economic costs of physical inactivity and obesity in Canada were evaluated in a 2001 analytical review (Katzmarzyk & Janssen, 2004). The review estimated that the economic burden of physical inactivity was $5.3 billion ($1.6 billion in direct costs and $3.7 billion in indirect costs), which represents 2.6% of total health care costs in Canada (Katzmarzyk & Janssen, 2004). Both studies highlight the negative effect unhealthy weight and inactivity has on the Canadian health care system. While the impact of overweight and obesity as well as physical inactivity in Canada can stand alone as major public health concerns, taking into account their interconnectivity highlights the potentially additive effect physical activity promotion efforts might have on the Canadian population.

Additionally, research suggesting that physical activity is associated with wellbeing (Penedo & Dahn, 2005), health related quality of life (Daskapan, Tuzun, & Eker, 2005), mental health (Deslandes et al., 2009; Fox, 1999; Ströhle, 2009), and stress (Byrne & Byrne, 1993; Cohen & Rodriguez, 1995; Cotman & Berchtold, 2002; Yoo, 2007) adds to the impetus for promoting physical activity.

1.3 The Assessment of Physical Activity

A central component to the promotion of physical activity in a given population is assessment (Booth, 2000). Moreover, Bauman, Phongsavan, Schoeppe, and Owen (2006) add that the accurate and reliable assessment and monitoring of activities, as well as their attributes, is an important part of health promotion research and evaluation practice. The assessment of physical activity has several important uses in informing health promotion efforts. For example, epidemiological research examining the relationship between physical activity and a range of

physical and mental health outcomes requires effective assessment instruments (Bauman, Phongsavan, Schoeppe, & Owen, 2006). Physical activity assessment can also be used to evaluate population activity levels for public health surveillance and monitoring purposes. In addition, the assessment of physical activity can be used to investigate the correlates and determinants of physical activity and guide future research to explore what the presence of an association signifies and how the direction of association can be used for health promotion. Activity assessment can further be utilized to evaluate the impact and effectiveness of health promotion programs and interventions designed to increase physical activity (Bauman, Phongsavan, Schoeppe, & Owen, 2006). Finally, physical activity assessment can be utilized to provide a sound and strong evidence base for broader initiatives in health promotion policy and public health practice (Booth, 2000).

1.3.1 Assessment Approaches

Generally, physical activity is not simple to assess because it is a complex multi-dimensional behaviour (Rennie & Wareham, 1998). Techniques for assessing physical activity include behavioural observation, questionnaires (diaries, recall questionnaires and interviews), and physiological markers such as heart rate, calorimetry, and motion sensors (Westerterp, 2009). Caspersen et al. (1985) highlight that, while physical activity is a complex behaviour, the simplest activity categories include leisure time physical activity, occupational physical activity, and sleep. Subsequent categories may also include activity due to transport as well as domestic activities.

Behavioural, or direct, observation uses an observer who watches live or recorded activities and then attempts to quantify them. These instruments can be used to assess activity patterns of a population of children in a defined space such as a school playground or park

(McKenzie, Marshall, Sallis, & Conway, 2000). While direct observation is useful when dealing with children and youth, the time-consuming and intrusive demands placed on the subject and observer make it unsuitable for large populations.

The current gold standard method for objectively measuring physical activity is the doubly labeled water technique, which utilizes isotopes to calculate energy expenditure (Schoeller, Kushner, & Jones, 1986). This method is thought to provide a criterion measure of activity participation by measuring the metabolic process directly related to the accepted definition of physical activity (Vanhees et al., 2005). However, the use of energy expenditure in objectively assessing physical activity has certain limiting factors. First, a limitation of directly measuring physical activity through measures of energy expenditure, such as doubly labeled water and calorimetry, is that these methods are not feasible for large-scale studies (Schutz, Weinsier, & Hunter, 2001). Additionally, the factors that limit the use of energy expenditure rest with the individual differences in body mass, fitness level, and the cost of energy expenditure per person of a given population (Schutz, Weinsier, & Hunter, 2001). Further objective measures of physical activity also include mechanical instruments, such as pedometers that provide an overall step count and accelerometers that measure intensity and account for planes of movement (Reilly et al., 2008). The utility of mechanical instruments for health promotion purposes is that these methods can provide an effective non-invasive assessment of physical activity participation, which also compare favorably to gold-standard techniques (Plasqui & Westerterp, 2007). While mechanical instruments are more feasible for public health use relative to criterion measures, the distribution and collection of instruments may prove problematic for studies with limited resources that are interested in large-scale assessment.

While objective assessment and direct observation offer many advantages, the assessment of physical activity for health promotion purposes primarily occurs through self-reports, such as the completion of questionnaires, interviews and surveys (Booth, 2000; Welk, 2002).

1.3.2 Self-Reports

Self-report instruments are the most widely used tools in the assessment of physical activity with respondents typically asked to recall their participation in certain activities over a specific period of time (Warren et al., 2010). Self-reported physical activity data can be used to provide insight into population activity levels, be used to identify proportions of individuals not meeting recommended thresholds, and be used in cross-sectional studies evaluating correlations.

The primary benefits of using self-report instruments in cross-sectional studies are their relative ease of use, low-cost, and their ability to describe large samples in a minimally invasive manner. Furthermore, self-reports offer the ability for researchers to evaluate specific activity behaviours (Warren et al., 2010). Public health professionals are also able to use self-reports to gauge population trends and develop, as well as monitor, potential health strategies.

Although self-reports are useful for gaining insight into the physical activity levels of populations, they have the capacity to overestimate or underestimate true physical activity energy expenditure and rates of inactivity (Prince et al., 2008). In addition, self-report methods are often wrought with issues of recall and response bias (e.g. social desirability, inaccurate memory) and the inability to capture absolute levels of physical activity (Prince et al., 2008; Warren et al., 2010). Shephard (2003) highlights that the use of intensity in self-reports poses the most risk for error in assessing physical activity levels. The focus on absolute rather than relative intensity of activities is problematic when considering the substantial inter-individual and intra-

individual variations in the energy cost of various activities, depending on the subject's age, sex, body mass, skill, and level of fatigue.

Self-report instruments are also limited in their ability to address certain age groups, such as young children and the elderly, due to issues related to cognitive immaturity/impairment and the inability of young children and the elderly to accurately recall their participation in various activities (Warren et al., 2010). This limitation is potentially mitigated by the use of proxy-reports but such instruments face the risk of reporting bias from the individual's proxy, in most cases family members or teachers. For example, some of the largest overestimates of the time a child spends being active comes from school gymnasiums, where the major fraction of a 30 or 40 minute physical education class may be spent in listening to instructions and awaiting a turn to use a particular item of equipment (Shephard, 2003). Finally, unlike the objective assessment of physical activity, self- reports are culturally dependent. Validity results assessed in one population cannot be systematically extrapolated to other populations, ethnic groups or other geographical regions and limited questionnaires exist for nonwestern immigrants (Warren et al., 2010).

1.4 Thesis Pretext: Health Assessment in the Canadian University Context

The previous sections have outlined the utility of self-report instruments for health promotion purposes. Moreover, public health surveillance was shown to be important to health promotion as an understanding of health correlates can influence policy directions and future research (Bauman, Phongsavan, Schoeppe, & Owen, 2006; Booth, 2000). While the focus of the previous sections has been on establishing the benefits of physical activity, the role of assessment, and mechanisms of assessment, the driving force behind this thesis rests in attempts to put the previous sections into practice. More specifically, this thesis was designed to address

the assessment of physical activity in a health promotion initiative focused on the associations between health indicators in the Canadian university setting.

1.4.1 Assessment and University Student Health

Population-level assessment, such as the Canadian Community Health Survey, has been successful in evaluating Canadian health behaviours and assisting in policy and program development. However, there are currently no population-based self-report mechanisms through which health behaviour assessments are made and associations examined in the Canadian university setting. An example of a population-based self-report instrument that could be used to gather information on student health is an omnibus survey, which is a research tool that collects data on a wide variety of topics through a combination of numerous focused items or through the inclusion of complete questionnaires. While there appears to be limited information on studies developing and using omnibus surveys to broadly assess student health associations, several cross-sectional studies assessing university student health behaviours and bivariate associations have shown the applications of student health assessment to health promotion. One effort assessed the differences in gendered responses to a small set of health behaviours in order to provide planning information for university educators, healthcare providers, and policy makers (Dawson, Schneider, Fletcher, & Bryden, 2007). Findings from the study provided valuable insight for university wellness stakeholders and highlighted the potential utility of broader assessment for health promotion purposes. However, one suggestion from the study indicated that future research is needed to examine physical activity behaviours and the relationship between activity, coping, and stress (Dawson, Schneider, Fletcher, & Bryden, 2007).

1.4.2 Population Selection: University Students

There are numerous benefits for choosing a university population for this study. First, little is known regarding the associations between physical activity habits and health factors among Canadian university students. In addition, it has been suggested that university student physical activity behaviour has been a seriously neglected research topic (Keating, Guan, Piñero, & Bridges, 2005). While there are numerous studies available, which document the utility of physical activity questionnaires; research studies have focused primarily on categorizing physical activity levels instead of how physical activity assessment could be used in conjunction with other self-report instruments to provide a broader picture of student health and wellness.

With respect to health correlates, Canadian university students have also remained relatively underrepresented on both the national and international scale, as there has been very little research on the associations between physical activity and health factors. For example, a 2003 international cross-sectional study on university student leisure time physical activity, health beliefs, and risk awareness spanned 23 countries but did not include Canadian students with North American focus being placed on the United States (Haase, Steptoe, Sallis, & Wardle, 2004). Instead, current research on Canadian students relative to international students tends to focus on a general question of whether students are active or not instead of offering possible insight into the associations between activity and health. As an example, a 2004 systematic review analyzing the prevalence of university students' participation in physical activity at the level necessary to acquire health benefits concluded that half of all Canadian students are not active enough to gain health benefits (Irwin, 2004). Moreover, while studies have been conducted to evaluate university student health correlates, such as physical activity and stress (Nguyen-Michel, Unger, Hamilton, & Spruijt-Metz, 2006), cross-sectional studies tend to limit

their focus to correlations between physical activity and single variables. Therefore, it appears that there is limited information available regarding the simultaneous assessment of multiple health variables in the Canadian university context.

1.4.3 Thesis Motivation: the Student Life Activity Questionnaire (SLAQ)

In an attempt to generate a surveillance tool, which could be used to influence health promotion policies, practice and research, questionnaires measuring stress, coping strategies, nutrition, personal wellbeing, sedentary behaviour, physical activity, mental health, and happiness were combined to form an omnibus survey of student health and wellbeing entitled the Student Life Activity Questionnaire (SLAQ). The SLAQ was a class project initiated by a team of graduate students from the University of Alberta School of Public Health under the guidance of their professor. The author of this thesis was part of the original project and the professor became one of the graduate supervisors for this thesis. During the 2013 winter term, the SLAQ was distributed to a random sample of 4,000 students from the University of Alberta. The 2013 SLAQ had a 24% response rate with 975 students participating in the project. As a collection of self-report questionnaires, the primary purpose of the SLAQ was to examine patterns, associations, and relationships between different health instruments as well as potentially develop models that could serve as templates for health promotion initiatives and intervention strategies.

The direct motivation for this thesis stemmed from analyzing the physical activity data from the 2013 SLAQ. During analysis, a subsequent area for inquiry became evident when the physical activity data as measured by the World Health Organization's Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006) appeared to have issues related to response difficulties and association inconsistencies. For the student sample in the 2013 SLAQ, physical

activity was measured by calculating energy expenditure scores (i.e., MET-minute per week scores) (Armstrong & Bull, 2006). The GPAQ MET-minute per week scores were calculated from self-report estimations of the number of days per week and minutes per day students engaged in occupational, recreational, and transit type activities of various intensities (Ainsworth et al., 2000; Armstrong & Bull, 2006). Additionally, the GPAQ included a specific scoring structure and analysis guideline, which set criteria for excluding incomplete responses from subsequent analyses. In contrast, concepts such as stress, personal wellbeing, coping, and nutrition were assessed through questionnaires that utilized fixed-choice items where the response formats were either frequency-ranged (e.g., never to very often) or Likert-based (e.g., strongly disagree to strongly agree). These questionnaires are structured to provide health outcomes in the form of scale scores, which are the averages of their item total. Questionnaire scaling was conducted and correlations calculated between outcomes, such as the SLAQ scale scores and GPAQ energy expenditure scores, to evaluate associations in the student sample.

This thesis was motivated primarily by two difficulties observed and noted during the analysis of the 2013 SLAQ. First, an issue with the scores obtained by GPAQ were noted when a high number of student responses were categorized as incomplete and required removal from the data set. Second, an inconsistency was noted when no or low correlations were observed between physical activity and other variables in the SLAQ. In particular, the lack of correlation between outcomes on physical activity and perceived stress (Cohen, Kamarck, & Mermelstein, 1983) and physical activity and personal wellbeing (Cummins, Eckersley, Pallant, Van Vugt, & Misajon, 2003) were most surprising. While a lack of association in cross-sectional studies is a potentially relevant finding, the absence of correlation was surprising given that previous studies have documented an association between physical activity and health factors such as wellbeing

(Penedo & Dahn, 2005), health related quality of life (Daskapan, Tuzun, & Eker, 2005), mental health (Deslandes et al., 2009; Fox, 1999; Ströhle, 2009), and stress (Byrne & Byrne, 1993; Cohen & Rodriguez, 1995; Cotman & Berchtold, 2002; Yoo, 2007). Both the author of this thesis and project supervisor worked to review the GPAQ response data from the 2013 SLAQ. The interpretation made by both the author of this thesis and project supervisor was that the SLAQ might have been limited by how students responded to the GPAQ in the context of the SLAQ. More specifically, this thesis was guided by the assumption that the GPAQ might have been too difficult to use in the context of the SLAQ. Following, a description of the difficulties observed with student responses to the GPAQ and why the GPAQ was considered problematic for assessment in the SLAQ will be presented.

1.4.4 Potential Difficulties with MET-based Questionnaires

First, a pilot test of the 2013 SLAQ among the group of graduate students involved in the project suggested that the GPAQ instrument was problematic. In particular, students from the pilot test indicated that they found the GPAQ too long and difficult, factors that Shephard (2003) suggests can potentially lead to boredom and/or confusion and influence results. In comparison to the questionnaires used in the SLAQ, students further indicated that the GPAQ was the instrument that contributed most to survey fatigue. During analysis, the difficulty observed with the responses to the GPAQ was that 13% (n = 125) of students were deemed incomplete cases, which needed to be excluded from analyses according to the analysis guidelines of the GPAQ (Armstrong & Bull, 2006). According to the GPAQ guidelines, a case is considered incomplete or inconsistent when a discrepancy exists between reported activity days and activity times (i.e., activity day = 0 and activity time > 0 or activity day > 0 and activity time = 0) (Armstrong & Bull, 2006). The need to remove 13% of the student sample when physical activity analyses were

performed was considered problematic and suggested that university students might have had difficulties with the GPAQ in the context of the SLAQ.

To possibly explain why the use of the GPAQ might have resulted in a high number of incomplete cases, the structural (i.e., format) differences between the GPAQ and questionnaires used in the SLAQ were considered. A focal difference noted between the GPAQ and questionnaires used in the SLAQ centered on the response formats used. More specifically, the majority of the questionnaires used in the SLAQ provided students with one of several options. These response formats are considered fixed or closed. In contrast, the GPAQ response format was open, as it required students to first estimate and then manually input the amount of time that they spent engaged in activities of various intensities in different settings. The difference in response format between the GPAQ and questionnaires used in the SLAQ was viewed as potentially problematic when research highlighting how open-formatted questionnaires are more prone to issues of recall bias, over- and under-estimation, missing data, and extreme values relative to closed-formatted questionnaires (Griffith, Cook, Guyatt, & Charles, 1999; Reja, Manfreda, Hlebec, & Vehovar, 2003) was considered. A further explanation as to why students might have had difficulties with the GPAQ might be due to the fact that the GPAQ was placed, by chance, at the end of the SLAQ. This might have contributed to the number of incomplete cases as students were presented with nearly 100 items on health and wellbeing and survey fatigue becomes prominent for items at the end of a web survey when the length of the survey is considerable (Galesic & Bosnjak, 2009).

The attempt to evaluate associations between the GPAQ activity scores and health scales from the 2013 SLAQ also served to motivate this thesis work. During the development of the 2013 SLAQ, objectives put forward by the graduate students involved in the project, such as

questioning how strongly associated physical activity and health factors were in a sample of university students, were influenced by previous research that served as a reference base. Additionally, a goal of the SLAQ project was the potential comparison of study findings on the health status and behaviours of students from the 2013 SLAQ to University of Alberta students from future SLAQ studies, national and international universities, and subsamples of the population. The inconsistencies perceived regarding correlations prompted questions on whether a direct comparison between the outcome scores provided by the GPAQ could be made with the scale scores derived from the 2013 SLAQ questionnaires.

It was previously highlighted that physical activity levels in Canada are relatively low (Colley et al., 2011). As such, it is plausible to assume that the majority of individuals in a given sample might be relatively inactive. Different levels of activity, or inactivity, in a given sample might therefore lead to distorted distributions of activity scores, which Thomas and Thomas (2002) suggest occurs frequently in both the objective and subjective assessment of physical activity. A histogram of the GPAQ total activity scores indicated that the distribution of scores in the student sample was positively skewed (Figure 1-1). One potential approach to handling skewed data from the 2013 SLAQ could have included truncating outliers and potentially transforming scores through data transformation techniques, such as logarithmic transformations or square root transformations. Examples of data transformations performed for the evaluation of associations are available in the current physical activity literature. However, approaching the data through transformations was viewed as potentially troublesome and limiting as there is no standard approach used for transforming physical activity data, which is evidenced by the use of a square root transformation in a study by Davey and Cochrane (2013) and a logarithmic transformation in a study conducted by Ferrari, Friedenreich, and Matthews (2007).

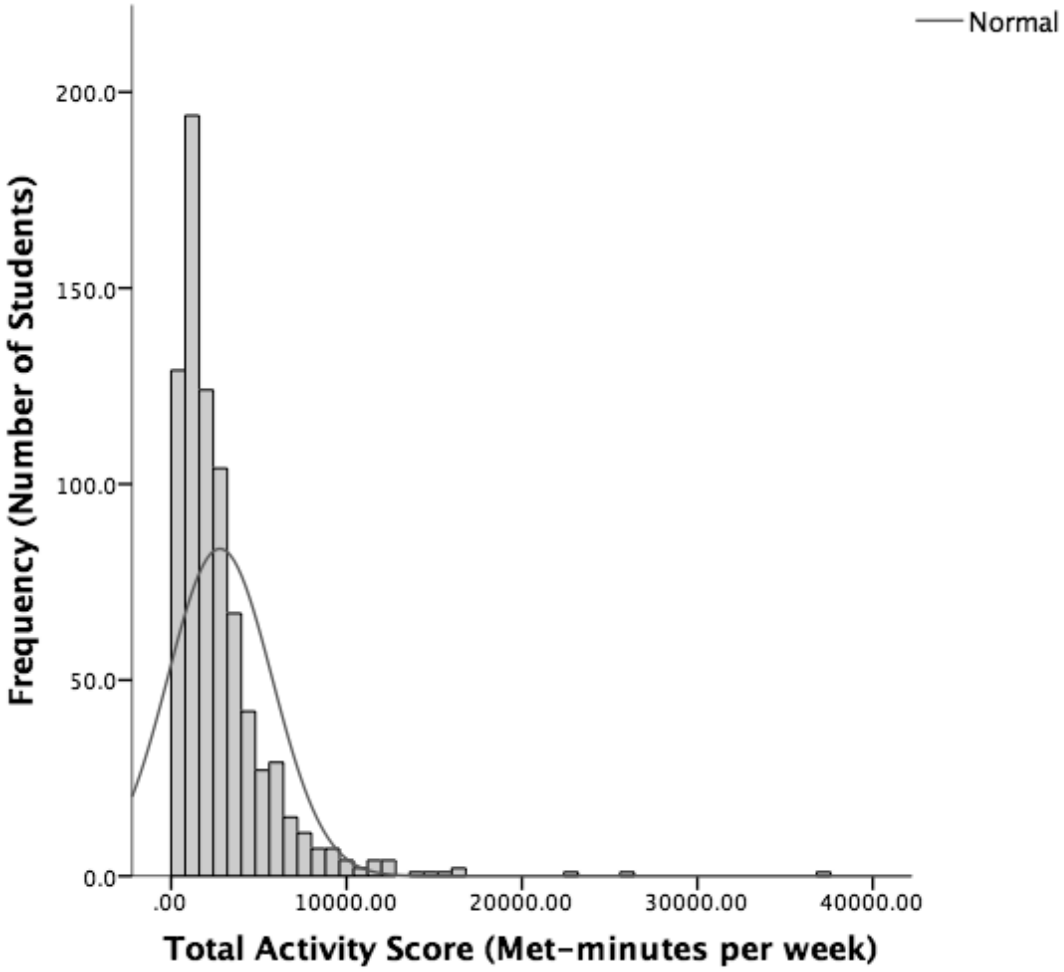


Figure 1-1. **Frequency Distribution of 2013 SLAQ GPAQ Total Activity Scores**

Discussions between the author of this thesis and graduate supervisor served to ultimately guide the research direction taken by this thesis. It was suggested to the author that the potential comparison of associations for the physical activity data obtained by the GPAQ would be unique to the sample of students at the University of Alberta and difficult to replicate and generalize if the GPAQ scores were modified through truncating outliers and performing data transformations. More specifically, this thesis was guided by the assumption that the student GPAQ scores, in the context of the SLAQ, might be suboptimal for evaluating associations. It was suggested that if the evaluation of associations between the GPAQ and SLAQ scale scores potentially required approaching the data through transformations then the interpretation of

associations would be rendered unique and difficult to replicate. The assumption of uniqueness stemmed from the fact that there is no standard approach to transforming data from the GPAQ (i.e., there is no single stable transformation procedure included in the scoring algorithm of the GPAQ).

Additionally, the author of this thesis was guided by the suggestion that data transformations might make findings difficult to compare across studies as the question becomes which transformation is appropriate, if there is no standard approach provided, as the choice of transformation might differ dramatically depending on the sample of interest, such as students in the SLAQ, seniors, and individuals from different socioeconomic groups. Ultimately, this thesis work is guided by the assumption that the evaluation of associations in the SLAQ might require similarly designed instruments, which for the SLAQ are scale scores.

Findings from cross-sectional research on the relationships between university student perceived stress, self-esteem, and physical activity add to the suggestion that MET-based questionnaires might be problematic when used in cross-correlation questionnaire research for a student sample (Hubbs, Doyle, Bowden, & Doyle, 2012). More specifically, the study utilized the WHO International Physical Activity Questionnaire (IPAQ) (Booth et al., 2003) to assess physical activity participation and found no correlation between activity scores generated from the IPAQ and perceived stress. For the study, both the self-esteem and perceived stress questionnaires were scored as scales. In contrast, the IPAQ, as the predecessor of the GPAQ, was scored by according to energy expenditure. While the study did not investigate whether the direct comparison of activity scores to scale scores was problematic, Hubbs, Doyle, Bowden, and Doyle (2012) reported that the lack of correlation was surprising given previous literature on the associations between physical activity and health. As the GPAQ is a modified and updated

version of the IPAQ (Armstrong & Bull, 2006), the lack of correlation observed in both studies casts doubt on the utility of MET-based questionnaires in cross-sectional studies examining student health associations.

In contrast, one of the applications of using closed- or fixed-choice response options in survey research is that fixed-response items can be used to generate average scale scores or indices that provide simple outcomes that are broad indicators of a health behaviour (Rattray & Jones, 2007). For example, the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) used in the SLAQ assessed stress by asking students how often (from 0: Never to 4: Very often) they felt stressed by a range of stressors. When the stressor item total was averaged, the Perceived Stress Scale provided an overall unidimensional score that served as a general indicator of perceived stress with higher values assessing higher self-perceived stress. While ascribed METs have been effectively used to categorize individuals according to activity thresholds (e.g. less than 300 MET-minutes per week = inactive) (Armstrong & Bull, 2006), the exploration of associations between physical activity and health in future iterations of the SLAQ might require physical activity assessment instruments that provide a broad indicator of physical activity behaviour and are formatted similarly to the questionnaires used in the SLAQ (i.e., fixed-response).

Therefore, this thesis was designed to address the limitations of the 2013 SLAQ by reviewing questionnaires used to assess physical activity and determining whether the current literature provided suitable questionnaires for use in the 2014 iteration of the SLAQ. In addition, the review also focused on whether the questionnaires assessed physical activity behaviours that were more representative of university students. The following section presents a general

overview of the current physical activity questionnaires used to assess physical activity behaviour along with a discussion on the outcomes that are derived from activity questionnaires.

1.5 Literature Review: Physical Activity Questionnaires

Physical activity questionnaires provide a feasible option for measuring population-level activity levels and offer a simple method for gathering information on a large sample in a short period of time (Warren et al., 2010). In addition, physical activity questionnaires offer researchers the ability to describe context specific activity behaviours (Warren et al., 2010) and develop a working history for longitudinal studies. Public health professionals are also able to use self-report questionnaires to gauge population trends and develop, as well as monitor, potential health strategies (Bauman, Phongsavan, Schoeppe, & Owen, 2006). Physical activity questionnaires primarily assess activity behaviour through evaluating physical activity participation. More specifically, these questionnaires are typically structured to assess the frequency with which physical activity is undertaken, the intensity or energy expenditure associated with activity, the type of activities undertaken, and the duration of the activity. Physical activity questionnaires also often take into account different domains of activity, such as: leisure-time physical activity, occupational activity, and transport (Caspersen et al., 1985).

1.5.1 Outcomes Derived from Physical Activity Questionnaires

A large range of questionnaires assessing physical activity behaviour is available for public health use, offering numerous assessment outcomes. Examples of the different types of outcomes that physical activity questionnaires provide include: calculations of energy expenditure, reported time engaged in activities, and dimensionless scores of activity participation. While this review will focus on discussing the outcomes provided by physical

activity questionnaires in order to assess activity participation, consideration is also given to reviewing the contexts and items questionnaires use to produce outcomes.

The current literature indicates that energy expenditure is the predominant outcome used to assess activity participation. This method, while subjective, attempts to provide a similar outcome to objective methods by categorizing individuals according to units of energy expenditure. Moreover, physical activity questionnaires primarily assess energy expenditure in the form of ascribed metabolic equivalents (METs) (Ainsworth et al., 2000). As previously mentioned, MET-based questionnaires focus on the intensity of activities performed and quantify intensity by comparing the energy expended during any activity to energy expenditure at rest. A potential benefit of categorizing individuals according to their self-reported energy expenditure is that the resulting information could be used to provide a means for identifying what proportion of a sample is in need of possible attention (e.g. those not meeting a specified threshold). While the previous sections have cast doubt on the utility of MET-based questionnaires for omnibus surveys of student health and wellness, MET-based questionnaires have been used successfully to assess physical activity at both the national and international level. In addition, while the findings from the 2013 SLAQ suggests that MET-based questionnaires be excluded from consideration in the 2014 SLAQ, the majority of questionnaires available in the current literature provide outcomes that are based on energy expenditure. Therefore, a review of the contextual items used by MET-based questionnaires might provide valuable insight into the types of activities that are relevant for a student population. Examples of international questionnaires include the aforementioned WHO International Physical Activity Questionnaire (IPAQ) (Booth et al., 2003) and the Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006). One of the benefits of using internationally recognized physical activity questionnaires is that the

findings provide a potential means of comparing cross-global activity behaviours in one subset of a population to activity behaviours from another. Although difficulties were experienced with the GPAQ data in regards to using MET-minutes per week scores to evaluate associations among university students in the SLAQ, the data obtained might provide useful insight into the proportional differences between students not meeting activity thresholds versus subsamples of the global population (e.g. other university students). Research objectives focused on comparing activity levels might benefit from using MET-based questionnaires, such as the GPAQ and IPAQ, as evidence supports the reliability of both questionnaires. More specifically, in a 12-country reliability and validity study, Craig et al. (2003) found that the IPAQ had a 1-week test-retest pooled coefficient of $\rho = 0.81$ (95% CI 0.79-0.82). In addition, among the same cohort of 774 adults, self-reported IPAQ results had a pooled correlation of $\rho = 0.33$ (95% CI 0.26-0.39) to CSA accelerometer activity counts (Craig et al., 2003).

MET-based questionnaires have also been used nationally to assess physical activity. However, reviewing the current state of physical activity questionnaires indicated that items used to assess activity behaviours became more contextualized as the population of interest became more specified. For example, the New Zealand Physical Activity Questionnaire (NZPAQ) is a modified form of the IPAQ that added items in order to broaden the scope of activities assessed (McLean & Tobias, 2004). More specifically, a review of the NZPAQ by Moy, Scragg, McLean, and Carr (2008) suggested that the addition of activities on domestic work, organized sport, and informal leisure-time and recreational pursuits were advantageous for assessing the totality of physical activity and increasing the accuracy of population-level assessments in the short term. The differences between the NZPAQ and IPAQ were examined in a study of 36 adults comparing of the average energy expenditure (AEE) calculated from the NZPAQ and IPAQ to

doubly labeled water (DLW) (Maddison et al., 2007). While the study indicated that the NZPAQ ($r = 0.38$, $p < 0.05$) showed stronger correlation to the DLW AEE relative to IPAQ ($r = 0.31$, $p < 0.05$) (Maddison et al., 2007), this review focused on the potential effect including domestic, sport, and recreational pursuit activities might have on broadening the ability of the SLAQ to assess student activity behaviours relative to the domains used in the GPAQ and IPAQ. Further examples of questionnaires that calculated MET scores to assess daily physical activity include: the Flemish Physical Activity Computerized Questionnaire (FPACQ) (Matton et al., 2007), the Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH) (Wendel-Vos, Schuit, Saris, & Kromhout, 2003), and the Past Year Total Physical Activity Questionnaire (PYTPAQ) (Friedenreich et al. 2005). Reviewing the items used by MET-based questionnaires to assess daily activities provided additional insight into activities that may be relevant to a student population. For example, the daily activity behaviours assessed included specialized items such as home and garden activities (i.e., cooking, cleaning, maintenance), sports and fitness, sitting at school, and stair climbing (Friedenreich et al., 2005; Matton et al., 2007; Wendel-Vos, Schuit, Saris, & Kromhout, 2003).

Physical activity questionnaires are also available that target specific activity domains such as occupational activities. Similar to general MET-based questionnaires, occupational questionnaires provide an assessment of physical activity through the frequency with which an individual engages in strenuous labour as well as their time spent sitting. While questionnaires designed to assess occupational-specific activity behaviours might not be particularly relevant for assessing university student activity behaviours, reviewing the current state of occupational physical activity questionnaires suggests that the SLAQ consider including items on the time spent sitting at a desk. Examples of occupation-specific questionnaires include: the Tecumseh

Occupational Physical Activity Questionnaire (TOPAQ) (Reiff et al., 1967), the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) (Chau et al., 2012), and the Occupational Physical Activity Questionnaire (OPAQ) (Reis et al., 2005). MET-based questionnaires have also been formatted successfully to evaluate specific activity behaviours, such as the assessment of walking behaviour in the Neighborhood Physical Activity Questionnaire (NPAQ) (Giles-Corti et al., 2006).

While the majority of questionnaires assessing physical activity behaviour through energy expenditure use ascribed METs from the Compendium of Physical Activities (Ainsworth et al., 2011), alternate units of assessment are available for public health use. For example, the Minnesota Leisure Time Activity Questionnaire (MLTAQ) calculates energy expenditure according to intensity codes that were based on experimentation in which rates of oxygen consumption (VO_2) were measured while various specific activities were performed (Taylor et al., 1978). In addition, the Seven-Day Physical Activity Recall (SDAR) calculated energy expenditure in terms of kilocalories per kilogram per day (kcal/kg/d) (Sallis et al., 1985). While the potential impact on assessment that differences in assigned intensities may have is important to consider, the review focused on the items used by the questionnaires. In particular, the MLTAQ included an array of items on walking such as the frequency with which stairs are voluntarily taken when elevators and escalators are available, exercising at home or a health club, and lawn and home repair (Taylor et al., 1978). Additional outcomes provided by physical activity questionnaires include assessing physical activity behaviour in units of time. For example, the Canadian School Health Action, Planning and Evaluation System (SHAPES) physical activity questionnaire calculated physical activity behaviour in units of minutes/week (Wong, Leatherdale, & Manske, 2006). Although energy expenditure dominates the literature on

physical activity assessment, findings from a study on the reliability and validity of the SHAPES physical activity questionnaire in comparison to accelerometer data suggested that units of self-reported time spent being active is a valid and viable means of assessing activity behaviour (Wong, Leatherdale, & Manske, 2006). However, a difficulty observed with questionnaires such as the SHAPES that try to provide a detailed picture of self-reported time spent participating in physical activities is that they tend to include a large set of items (e.g. the 45 items used in the SHAPES questionnaire). In addition, Wong, Leatherdale, and Manske (2006) indicate that over reporting is equally problematic for time-outcome questionnaires when activity recall incorporates specified times (e.g. hours and minutes). The items used in the SHAPES questionnaire were similar to the items used by questionnaires calculating energy expenditure, such as the frequency of sport participation. However, the questionnaire did include environmental items such as the opportunities to participate in physical activity as well as assessing indoor and outdoor activity participation (Wong, Leatherdale, & Manske, 2006).

1.5.2 Physical Activity Questionnaires and Dimensionless Scoring

A slightly alternate measurement approach used in physical activity questionnaires is dimensionless scoring in the form of calculated scales and indices. The slight difference between these questionnaires and questionnaires that provide overall energy expenditure and duration information is that index and scale scored questionnaires provide an indication of physical activity participation that is not predicated upon set units (e.g. METs, kcal, minutes, etc.). However, it is important to note that many of these questionnaires use energy expenditure prompts in their questions. For example, the Godin Leisure-Time Exercise Questionnaire (GLTEQ) consists of three simple items that ask individuals to report how many times per week they engaged in strenuous, moderate, and mild exercises with examples provided for reference

(Godin & Shephard, 1985). The three responses are multiplied by equivalent MET scores and summed to provide the GLTEQ index score, which is expressed in terms of activity units (Godin & Shephard, 1985). A significant difference between the MET-scores produced by the open-structured questionnaires such as the GPAQ and the GLTEQ is that the response format of the GLTEQ is relatively fixed (i.e., frequency is expressed between 0 and 7). As an objective of the current review was to determine whether dimensionless questionnaires provide a viable means for examining direct associations, an important discovery during the review included the findings from a study on the association between exercise and quality of life in multiple myeloma cancer survivors (Jones et al., 2004) where exercise behaviour was assessed by the GLTEQ and quality of life was assessed by the Functional Assessment of Cancer Therapy–General Cancer (FACT-G) scale (Cella et al., 1993). While the study was conducted in a specialized sample, the findings provided evidence to suggest that an index score serving as an indicator of physical activity could be used to evaluate linear associations between activity and the FACT-G subscales of social, emotional, and functional wellbeing as well as depression (Cella et al., 1993). However, a noted limitation of the GLTEQ is that the outcome primarily assesses structured physical activity (i.e. sports) (Jacobs, Ainsworth, Hartman, & Leon, 1993). Further examples of questionnaires providing a summative score include: the Physical Activity Scale for the Elderly (PASE) (Washburn, Smith, Jette, & Janney, 1993), the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) (Washburn, Zhu, McAuley, Frogley, & Figoni, 2002), the Rapid Assessment of Physical Activity (RAPA) (Topolski et al., 2006), the Paffenbarger Physical Activity Questionnaire (PPAQ) (Paffenbarger et al., 1993), and the Yale Physical Activity Survey (YPAS) (Dipietro, Caspersen, Ostfeld, & Nadel, 1993).

Furthermore, physical activity scoring can also be achieved through information from fixed-option responses. These questionnaires require individuals to evaluate a statement or question by selecting one option from a spectrum of ordered responses. Fixed-ordered items, such as Likert-type or frequency-ordered items, are frequently used in survey research (McLafferty, 2003). A benefit of using these types of questionnaires for health promotion purposes is that fixed-type questionnaires are easy to understand and can be scored with ease (McLafferty, 2003). Examples of fixed-response activity questionnaires include the Baecke Physical Activity Questionnaire (BPAQ) (Baecke, Burema, & Frijters, 1982), the Kaiser Physical Activity Survey (KPAS) (Sternfeld, Ainsworth, & Quesenberry, 1999), and the Brunel Lifestyle Physical Activity Questionnaire (BLPAQ) (Karageorghis, Vencato, Chatzisarantis, & Carron, 2005). These questionnaires often assess physical activity behaviour through arbitrarily fixed frequency items that are scored from least to most. For example, the BPAQ assessment of habitual physical activity uses items where the response format is structured from 1: Never to 5: Always (Baecke, Burema, & Frijters, 1982). The overall outcome score is calculated by averaging the responses for the items. Similar to the GLTEQ previously discussed, the findings from a study displaying linear correlations using the BPAQ and SF-36 quality of life questionnaire (Ware & Sherbourne, 1992) provides further evidence that indices and scale scores would provide the SLAQ with a viable means of examining associations (Vancampfort et al., 2011). However, a difficulty observed with the BPAQ is that half of the items used in the questionnaire are specific to occupational activities. One of the benefits offered by questionnaires designed to provide a dimensionless measure of activity is the ability to use expanded or broader items that incorporate activity-related behaviours. For example, the questionnaire developed by Baecke, Burema, and Frijters (1982) assessed habitual activity

behaviours by incorporating items linked with activity participation, such as how often a person sweats, walks, sits, and plays sports.

1.5.3 Questionnaire Development

In reviewing the activity questionnaires available for use in the 2014 iteration of the SLAQ, there did not appear to be any questionnaires available where assessment and validation was focused on Canadian university students. Of the questionnaires reviewed, the Godin Leisure-Time Exercise Questionnaire (GLTEQ) and the Baecke Physical Activity Questionnaire (BPAQ) offer the most promise for the 2014 SLAQ, as both have shown utility in providing scores that have been used in correlation research (Jones et al., 2004; Vancampfort et al., 2011). However, a difficulty noted with using the GLTEQ is that the focus of the questionnaire is almost exclusively limited to structured or organized activity participation (Jacobs, Ainsworth, Hartman, & Leon, 1993). In addition, a limitation of the BPAQ is that the items were developed to assess habitual activity for a sample that is primarily employed. For example, the BPAQ overall score includes an item where occupations are assigned values (1, 3, or 5) for low (e.g. shop keeping), middle (e.g. carpentry), and high (e.g. construction) level employment (Baecke, Burema, & Frijters, 1982). The use of occupational specific items may limit the scope of activities assessed by the 2014 SLAQ, as full-time employment is generally uncommon among university students. In addition, while questionnaires were available where the items included were potentially relevant for a student sample (e.g. exercising, taking the stairs, household activities, etc.), there did not appear to be any questionnaires available where items used were developed and designed for usability with university students as the frame of reference. In reviewing the current literature on physical activity questionnaires, one approach used to develop questionnaires for a sample of interest included using factor analysis to determine whether similarly designed activity items can

be grouped together in order to provide an overall assessment of physical activity behaviour. As a technique, factor analysis is a method of investigating the interrelationships among a set of variables in a given population (Beavers et al., 2013). For example, the 16 items used to assess habitual physical activity in the BPAQ were selected from a pool of 29 original items after Baecke, Burema, and Firjters (1982) used factor analysis to reduce the number of activity-related items used in order to provide a simple score. Essentially, factor analysis allows researchers to distribute a broad set of items developed to assess an outcome of interest (e.g. physical activity participation) and examine how, and which, items statistically group together through loading values. These groupings are termed factors and the items included can be averaged to provide a score. This score, it is argued, provides an assessment of the outcome of interest (Comrey & Lee, 2013). The final activity-related items used in the BPAQ were determined to be an effective indicator of physical activity participation as they had strong factor loadings and were tested in a sample of interest (i.e., the general Dutch population). In addition to the BPAQ, factor analytic techniques were also used in the development of the Brunel Lifestyle Physical Activity Questionnaire (BLPAQ) (Karageorghis, Vencato, Chatzisarantis, & Carron, 2005), which was developed to provide researchers with an instrument that allowed theories on unplanned and planned physical activity to be tested.

As outlined by this review, there have currently been no questionnaires constructed where the items included were evaluated in a Canadian university setting. Therefore, this review suggests that survey research might benefit from the development of a questionnaire where items are designed to focus on student-relevant behaviours and tested in a student population through factor analytic techniques. Given that the purpose of this review was to examine whether questionnaires were available for use in the 2014 SLAQ, the development of a questionnaire

designed to assess Canadian university student physical activity behaviours through factor analysis seemingly addresses the limitations of the 2013 SLAQ and addresses a potential knowledge gap.

1.6 Goals and Objectives

The overall goal of this thesis is to add to the practice of physical activity assessment in the Canadian university context. In doing so, the objectives of this thesis include a) developing a simple questionnaire focused on the physical activity of university students and b) exploring potential associations between physical activity and various indicators of self-reported health.

1.7 Thesis Organization

This thesis is organized in four chapters and presented as a paper-based thesis wherein each research objective stands alone as an unpublished original manuscript. Each chapter includes an abstract and uses data gathered from the 2014 Student Life Activity Questionnaire. Chapter two represents the first objective of this research in outlining the steps taken in developing a simple and broad indicator of student physical activity through factor analytic techniques on a set of developed questionnaire items. Chapter three represents the second objective of this research, which is the examination of potential associations of student health and wellbeing. The following associations related to physical activity and health in the university context will be examined: 1) the association between physical activity and perceived stress, 2) the association between physical activity and personal wellbeing, 3) the association between physical activity and sleep quality, and 4) The association between physical activity and positive nutritional behaviours. Chapter four represents the overall conclusion of this thesis and discusses limitations and implications for future research.

1.8 References

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., ... & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise*, *32*(9; SUPP/1), S498-S504.

Anis, A. H., Zhang, W., Bansback, N., Guh, D. P., Amarsi, Z., & Birmingham, C. L. (2010). Obesity and overweight in Canada: an updated cost-of-illness study. *Obesity Reviews*, *11*(1), 31-40.

Armstrong, T., & Bull, F. (2006). Development of the World Health Organization global physical activity questionnaire (GPAQ). *Journal of Public Health*, *14*(2), 66-70.

Baranowski, T., Mendlein, J., Resnicow, K., Frank, E., Cullen, K. W., & Baranowski, J. (2000). Physical activity and nutrition in children and youth: an overview of obesity prevention. *Preventive Medicine*, *31*(2), S1-S10.

Bauman, A., Phongsavan, P., Schoeppe, S., & Owen, N. (2006). Physical activity measurement-a primer for health promotion. *Promotion & Education*, *13*(2), 92-103.

Beavers, A. S., Lounsbury, J. W., Richards, J. K., Huck, S. W., Skolits, G. J., & Esquivel, S. L. (2013). Practical considerations for using exploratory factor analysis in educational research. *Practical Assessment, Research & Evaluation*, *18*(6), 1-13.

Biddle, S. J., Gorely, T., Pearson, N., & Bull, F. C. (2011). An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 1.

Bishara, A. J., & Hittner, J. B. (2012). Testing the significance of a correlation with nonnormal data: comparison of Pearson, Spearman, transformation, and resampling approaches. *Psychological Methods*, *17*(3), 399.

Booth, M. (2000). Assessment of physical activity: an international perspective. *Research Quarterly for Exercise and Sport*, *71*(sup2), 114-120.

Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *195*(9131/03), 3508-1381.

Byrne, A., & Byrne, D. G. (1993). The effect of exercise on depression, anxiety and other mood states: a review. *Journal of Psychosomatic Research*, *37*(6), 565-574.

Caspersen, C. J., Bloemberg, B. P., Saris, W. H., Merritt, R. K., & Kromhout, D. (1991). The prevalence of selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen Study, 1985. *American Journal of Epidemiology*, *133*(11), 1078-1092.

Cella, D. F., Tulsky, D. S., Gray, G., Sarafian, B., Linn, E., Bonomi, A., ... & Brannon, J. (1993). The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. *Journal of Clinical Oncology*, *11*(3), 570-579.

Chau, J. Y., Van der Ploeg, H. P., Dunn, S., Kurko, J., & Bauman, A. E. (2012). Validity of the occupational sitting and physical activity questionnaire. *Medicine & Science in Sports & Exercise*, *44*(1), 118-125.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Cohen, S., & Rodriguez, M. S. (1995). Pathways linking affective disturbances and physical disorders. *Health Psychology*, *14*(5), 374.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, *22*(1), 1-8.

Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician*, *35*(3), 124-129.

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295-301.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., & Oja, P. (2003). and the IPAQ Consensus Group and the IPAQ Reliability and Validity Study Group. International Physical Activity Questionnaire (IPAQ): 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*, 1381-1395.

Cummins, R. A., Eckersley, R., Pallant, J., Van Vugt, J., & Misajon, R. (2003). Developing a national index of subjective wellbeing: The Australian Unity Wellbeing Index. *Social Indicators Research*, *64*(2), 159-190.

Daskapan, A., Tuzun, E. H., & Eker, L. (2005). Relationship between physical activity level and health related quality of life among university students. *Saudi Medical Journal*, *26*(6), 1026-1028.

Dawson, K. A., Schneider, M. A., Fletcher, P. C., & Bryden, P. J. (2007). Examining gender differences in the health behaviors of Canadian university students. *The Journal of the Royal Society for the Promotion of Health*, *127*(1), 38-44.

Deslandes, A., Moraes, H., Ferreira, C., Veiga, H., Silveira, H., Mouta, R., ... & Laks, J. (2009). Exercise and mental health: many reasons to move. *Neuropsychobiology*, *59*(4), 191-198.

Dipietro, L., Caspersen, C. J., Ostfeld, A. M., & Nadel, E. R. (1993). A survey for assessing physical activity among older adults. *Medicine & Science in Sports & Exercise*.

Edgell, S. E., & Noon, S. M. (1984). Effect of violation of normality on the t test of the correlation coefficient. *Psychological Bulletin*, *95*(3), 576.

Fox, K. R. (1999). The influence of physical activity on mental well-being. *Public Health Nutrition*, *2*(3a), 411-418.

Friedenreich, C. M., Courneya, K. S., Neilson, H. K., Matthews, C. E., Willis, G., Irwin, M., Troiano, R., & Ballard-Barbash, R. (2006). Reliability and validity of the past year total physical activity questionnaire. *American Journal of Epidemiology*, *163*(10), 959-970.

Galesic, M., & Bosnjak, M. (2009). Effects of questionnaire length on participation and indicators of response quality in a web survey. *Public Opinion Quarterly*, *73*(2), 349-360.

Giles-Corti, B., Timperio, A., Cutt, H., Pikora, T. J., Bull, F. C., Knuiman, M., ... & Shilton, T. (2006). Development of a reliable measure of walking within and outside the local neighborhood: RESIDE's Neighborhood Physical Activity Questionnaire. *Preventive Medicine*, *42*(6), 455-459.

Good, P. (2009). Robustness of Pearson correlation. *InterStat*, *15*(5), 1-6.

Griffith, L. E., Cook, D. J., Guyatt, G. H., & Charles, C. A. (1999). Comparison of open and closed questionnaire formats in obtaining demographic information from Canadian general internists. *Journal of Clinical Epidemiology*, *52*(10), 997-1005.

Haase, A., Steptoe, A., Sallis, J. F., & Wardle, J. (2004). Leisure-time physical activity in university students from 23 countries: associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*, *39*(1), 182-190.

Havlicek, L. L., & Peterson, N. L. (1977). Effect of the violation of assumptions upon significance levels of the Pearson r. *Psychological Bulletin*, *84*(2), 373.

Health Council of Canada. (2007). Why Health Care Renewal Matters: Learning from Canadians with Chronic Health Conditions. Toronto: Health Council. www.healthcouncilcanada.ca.

Heath, G. W., & Fentem, P. H. (1996). Physical activity among persons with disabilities--a public health perspective. *Exercise and Sport Sciences Reviews*, *25*, 195-234.

Irwin, J. D. (2004). Prevalence of University Students' Sufficient Physical Activity: A Systematic Review 1. *Perceptual and Motor Skills*, *98*(3), 927-943.

Jacobs Jr, D. R., Ainsworth, B. E., Hartman, T. J., & Leon, A. S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise*, *25*(1), 81-91.

Jones, L. W., Courneya, K. S., Vallance, J. K., Ladha, A. B., Mant, M. J., Belch, A. R., ... & Reiman, T. (2004). Association between exercise and quality of life in multiple myeloma cancer survivors. *Supportive Care in Cancer*, *12*(11), 780-788.

Karageorghis, C. I., Vencato, M. M., Chatzisarantis, N. L. D., & Carron, A. V. (2005). Development and initial validation of the Brunel lifestyle physical activity questionnaire. *British journal of sports medicine*, *39*(5), e23-e23.

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. *Canadian Medical Association Journal*, *163*(11), 1435-1440.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology*, *29*(1), 90-115.

Keating, X. D., Guan, J., Piñero, J. C., & Bridges, D. M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health*, *54*(2), 116-126.

Kohl III, H. W. (2001). Physical activity and cardiovascular disease: evidence for a dose response. *Medicine & Science in Sports & Exercise*, *33*(6 Suppl), S472-83.

Kohl III, H. W., Fulton, J. E., & Caspersen, C. J. (2000). Assessment of physical activity among children and adolescents: a review and synthesis. *Preventive Medicine*, *31*(2), S54-S76.

Lee, I. M., & Skerrett, P. J. (2001). Physical activity and all-cause mortality: what is the dose-response relation?. *Medicine & Science in Sports & Exercise*, *33*(6; SUPP), S459-S471.

Lee Rodgers, J., & Nicewander, W. A. (1988). Thirteen ways to look at the correlation coefficient. *The American Statistician*, *42*(1), 59-66.

Leslie, E., Sparling, P. B., & Owen, N. (2001). University campus settings and the promotion of physical activity in young adults: lessons from research in Australia and the USA. *Health Education*, *101*(3), 116-125.

Maddison, R., Mhurchu, C. N., Jiang, Y., Vander Hoorn, S., Rodgers, A., Lawes, C. M., & Rush, E. (2007). International physical activity questionnaire (IPAQ) and New Zealand physical activity questionnaire (NZPAQ): A doubly labelled water validation. *International Journal of Behavioral Nutrition and Physical Activity*, *4*(1), 62.

Matton, L., Wijndaele, K., Duvigneaud, N., Duquet, W., Philippaerts, R., Thomis, M., & Lefevre, J. (2007). Reliability and validity of the Flemish Physical Activity Computerized Questionnaire in adults. *Research Quarterly for Exercise and Sport*, *78*(4), 293-306.

McLean, G., & Tobias, M. (2004). The New Zealand Physical Activity Questionnaires: Report on the validation and use of the NZPAQ-LF and NZPAQ-SF self-report physical activity survey instruments. SPARC.

McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Leisure-time physical activity in school environments: an observational study using SOPLAY. *Preventive Medicine*, *30*(1), 70-77.

McLafferty, S. L. (2003). Conducting questionnaire surveys. *Key Methods in Geography*, 87-100.

Moy, K. L., Scragg, R. K., McLean, G., & Carr, H. (2008). The New Zealand Physical Activity Questionnaires: validation by heart-rate monitoring in a multiethnic population. *Journal of Physical Activity & Health*, *5*, S45.

Myers, J. L., Well, A., & Lorch, R. F. (2010). *Research design and statistical analysis*. Routledge.

Nguyen-Michel, S. T., Unger, J. B., Hamilton, J., & Spruijt-Metz, D. (2006). Associations between physical activity and perceived stress/hassles in college students. *Stress and Health*, *22*(3), 179-188.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, *15*(5), 625-632.

Rennie, K. L., & Wareham, N. J. (1998). The validation of physical activity instruments for measuring energy expenditure: problems and pitfalls. *Public Health Nutrition*, *1*(04), 265-271.

Paffenbarger Jr, R. S., Blair, S. N., Lee, I. M., & Hyde, R. T. (1993). Measurement of physical activity to assess health effects in free-living populations. *Medicine & Science in Sports & Exercise*, *25*(1), 60-70.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., ... & Wilmore, J. H. (1995). Physical activity and public health: a recommendation from the Centers for

Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, *273*(5), 402-407.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189-193.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 56.

Rattray, J., & Jones, M. C. (2007). Essential elements of questionnaire design and development. *Journal of Clinical Nursing*, *16*(2), 234-243.

Reiff, G. G., Montoye, H. J., Remington, R. D., Napier, J. A., Metzner, H. L., & Epstein, F. H. (1967). Assessment of physical activity by questionnaire and interview. *Journal of Sports Medicine and Physical Fitness*, *7*(3), 135-142.

Reja, U., Manfreda, K. L., Hlebec, V., & Vehovar, V. (2003). Open-ended vs. close-ended questions in web questionnaires. *Developments in Applied Statistics*, *19*, 159-177.

Sallis, J. F., Haskell, W. L., Wood, P. D., Fortmann, S. P., Rogers, T., Blair, S. N., & Paffenbarger, R. S. (1985). Physical activity assessment methodology in the Five-City Project. *American Journal of Epidemiology*, *121*(1), 91-106.

Sallis, J. F., Owen, N., & Fisher, E. B. (2008). Ecological models of health behavior. *Health behavior and health education: Theory, research, and practice*, *4*, 465-486.

Sallis, J. F., & Patrick, K. (1994). Physical activity guidelines for adolescents: consensus statement. *Pediatric Exercise Science*, *6*, 302-302.

Schutz, Y., Weinsier, R. L., & Hunter, G. R. (2001). Assessment of free-living physical activity in humans: an overview of currently available and proposed new measures. *Obesity Research*, *9*(6), 368-379.

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine*, *37*(3), 197-206.

Sothern, M. S. (2004). Obesity prevention in children: physical activity and nutrition. *Nutrition*, *20*(7), 704-708.

Sternfeld, B., Ainsworth, B. E., & Quesenberry, C. P. (1999). Physical activity patterns in a diverse population of women. *Preventive Medicine*, *28*(3), 313-323.

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission*, *116*(6), 777-784.

Taylor, H. L., Jacobs, D. R., Schucker, B., Knudsen, J., Leon, A. S., & Debacker, G. (1978). A questionnaire for the assessment of leisure time physical activities. *Journal of Chronic Diseases*, *31*(12), 741-755.

Thomas, J. R., Nelson, J. K., & Thomas, K. T. (1999). A generalized rank-order method for nonparametric analysis of data from exercise science: a tutorial. *Research Quarterly for Exercise and Sport*, *70*(1), 11-23.

Thomas, J. R., & Thomas, K. T. (2002). Physical activity data: Odd distributions yield strange answers. In G. Welk (Ed.), *Physical Activity Assessments for Health-Related Research* (pp. 73-80). Champaign, IL: Human Kinetics.

Thune, I., & Furberg, A. S. (2001). Physical activity and cancer risk: dose-response and cancer, all sites and site-specific. *Medicine & science in Sports & Exercise*, *33*(6 Suppl), S530-50.

Topolski, T. D., LoGerfo, J., Patrick, D. L., Williams, B., Walwick, J., & Patrick, M. M. B. (2006). Peer Reviewed: The Rapid Assessment of Physical Activity (RAPA) Among Older Adults. *Preventing Chronic Disease*, *3*(4).

Tremblay, M. S., Warburton, D. E., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., ... & Duggan, M. (2011). New Canadian physical activity guidelines. *Applied Physiology, Nutrition, and Metabolism*, *36*(1), 36-46.

Vancampfort, D., Probst, M., Scheewe, T., Maurissen, K., Sweers, K., Knapen, J., & De Hert, M. (2011). Lack of physical activity during leisure time contributes to an impaired health related quality of life in patients with schizophrenia. *Schizophrenia research*, *129*(2), 122-127.

Vogel, T., Brechat, P. H., Leprêtre, P. M., Kaltenbach, G., Berthel, M., & Lonsdorfer, J. (2009). Health benefits of physical activity in older patients: a review. *International Journal of Clinical Practice*, *63*(2), 303-320.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, *174*(6), 801-809.

Ware Jr, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical care*, 473-483.

Warren, J. M., Ekelund, U., Besson, H., Mezzani, A., Geladas, N., & Vanhees, L. (2010). Assessment of physical activity–a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. *European Journal of Cardiovascular Prevention & Rehabilitation*, *17*(2), 127-139.

Welk, G. (Ed.). (2002). *Physical activity assessments for health-related research*. Champaign, IL: Human Kinetics.

Wendel-Vos, G. C., Schuit, A. J., Saris, W. H., & Kromhout, D. (2003). Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *Journal of Clinical Epidemiology*, *56*(12), 1163-1169.

Westerterp, K. R. (2009). Assessment of physical activity: a critical appraisal. *European Journal of Applied Physiology*, *105*(6), 823-828.

Wong, S. L., Leatherdale, S. T., & Manske, S. R. (2006). Reliability and validity of a school-based physical activity questionnaire. *Medicine & Science in Sports & Exercise*, *38*(9), 1593-1600.

Yoo, H. L. (2007). *Relationship between physical activity, perceived stress, and the metabolic syndrome in law enforcement officers*. ProQuest.

Chapter 2: First Manuscript - The Development of a Physical Activity Questionnaire for Canadian University Students

Abstract

Background: The Student Life Activity Questionnaire (SLAQ), conducted in 2013 at the University of Alberta, was a collection of various health-related questionnaires aimed to provide insight into student health. Analysis indicated that the use of an energy expenditure-based activity questionnaire might pose difficulties in the context of the SLAQ. Therefore, this study was designed as an attempt to construct a new student physical activity questionnaire.

Methods: The current study used data from the 2014 SLAQ, which was sent to 4,000 random University of Alberta students in May 2014. Included in the 2014 SLAQ were 14 broad physical activity items, developed by the research team and scored on a 7-point scale, and the Global Physical Activity Questionnaire (GPAQ). Once the SLAQ data was obtained, factor analysis and internal consistency analysis were used to determine whether the set of 14 items could be reduced to a single and reliable factor, serving as the scaled questionnaire. Then, a comparison of the constructed questionnaire and GPAQ scores was performed to assess convergent validity.

Results: Factor analysis findings indicated that a 9-item physical activity questionnaire (PAQ) could be developed from the set of original items with high internal consistency (α= 0.81). Positive Pearson correlations ($p < 0.01$) were observed between the PAQ and the GPAQ total ($r = 0.28$), recreational ($r = 0.46$), and work/school ($r = 0.12$) MET-scores. Significant ($p < 0.01$) positive Spearman correlations were observed between the PAQ and GPAQ transit ($r_s = 0.19$) total ($r_s = 0.45$), recreational ($r_s = 0.60$), and work/school ($r_s = 0.25$) activity MET-scores.

Conclusion: The 9-item PAQ has some promise as an indicator of activity. However, the PAQ cannot be considered a purely behavioural indicator of activity.

2.1 Introduction

Physical activity is an important part of leading a healthy lifestyle (Warburton, Nicol, and Bredin, 2006). The health benefits of engaging in regular physical activity include reduced risks for mortality and chronic disease (Kokkinos, 2012). For example, engagement in physical activity is associated with a reduction in coronary heart disease (CHD) risk (Sesso, Paffenbarger, & Lee, 2000) as well as a reduction in the risk of developing type-2 diabetes across body mass index (BMI) categories in both men and women (InterAct Consortium, 2012). Moreover, routine physical activity has been associated with reduced stress (Warburton, Gledhill, & Quinney, 2001), and reduced anxiety (Landers & Arent, 2001).

Currently, the majority of Canadians are not meeting recommended activity guidelines (Colley et al., 2011) and evidence suggests that 50% of Canadian university students are insufficiently active (Irwin, 2004). These statistics underlie the fact that health promotion efforts are needed to improve physical activity participation. However, there is also limited information available about the association between Canadian university student health correlates such as physical activity, stress, dietary habits, sleep, and personal wellbeing. As students in post-secondary education are faced with numerous challenges to their health and wellness (Regehr, Glancy, & Pitts, 2013), assessment mechanisms that investigate health correlates may be invaluable to stakeholders interested in the health of students (Bauman, Phongsavan, Schoeppe, & Owen, 2006). One method of investigating associations is through the use of omnibus surveys, which are research tools that collect data on a wide variety of topics either through a large collection of focused items or through the inclusion of complete questionnaires.

In 2013, the author of the present study was part of a team of graduate students from the University of Alberta School of Public Health who designed an omnibus survey as a class project

under the supervision of their associate professor. The Student Life Activity Questionnaire (SLAQ) was comprised of health-focused questionnaires on topics such as stress, personal wellbeing, physical activity, nutrition, and coping. The 2013 SLAQ was distributed to 4,000 University of Alberta students and received 975 student responses (24%). During data analysis, the author of this study and his graduate supervisor noted that the 2013 SLAQ had difficulties related to the physical activity instrument used, which was the Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006).

It was suggested that the GPAQ was potentially too difficult for students to use in the context of the SLAQ. One of the factors that contributed to this assumption was the fact that 13% of the students had to be removed during analysis as they were categorized as incomplete cases by the scoring structure of the GPAQ. According to the GPAQ guidelines, a case was considered incomplete or inconsistent if a discrepancy arose between reported activity days and activity times (i.e., activity day = 0 and activity time > 0 or activity day > 0 and activity time = 0) (Armstrong & Bull, 2006). It was therefore deemed problematic that 13% of the sample had to be removed. By chance, the GPAQ was placed at the end of the 2013 SLAQ. It was thought that survey fatigue might have played a role in the high number of incomplete cases as the 2013 SLAQ included over 100 items on health and wellbeing. Furthermore, a difference was noted in the method through which the GPAQ and questionnaires used in the SLAQ obtained information. More specifically, while the majority of questionnaires used in the SLAQ presented students with fixed-choice responses on a rating scale, the GPAQ required students to manually input the number of days and minutes they spent engaged in various activities. This was considered an added difficulty, as open-formatted questions are more prone to biases (Griffith, Cook, Guyatt, & Charles, 1999; Reja, Manfreda, Hlebec, & Vehovar, 2003). Additionally, it was

proposed that future iterations of the SLAQ might benefit from a simple physical activity questionnaire structured to provide a relative scale score of activity compared to the energy expenditure physical activity scores provided by the GPAQ. This was proposed as the questionnaires used in the SLAQ primarily provide health outcomes in the form of scale scores.

Therefore, this study was designed to address perceived issues from the 2013 SLAQ. The present study utilized data from the 2014 SLAQ, which was also led by the author of this paper and conducted in May 2014. The overall objective of the present study was the attainment of a physical activity questionnaire to potentially serve as a broad indicator of student physical activity to be used in evaluating the correlations between physical activity and health factors. By attempting to construct an indicator, the author proposed that the scale score provided by the developed questionnaire might provide a relative assessment of physical activity whereby higher scores will theoretically correspond to higher self-reported activity engagement. This distinction is important to note as the proposed physical activity questionnaire that this study attempted to create is not a measure of activity such as the GPAQ, which attempts to provide a measurement of physical activity through calculations according to a combination of time and energy expenditure units in the form of metabolic equivalents or METs (Ainsworth et al., 2000; Armstrong & Bull, 2006). Instead, the aim of the present study was to develop a simple instrument that could be used to provide a general and broad indication of how active university students potentially are from their responses to a number of self-report items.

Following, this paper will present the rationale used in selecting items for inclusion in the activity questionnaire and describe the statistical technique (i.e., factor analysis) used to determine which items could be effectively considered an indicator of physical activity. Finally, this paper will investigate the convergent validity of the questionnaire through a comparison with

the World Health Organization's Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006), which is a self-report measure of physical activity that uses energy expenditure.

2.2 Methods

The current study utilized data from the 2014 Student Life Activity Questionnaire (SLAQ). The SLAQ is a collection of self-report questionnaires aimed to provide insight into student health and wellbeing and was conducted at the University of Alberta in May 2014. The SLAQ assessment instrument used in present study is the Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull). However, the 2014 SLAQ questionnaires also provided subjective assessments of perceived stress (Cohen, Kamarck, & Mermelstein, 1983), personal wellbeing (Cummins, Eckersley, Pallant, Van Vugt, & Misajon, 2003), physical activity (Armstrong & Bull, 2006), nutrition (Vidgen & Gallegos, 2012), and sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

To accomplish the overall objective of attaining a new physical activity questionnaire focused on university students and serving as a broad indicator of student activity, the author and his graduate supervisors first developed a set of 14 physical activity themed questionnaire items. Next, the set of items were included in the 2014 iteration of the SLAQ. Once data was gathered on the set of items, factor analysis would be used to determine whether an item grouping (i.e., factor) with strong internal properties could be extracted from the original set of items. The final set of items would be considered a new student-related physical activity questionnaire. Finally, the extracted item set would be scaled and the overall score compared to the GPAQ, which was included in the 2014 SLAQ for convergent comparative purposes. While the GPAQ was included to evaluate whether the constructed questionnaire correlated with an established activity questionnaire, the inclusion of the GPAQ would also provide an additional benefit of allowing an

evaluation of whether the purposeful placement of the GPAQ at the front of the SLAQ led to a different percentage of incomplete responses.

Global Physical Activity Questionnaire (GPAQ) - The GPAQ provides a total score of physical activity based on how often individuals engage in high and moderate intensity activities in three settings: occupation, recreation, and transit (Armstrong & Bull, 2006). Metabolic equivalents (METs) are used to characterize intensity (moderate = 4 METs and high = 8 METs) and provide a relative measure of energy expenditure (Ainsworth et al., 2000). For the 2014 SLAQ, students manually inputted how many days per week and minutes per day they engaged in high or moderate intensity activities per each setting. Activity scores were calculated for each SLAQ setting according to intensity. The total score, expressed in units of MET-minutes per week, was calculated as the sum of all activities.

2.2.1 Participants

The University of Alberta Registrar was asked to provide a list of 4,000 randomly selected student email addresses and first names based on enrolment lists. The student population at the University of Alberta numbers close to 40,000, representing 151 countries, and provides a representative sample of the population at large. All students were invited by email to participate in the SLAQ. Students were awarded a credit of $10 on their university identification card (ONEcard) for participating in the study.

2.2.2 Questionnaire Development: Item Format

The development process began with a selection of the format used for the items and response options. For the present study, fixed-response frequency-rated items were developed similar to Likert-type questionnaires as fixed-type questionnaires are easy to understand and can be evaluated with ease (McLafferty, 2003). In respect to the present study, fixed-response

frequency-rated items can be thought of items that require respondents to indicate which option describes their behaviour best from a list of items ranging from least to most (e.g. never to very often). Next, development included the selection of a 7-point item response type. Evidence suggests that 7-point response item type questionnaires add more sensitivity to participant evaluations over 5-point response item type questionnaires (Leung, 2011). While 5-point items traditionally provide accurate information, several recent studies highlight the added robustness and sensitivity of 7-point and 11-point items relative to 5-point items (Finstad, 2010; Leung, 2011). Furthermore, 7-point item response types were selected over 11-type response types to also limit potential respondent fatigue (Leung, 2011).

2.2.3 Questionnaire Development: Conceptual Framework

The guiding framework used to design the questionnaire items stems from facet theory, which is a systematic approach to facilitating theory construction, research design, and data analysis for complex studies, that is particularly appropriate to the behavioral and social sciences (Guttman & Greenbaum, 1998). Facet theory is applicable to the behavioural sciences and particularly useful for defining a construct of interest for assessment purposes (Canter, 2012). In particular, the tenets of facet theory suggest that a finite collection of conceptually related and defined variables (e.g. observed behaviour categories, questionnaire items) can be scaled in order to represent a unidimensional indication of a construct (e.g., physical activity). What is required is the establishment of domains and ranges (Guttman & Greenbaum, 1998). Simplistically, domains are the conceptual components of a construct and ranges provide the basis for quantifying component-specified assessment elements (i.e., items). In essence, facet theory suggests that a set of domain-specific items can be combined to represent a given construct with the determination of conceptual domains, ranges, and item combinations left to the investigator.

The assertion that physical activity behaviours can be described and assessed through conceptual domains is neither new nor limited to the present study. Instead, examples of questionnaires incorporating activity domains span the current literature. As an illustration, the GPAQ will be considered through a facet theory lens. The GPAQ provides a total activity score that is calculated through the summation of separate occupational, recreational, and transit activity scores (Armstrong & Bull, 2006). The GPAQ total score serves as an overall indicator of self-reported physical activity participation. In the language of facet theory, the construct of interest that the GPAQ provides an indication of is physical activity behaviour. However, to generate an indicator of total physical activity, the GPAQ first contextualizes daily activities into conceptually defined activity domains. These domains (occupation, recreation, and transit) represent, in a very broad sense, how daily schedules are organized in the real world. Second, the GPAQ activity domains include subdomains that further divide activities according to their relative intensities (i.e., the empirically determined energy cost associated to performing an activity). Finally, the GPAQ quantifies domain-specific physical activity participation through a biaxial range that is determined by frequency (time reported in minutes) but predicated on the subdomain of intensity (energy expenditure determined by metabolic equivalents or METs) (Ainsworth et al., 2000; Armstrong & Bull, 2006). More specifically, the GPAQ asserts that for each activity domain; the product between a) how frequently activities of various intensities are performed and b) the energy cost attributed to activities of various intensities provides a score that can be subdomain- or domain-summed and used as a strong indicator of physical activity behaviour. It is therefore apparent that principles of facet theory can be applied broadly to physical activity assessment (i.e., assess a construct through conceptually defined domains and set evaluation ranges).

Furthermore, the broad descriptive power and utility of facet theory is evident when contextual questionnaires are also considered. Assessment, as previously mentioned, is predicated upon determined domains and ranges. The strength of approaching assessment through facet theory is that no reservations are made regarding the construct to be assessed as well as the domains and ranges to be established (Canter, 2012). For example, the GPAQ proposes that the domains relevant to daily physical activity participation include occupational, recreational, and transit activities. However, questionnaires have been developed to specifically assess occupational activities (Chau et al., 2012) as a construct of interest and leisure activities (Godin & Shephard, 1985) activities as a construct of interest. Interestingly, a similar approach to questionnaire development is observed for both occupational and leisure questionnaires where domains are determined that can be scaled or summed to provide an overall assessment. For example, the Godin-Leisure Time Exercise Questionnaire is composed of three domains relating to one of three types of exercise: strenuous, moderate, and light (Godin & Shephard, 1985).
As the assessment principles central to facet theory can be applied to describe current physical activity questionnaires, the selection of facet theory principles as a guiding framework and inspiration for the development of a questionnaire on student activity behaviours appeared justified. In addition, Guttman and Greenbaum (1998) suggest that assessment ranges, which are in essence item response options, can be effectively ordered from least-to-most (e.g. frequency of participation). As the development of a fixed-response questionnaire, providing an assessment of student activity behaviours through scores where higher scores related to more frequent activity participation, was the objective of the current study; the ability to relatively order items on a gradient-directed response scale was an important result as it allows the overall score (e.g. the sum or average of the items) to reflect the direction of the response scale. Therefore, the tenets of

facet theory suggest that questionnaire development would benefit most from the selection of a frequency-response scale where the direction of responses increased as the frequency of participation increased.

For this study, the domains of student physical activity were established by utilizing activity themes. Theme establishment was accomplished through feedback discussions on what the author of this paper and his two graduate supervisors subjectively considered were the essential components of physical activity. The discussion began by contemplating what it meant, in a broad sense, to be physically active. That led to viewing physical activity through the current framework used to define physical activity (i.e., movement, exercise, and fitness) (Caspersen, Powell, & Christenson, 1985). Physical activity was broadly understood, through the Caspersen, Powell, and Christenson (1985) definition, as any behaviour that resulted in bodily movement. This broad categorization allowed the author and supervisors to discuss different behaviours rooted in movement. However, the discussions between the author and supervisor also incorporated the distinctions made by Caspersen, Powell, and Christenson (1985) regarding exercise and fitness. That led to conceptualizing physical activity as behaviours resulting in bodily movement that were separate from both exercise and fitness behaviours. A part of process involved in theme establishment included individual reflection on whether the groupings could be extended upon. While the possibility for organizing the active behaviours of daily life could potentially result in numerous themes, the author presented additional themes to his supervisors by proposing whether certain activities related to university students should be considered as stand-alone themes. In particular, these themes were related to what the author understood to be contexts related to student life such as recreation/sports (Downs & Ashton, 2011; Kilpatrick, Hebert, & Bartholomew, 2005) and sitting or being overly sedentary (Grace, 1997; Owen, Healy,

Matthews, & Dunstan, 2010). Once the author received approval from the supervisors regarding the additional themes, the author met with each supervisor to discuss whether additional themes were required or if the established themes could be finalized and used for item selection. In essence, activity themes were used to categorize the broad types of activities that students might primarily engage in as well as encompass the components used to define physical activity. The final list of themes included: movement, exercise, fitness, recreation/sports, and sitting.

2.2.4 Questionnaire Development: Item Selection

The set of items developed attempted to span the general activities associated with a student population. While items were developed to account for each activity theme, the majority of items developed were guided by the broad theme of movement as bodily movement is the central focus of the Caspersen, Powell, and Christenson (1985) definition of physical activity and can encompass a wide range of activities such as walking behaviour, household and maintenance tasks, and leisure behaviour. The attempt to group activities related to bodily movement but not subscribing to exercise or sports has previously been explored in physical activity research. More specifically, the concept of non-exercise activity thermogenesis (NEAT) is an attempt to define and describe the energy expenditure associated with the physical activity of daily life (Levine, Eberhardt, & Jensen, 1999).

To provide a broad assessment of physical activity behaviours, several items were developed where students could report engaging in positive activity behaviours relative to a less active alternative. A review of the current literature on physical activity assessment provides examples of questionnaires where items were included to assess activities where physical activity behaviours included alternatives. As previous research has suggested that using the stairs instead of taking an escalator or elevator is an important activity behaviour relevant to university

students (Grimstvedt et al., 2010), the set of items included an assessment of how often students used stairways over an elevator or escalator. The frequency of stairway use over elevator/escalator use also comprised the Minnesota Leisure-Time Physical Activity Questionnaire (Taylor et al., 1978). A second alternative item included how frequently students chose to spend their leisure time outdoors instead of staying indoors (Thompson et al., 2011). The inclusion of an outdoors item was derived from evidence suggesting that spending leisure time being active outdoors relative to staying indoors was a positive physical activity behaviour (Thompson et al., 2011). Remaining items focused on capturing behaviours relevant to a student population. Lifestyle behaviours such as performing household maintenance and cleaning tasks were included as well as how often students walked for relaxation purposes. The set of movement items also included an item on how often students limited their daily activities to avoid fatigue or exhaustion. Finally, to ensure that the questionnaire encompassed Canadian student behaviours, the current activity guidelines for Canadian adults were included as an item and students asked to indicate how often they met the provided requirements (Tremblay et al., 2011). Therefore, the bodily movement items used included how often: students walked for relaxation/pleasure, performed household tasks, performed maintenance tasks, took the stairs over using an elevator/escalator, spent their leisure time outside rather than inside, limited their daily activities, and met the current Canadian physical activity guidelines for adults.

Two exercise items were included, which consisted of how often students exercised and how often students make time to exercise regardless of their schedule. To ensure that items encompassed exercise behaviour, the Caspersen, Powell, and Christenson (1985) definition of exercise was included as a prompt for students. Furthermore, the questionnaire included one item on how often students actively monitored their level of fitness as self-monitoring has been

identified as a positive health behaviour that is associated with increased activity participation (Anshel & Seipel, 2009). As physical fitness is considered to be a condition (Blair et al., 1995), the monitoring and self-regulation of fitness levels is a potentially relevant behaviour to student populations. Two recreation and sports items were included, which consisted of how often students participated in organized sports and how often students used their academic institutions recreation facilities. Participation in organized sports was included due to the suggestion by several studies that sport participation is an important part of being physically activity (Baumert, Henderson, & Thompson, 1998; Elliot et al., 2004; Khan et al., 2012). The decision to include recreation facility use stems from the fact that university students have access to their institution's recreation facilities, which allows them the opportunity to engage in a variety of recreation activities that are not necessarily organized. Current research makes the case that too much sitting should now be considered an important stand-alone component of the physical activity equation (Dunstan, Howard, Healy, & Owen, 2012). Two items on sitting behaviour were included, which consisted of how often students sat with their computer or television to relax and how often students spent long periods of time sitting or reclining without feeling the urge to get up. Item selection included the frequency with which students spent long periods of time sitting due to evidence highlighting the deleterious effects associated with prolonged sitting (Healy et al., 2008).

Altogether, the questionnaire included 14 items that assessed a number of activity behaviours covering bodily movement (7 items), exercise (2 items), fitness (1 item), recreation and sports (2 items), and sitting (2 items). The complete set of items is available in Appendix A.

2.3 Analysis Procedures

Once the data from the 2014 SLAQ was obtained, several steps were performed to 1) construct the final questionnaire and 2) evaluate both the internal properties and convergent validity of the final questionnaire. Specifically, the order of procedures began with performing factor analysis on the original set of 14 items. This step included multiple iterations whereby items were removed in succession if they did not meet a specified criterion. Following, once an item group was extracted from the factor analysis, internal consistency analysis was performed to determine how closely related items are as a group according to a specific criterion. Finally, the factor-extracted and internally consistent set of items was scaled (i.e., average of their item total) and correlations were calculated between the questionnaire scale scores and GPAQ activity scores. The correlations were calculated in an attempt to observe whether the instrument this study attempted to construct agreed with a previously validated physical activity questionnaire.

2.3.1 Factor Analysis

To determine whether the set of developed items could be grouped to provide a simplified instrument, factor analysis was used to explore item interrelations and variable reduction (Floyd & Widaman, 1995). Factor analysis is a multivariate technique that empirically explores variable or pattern relationships for complex concepts (Comrey & Lee, 2013). Moreover, as a statistical technique, factor analysis has been utilized in the examination of physical activity behaviours (Prochaska, Sallis, Sarkin, & Calfas, 2000). Given a set of items, factor analysis extracts components that account for the maximum possible variance in a set of observations (Floyd & Widaman, 1995). These components are the linear combinations of a set of items that are calculated in succession where each subsequent factor is extracted once the variance from the previous factor is removed (Comrey & Lee, 2013; Floyd & Widaman, 1995).

The components are of particular interest as they are empirically derived groupings, which have been reduced by the data available. For the purposes of this study, the items developed were included for their potential ability to serve as an indicator of physical activity behaviour. It is evident then that factor analysis should uncover whether the items utilized examine a construct, which this paper suggests is an indicator of physical activity behaviour suitable for use in omnibus surveys on health and wellness. Furthermore, factor analysis provides the basis for determining which of the developed items should be excluded from a potential extracted construct through loading values. Loading values are the numerical representation of an item's relationship to the extracted construct (Comrey & Lee, 2013). For an item to be considered factor loaded, the accepted criteria is a loading of ≥ 0.3 (Kline, 2014). Moreover, factor loadings can be both positive and negative. As factor interpretation is improved when items are positively loaded (Floyd & Widaman, 1995), the analyses performed will include reverse-scored items. As a procedure, factor analysis is an iterative process where successive analyses are run after low loading items are removed in sequence (Comrey & Lee, 2013). Items are removed individually in stepwise fashion and analyses performed in succession to account for the differences in overall loadings that occur when single items are removed (Comrey & Lee, 2013). Ultimately, factor analytic techniques should identify an extracted factor that includes the largest number of items.

Several tests are available that provide the basis for determining whether factor analysis is a suitable technique in a given study. These techniques examine the factorability of a set of items through a set of criteria. For the present study, factorability was evaluated through the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO statistic ranges from 0 to 1, with 0.50 the minimum threshold used to determine whether factor analysis would yield reliable factors (Williams, Brown, & Onsman, 2012). Bartlett's test

of sphericity tests the null hypothesis that the original correlation matrix is an identity matrix. More specifically, it is a measure of whether there are relationships between the items included in the factor analysis. A significant test ($p < 0.05$) indicates that factor analysis is appropriate.

While the current study expected to identify a singular factor with maximum item loadings, the process of factor analysis seeks to ensure that the total variance of a data set is accounted for by producing numerous factors. The criterion used to truncate the complete set of factors produced is the eigenvalue of each factor (Comrey & Lee, 2013; Floyd & Widaman, 1995). More specifically, factors are retained with eigenvalues > 1.00 (Comrey & Lee, 2013; Floyd & Widaman, 1995; Hayton, Allen, & Scarpello, 2004; Kaiser, 1960). The eigenvalue > 1.00 rule is also the default retention in a number of statistical software packages such as SPSS, which was the program used in this study.

2.3.2 Internal Consistency and Convergent Validity

Once the finalized set of factor-loaded items was determined, the reliability of the resulting grouping (i.e., the developed questionnaire) was evaluated through the Cronbach's alpha value. Cronbach's alpha is a measure of internal consistency and evaluates how closely related a set of items are as a group with a criterion of 0.7 used to indicate whether a set of items can be considered a reliable construct (Cronbach, 1951; Nunnally, Bernstein, & Berge, 1967; Santos, 1999).

The convergent validity of the resulting questionnaire was also tested. Convergent validity can be thought of as a parameter that is used to evaluate whether there is agreement between two assessment instruments attempting to evaluate similar constructs. According to Kowalski, Crocker, and Kowalski (1997), physical activity assessment instruments, such as objective measures, questionnaires, interviews, and motion sensors, should theoretically be

related to one another. While various instruments are available that attempt to assess either actual or usual activity levels, Kowalski, Crocker, and Kowalski (1997) suggest that it is plausible to expect a relationship between physical activity instruments as they are assessing a similar construct. Moreover, convergent validity is examined through a calculation of correlation coefficients between different instruments attempting to assess the same construct (Macfarlane, Lee, Ho, Chan, & Chan, 2006). Convergent validity is supported when the scores of a new assessment instrument are related to the scores from a previously established instrument assessing similar constructs. Shephard (2003) notes that in the absence of a gold standard for self-reported physical activity assessment, the validity of a newly developed questionnaire can potentially be investigated through a comparison of observations with a criterion-validated questionnaire. Returning to the objective of the present study, the aim of this research was to develop a physical activity questionnaire where the items are focused on university student behaviours and the outcome of interest is a relative scale score of student activity. The present study did not have the ability to empirically evaluate the final questionnaire through objective testing. However, the use of the SLAQ to construct the questionnaire through factor analysis allowed for the convergent validity of the finalized item grouping to be tested against another physical activity instrument, such as the GPAQ. The comparison of the resulting questionnaire scores with the GPAQ may provide support for determining whether the developed instrument is potentially useful for health promotion purposes. While there is no gold standard in subjective physical activity assessment, studies are available where physical activity questionnaires have been compared to criterion (i.e., objective) measures of physical activity such as doubly labeled water (Philippaerts, Westerterp, & Lefevre, 1999; Sallis & Saelens, 2000). Therefore, the developed activity questionnaire was compared with the Global Physical Activity Questionnaire

developed by the World Health Organization (Armstrong & Bull, 2006). While the GPAQ was previously noted to be potentially difficult for use in the context of the SLAQ, the fact remained that the GPAQ provided a potentially useful comparison for the present study as it has been compared to objective measures of physical activity.

The GPAQ is an internationally recognized activity questionnaire that collects information on physical activity participation in three domains (Armstrong & Bull, 2006). The domains of activity include: activity at work, travel to and from places, and recreational activities. The GPAQ provides an assessment of physical activity through an outcome that is a time-derived calculation of the energy expenditure associated with physical activity: MET-minutes (Armstrong & Bull, 2006). Total MET-minute scores were obtained by summing the MET-minute scores associated with each domain. The study computed MET-minute scores through GPAQ responses on how often, in days per week and minutes per day, students engaged in activities of various intensities (e.g. vigorous and moderate). As the GPAQ has shown fair criterion validity with objective measures (Bull, Maslin, & Armstrong, 2009), convergent validity for the present study was established through estimating both the Pearson and Spearman correlation coefficients between the GPAQ activity scores and the developed questionnaire. While the Pearson product-moment correlation coefficient provides a direct means of evaluating correlations (Bishara & Hittner, 2012; Havlicek & Peterson, 1977; Edgell & Noon, 1984; Good, 2009; Norman, 2010), it is very plausible to assume that physical activity energy expenditure scores used in the SLAQ might be skewed as the majority of the general population is considered relatively inactive (Colley et al., 2011). The presence of a skewed distribution might influence the evaluation of Pearson correlations and suggests the addition of the Spearman rank-order correlation as the rank-order correlation provides a robust means of evaluating correlations

(McDonald, 2009). Additionally, recent Canadian research correlating two physical activity questionnaires with each other as well as with accelerometer data highlights the benefit of approaching comparisons through multiple correlation coefficients (Garriguet, Tremblay, Colley, 2015).

2.4 Results

Table 2-1 presents the general characteristics of the 2014 SLAQ participants. The 2014 SLAQ had a 34% response rate (n = 1366). There were 810 female respondents and 551 male respondents. Students who were ≤ 20 years of age comprised 45% of the study sample (n = 614). Domestic students accounted for 77% of the participant pool (n = 1051). Over 60% (n = 912) of the respondents reported living at least half an hour away from the University of Alberta campus. Students on a meal plan made up approximately 17% (n = 230) of the participant pool. Demographic data also showed that of the approximately 47% (n = 648) of students who were employed, 36% (n = 494) of students were employed part-time and 11% (n = 154) were employed full-time.

Table 2-1: General Characteristics of 2014 SLAQ Participants

Variable		n (%)
Gender of Participants		
	Female	810 (59)
	Male	551 (40)
Age		
	≤ 20	614 (45)
	21 – 23	307 (22)
	24 – 26	168 (12)
	27 – 29	117 (9)
	30+	155 (11)
Program		
	Undergraduate	867 (63)
	Graduate	386 (28)
	Open Studies	4 (0.3)
	After-Degree Program	39 (2.9)
	Other	60 (4.4)
International Student		
	Yes	308 (23)
	No	1051(77)
Distance from Campus		
	Live on campus	216 (16)
	Live within walking distance	233 (17)
	Live within 1/2h by vehicle	457 (33)
	Live within 1/2-1h by vehicle	385 (28)
	Live more than 1h by vehicle away	70 (5)
Employment Status		
	Employed Part-Time	494 (36)
	Employed Full-Time	154 (11)
	Not Employed	711 (52)
Meal Plan		
	Yes	230 (17)
	No	1128 (83)

2.4.1 Factor Analysis

The criteria measures testing factorability are presented in Table 2-2. Study findings showed that the Kaiser-Meyer-Olkin measure of sampling adequacy (0.825) was above the recommended limit (0.500) and Bartlett's test of sphericity was significant ($p < 0.05$). The factor analysis of the 14 developed items yielded 4 extracted factors with eigenvalues > 1.00. The eigenvalues for each factor and percentage of variance explained is presented in Table 2-3.

Factor 1 explained 28% of the variance and factors 2 to 4 did not show sufficient item representation to warrant the creation of separate scales.

Table 2-2: Factorability Criteria for the 14-item Physical Activity Items

Measure		
Kaiser-Meyer-Olkin	0.825	
Bartlett's Test of Sphericity	Approximate Chi-Square	2372.692
	Degrees of Freedom	91
	Significance	0.000

Table 2-3: Eigenvalues and Percent of Variance Explained

Factor	Eigenvalue	% of Variance Explained
1	3.584	27.5
2	1.901	13.6
3	1.314	9.38
4	1.010	7.21

Component matrix loadings are presented in Table 2-4. From the initial factor analysis of the 14 developed items, 4 items did not meet the 0.3 loading criteria indicating that further analyses proved necessary. Stepwise item exclusions and additional analyses were performed until all items factor analyzed met the 0.3 loading criteria. A total of 5 factor analyses were performed reducing the original 14 items to 9 items. The component matrix for the final 9 items is presented in Table 2-5. The set of items excluded during each successive factor analysis is presented in Table 2-6. The final grouping of factor-loaded items consisted of 4 movement items, 2 exercise items, 2 recreation and sports items, and 1fitness item (Table 2-7).

Table 2-4: Factor Loading Component Matrix of Physical Activity Items (14 items)

Order	Item	Factor			
		1	2	3	4
1	I make time to exercise regardless of my schedule	0.81	-0.19	0.06	-0.06
2	Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these suggested guidelines	0.79	-0.18	0.08	-0.03
3	I actively monitor my level of fitness	0.79	-0.17	0.03	-0.05
4	Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (e.g. workout regimen, classes, trainer, etc.)	0.74	-0.32	0.03	-0.07
5	I play an organized sport (team or individual)	0.56	-0.31	-0.01	0.09
6	When the weather permits, I spend my leisure time outside rather than inside	0.53	0.48	-0.15	0.33
7	I use my academic institution's recreation facilities	0.53	-0.28	0.03	0.38
8	I take the stairs rather than the elevator or escalator	0.41	0.34	-0.23	-0.53
9	I spend long periods of time sitting/reclining without feeling the urge to get up and move around [reversed]	0.36	0.47	0.51	-0.12
10	I perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep)	0.34	0.36	-0.34	-0.47
11	When I want to relax, I go for a walk	0.23	0.50	-0.38	0.43
12	I perform household tasks (cleaning, preparing meals, etc.)	0.22	0.48	-0.38	0.14
13	I sit with my computer or watch television to relax [reversed]	0.18	0.41	0.49	0.14
14	To avoid fatigue or exhaustion, I limit my daily activities [reversed]	0.05	0.44	0.56	-0.02

Table 2-5: Factor-Loading Component Matrix of Physical Activity Items (9 items)

Order	Item	Factor 1
1	I make time to exercise regardless of my schedule	0.85
2	Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these suggested guidelines	0.82
3	I actively monitor my level of fitness	0.81
4	Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (e.g. workout regimen, classes, trainer, etc.)	0.80
5	I use my academic institution's recreation facilities	0.60
6	I play an organized sport (team or individual)	0.59
7	When the weather permits, I spend my leisure time outside rather than inside	0.46
8	I perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep)	0.34
9	I take the stairs rather than the elevator or escalator	0.30

Table 2-6: Order of Excluded Physical Activity Items Undergoing Stepwise Factor Analysis

Order	Item	Activity Theme
1	To avoid fatigue or exhaustion, I limit my daily activities	Movement
2	I sit with my computer or watch television to relax	Sitting
3	I perform household tasks (cleaning, preparing meals, etc.)	Movement
4	When I want to relax, I go for a walk	Movement
5	I spend long periods of time sitting/reclining without feeling the urge to get up and move around	Sitting

Table 2-7: Finalized Grouping of Factor-Loaded Physical Activity Items

Order	Item	Activity Theme
1	I make time to exercise regardless of my schedule	Exercise
2	Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these suggested guidelines	Movement
3	I actively monitor my level of fitness	Fitness
4	Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (e.g. workout regimen, classes, trainer, etc.)	Exercise
5	I use my academic institution's recreation facilities	Recreation and Sports
6	I play an organized sport (team or individual)	Recreation and Sports
7	When the weather permits, I spend my leisure time outside rather than inside	Movement
8	I perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep)	Movement
9	I take the stairs rather than the elevator or escalator	Movement

2.4.2 Internal Consistency

The internal consistency findings for the 9-item grouping are presented in Table 2-8. The Cronbach's alpha score for the 9 items was $\alpha = 0.81$, which meets the accepted construct development criteria of $\alpha = 0.7$. Table 2-8 also provides the Cronbach's alpha scores if items were deleted from the reliability analysis. Findings indicated that internal consistency would only be slightly improved if item 8 ($\alpha = 0.81$ to $\alpha = 0.82$) or item 9 were excluded ($\alpha = 0.81$ to $\alpha = 0.82$). The strong internal consistency results suggested that the 9 physical activity items could be averaged to provide a construct score. Bivariate correlation analysis used the average score of the factor-determined 9-item physical activity questionnaire to establish convergent validity with the GPAQ.

Table 2-8: 9-Item Cronbach's Alpha Scores (Internal Consistency)

Cronbach's alpha = 0.81		
Order	Item	Cronbach's alpha if item is deleted
1	I make time to exercise regardless of my schedule	0.76
2	Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these suggested guidelines	0.76
3	I actively monitor my level of fitness	0.77
4	Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (e.g. workout regimen, classes, trainer, etc.)	0.77
5	I use my academic institution's recreation facilities	0.80
6	I play an organized sport (team or individual)	0.80
7	When the weather permits, I spend my leisure time outside rather than inside	0.80
8	I perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep)	0.82
9	I take the stairs rather than the elevator or escalator	0.82

2.4.3 Descriptive Statistics and Frequency Distributions for the GPAQ and PAQ

The descriptive statistics for the PAQ and GPAQ are presented in Table 2-9. The mean PAQ score for the 2014 SLAQ participants was 3.77. The mean GPAQ total activity score for the 2014 SLAQ participants was 3,772 MET-minutes per week. The PAQ scores appear to be normally distributed (Figure 2-1) while the GPAQ total activity scores appear positively skewed (2-2). A comparison of incomplete responses between the 2013 and 2014 SLAQ is presented in Table 2-10. For the 2014 SLAQ, 166 (12%) were removed during GPAQ analysis.

Table 2-9: Total PAQ and GPAQ Descriptive Statistics for 2014 SLAQ Participants

	M	SD	Range	Skewness	Kurtosis
PAQ	3.77	1.09	6	0.173	-0.465
GPAQ	3772	4252	33120	3.010	11.835

Table 2-10: Incomplete Global Physical Activity Questionnaire Responses

	SLAQ Participants	Incomplete GPAQ Cases
SLAQ Year	n	n (%)
2013	975	125 (13)
2014	1366	166 (12)

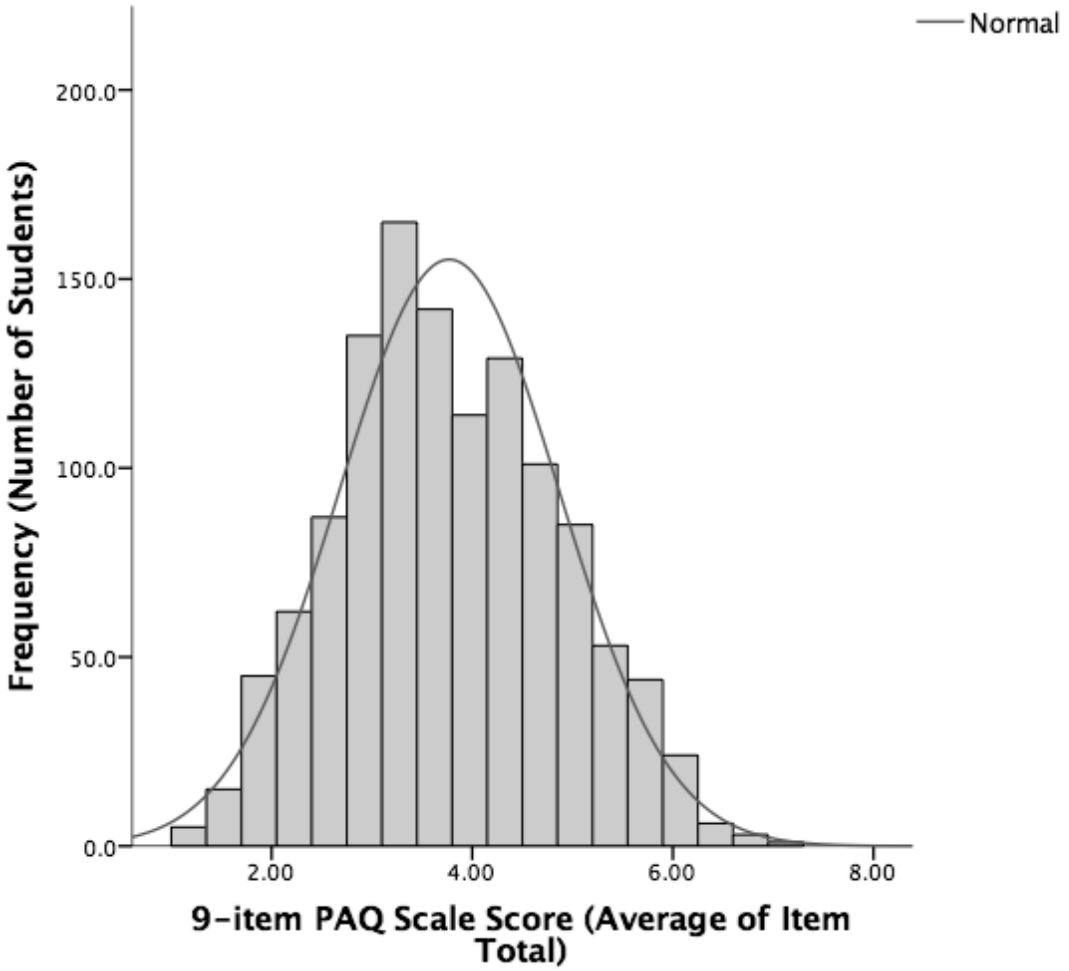


Figure 2-1. **Frequency Distribution of 2014 SLAQ PAQ Scores**

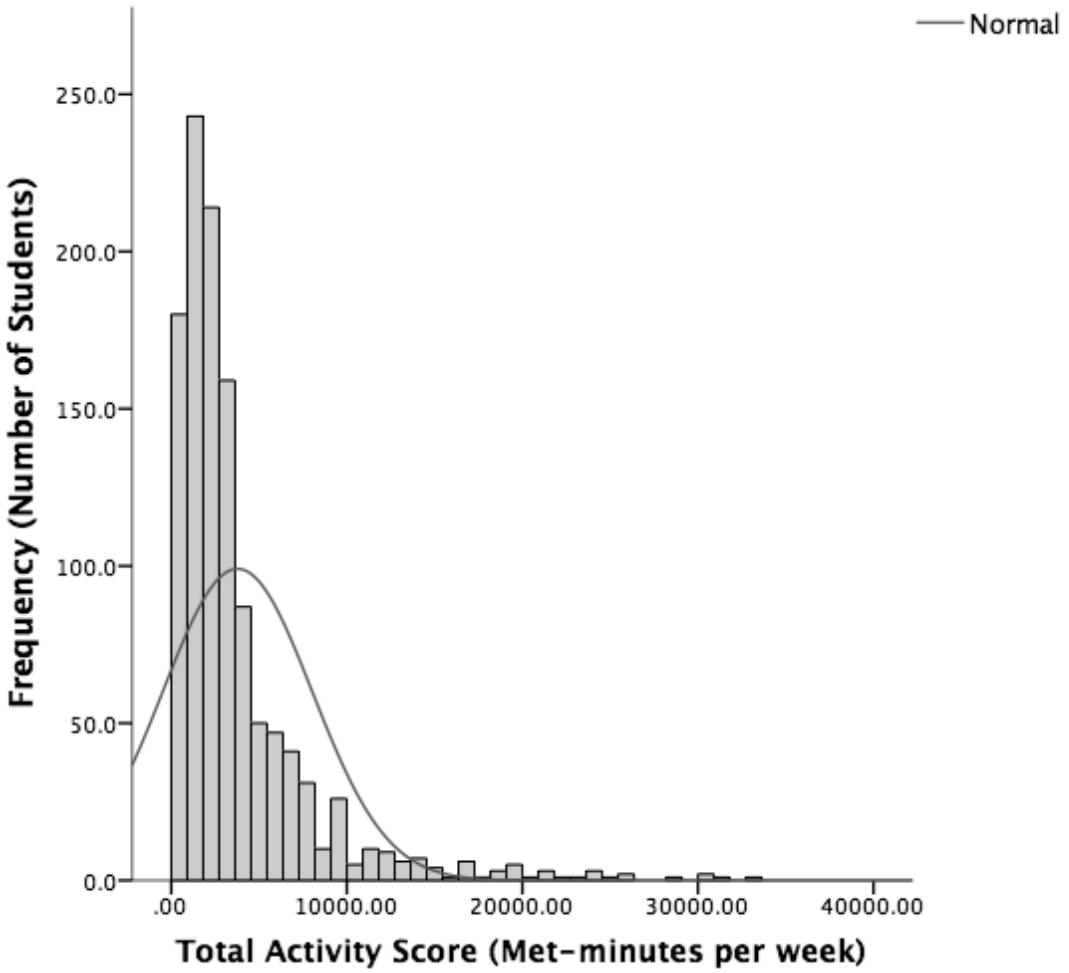


Figure 2-2. **Frequency Distribution of 2014 SLAQ GPAQ Total Activity Scores**

2.4.4 Convergent Validity

The Pearson product-moment correlation coefficients between the 9-item physical activity questionnaire (PAQ) and GPAQ scores are presented in Table 2-11. For the PAQ and GPAQ, the PAQ displayed stronger correlations with self-reported recreational activities ($r = 0.44$, $p < 0.01$) compared to self-reported work and school activities ($r = 0.11$, $p < 0.01$). For both recreational and work/school activities, correlations between the PAQ and GPAQ were strongest for vigorous intensity activities compared to moderate intensity activities. The Pearson correlation between the PAQ and GPAQ transit activities was not significant ($p > 0.05$) and a

moderate correlation was observed between total GPAQ physical activity and the PAQ ($r = 0.28$, $p < 0.01$).

Table 2-11: Pearson Correlation Coefficients between 9-item PAQ and GPAQ Domains

	REC	RECvig	RECmod	WORK	WORKvig	WORKmod	TRNS	SUM
PAQ	0.44**	0.49**	0.15**	0.13**	0.11**	0.08**	--	0.28**

Note. **p < .01, -- = Not significant
GPAQ = Physical Activity Questionnaire, PAQ = Physical Activity Questionnaire, REC = Total MET-minutes for all recreational activity per week, RECmod = Total MET-minutes for all moderate recreational activity per week, RECvig = Total MET-minutes for all vigorous recreational activity per week, SUM = Total MET-minutes for the week, TRNS = Total MET-minutes for transit activity per week, WORK = Total MET-minutes for all work/school activity per week, WORKmod = Total MET-minutes for all moderate work/school activity per week, WORKvig = Total MET-minutes for all vigorous work/school activity per week

The Spearman correlation coefficients between the 9-item physical activity questionnaire (PAQ) and GPAQ are presented in Table 2-12. The Spearman coefficients between the PAQ and GPAQ were significant for all activity domains ($p < 0.01$). A strong correlation was observed between the PAQ and self-reported recreational activities ($r_s = 0.60$). A moderate correlation between the PAQ and self-reported work and school activities ($r_s = 0.25$) was also observed. The Spearman correlations between the PAQ and GPAQ were strongest for vigorous intensity activities compared to moderate intensity activities, for both recreational and work/school activities. A positive correlation was also observed between GPAQ transit behaviours and the PAQ ($r_s = 0.10$).

Table 2-12: Spearman Correlation Coefficients between 9-item PAQ and GPAQ Domains

	REC	RECvig	RECmod	WORK	WORKvig	WORKmod	TRNS	SUM
PAQ	0.60**	0.65**	0.32**	0.23**	0.20**	0.17**	0.10**	0.44**

Note. **p < .01
GPAQ = Physical Activity Questionnaire, PAQ = Physical Activity Questionnaire, REC = Total MET-minutes for all recreational activity per week, RECmod = Total MET-minutes for all moderate recreational activity per week, RECvig = Total MET-minutes for all vigorous recreational activity per week, SUM = Total MET-minutes for the week, TRNS = Total MET-minutes for transit activity per week, WORK = Total MET-minutes for all work/school activity per week, WORKmod = Total MET-minutes for all moderate work/school activity per week, WORKvig = Total MET-minutes for all vigorous work/school activity per week

2.5 Discussion

This study sought to develop a short questionnaire for use in omnibus surveys on student health and wellness. Findings from the study indicate that a 9-item questionnaire may provide a suitable instrument for physical activity assessment. Of the original 14 items developed, both items on sitting did not meet the minimum criteria needed for inclusion on the extracted factor. While sitting behaviour has been recognized as an important stand-alone component of the physical activity equation (Dunstan, Howard, Healy, & Owen, 2012), the low loadings observed during factor analysis may be explained by the growing body of evidence suggesting that sedentary behaviour and sitting is an independent behaviour (Thorp, Owen, Neuhaus, & Dunstan, 2011). The study also expected the emergence of one factor from the set of developed items, which would serve as an indicator of physical activity behaviour. The analysis indicated that four factors were extracted from the set of items. While not within the scope of the present study, an examination of the resulting factors showed that no additional factor emerged with sufficiently strong assessment properties warranting further study. More specifically, the additional extracted factors from the 14-item factor analysis did not include any high loading items (≥0.6) (Kline, 2014). Moreover, the constraints of the study context prevented the asking

of a large enough set of items as would have been required to perform exploratory analyses of the structure of the domain of items being examined.

Three movement items were also excluded during factor analysis. Surprisingly, the set of excluded physical activity items contained the frequency with which students report engaging in household activities (e.g., cooking, cleaning). However, results from a 2006 study of physical activity behaviours among college students indicated that students do not recall their household activities as well as they recall recreational activities such as exercising (Dinger, Behrens, & Han, 2006). This documented difference in what behaviours students may effectively recall might serve to explain why household activities were excluded from the final questionnaire. The exclusion of items on walking for relaxation and limiting daily movements may be attributed to item wording. As frequent walking is considered to be an important part of leading a healthy lifestyle (Morris & Hardman, 1997; Ogilvie et al., 2007), the exclusion of a walking behaviour item was surprising. However, the low item loading observed might be attributed to asking students how often they walked for relaxation rather than how often they walked for transportation purposes (Sallis, Frank, Saelens, & Kraft, 2004). By focusing on walking for leisure purposes, the set of developed items may have erroneously limited the scope of walking behaviours that students engage in. Item wording may also explain the low loadings observed for the item asking students how often they limited their daily movements. While the intention of the item was to evaluate how often students deliberately hindered their movements, the wording of the item may have assumed that students limited their daily movements for a particular purpose. The frequency with which students deliberately limit their daily movements is a potentially important area for research, however the findings from the study suggest that one item may not capture the complete scope of how often movements are limited.

The study findings provided reasonable evidence to suggest that the 9-item PAQ is a potentially useful indicator of physical activity. The internal consistency analysis of the 9-item PAQ indicated that the items could be effectively grouped to provide a reliable score. The strong Cronbach's alpha score for the 9-item PAQ also provided additional support to the step-wise procedure used as the resulting set of factor-loaded items, while broad, were highly inter-correlated. It was observed that 12% of the students from the 2014 SLAQ had incomplete GPAQ responses. This figure was similar to the 13% of students responding incompletely from the 2013 SLAQ. The similar findings might suggest that the placement of the items in the SLAQ might not be a limiting factor. Convergent validity findings between the 9-item PAQ and GPAQ were also encouraging as positive correlations were observed between the PAQ and GPAQ activity scores. As the objective of the present study was the construction of a new physical activity questionnaire, a positive correlation between the PAQ and GPAQ was considered encouraging as the correlation might potentially suggest that the PAQ provides a broad score of increasing self-reported physical activity. However, this correlation does not provide empirical evidence to suggest that the PAQ and GPAQ assess physical activity in a similar manner. Moreover, the Pearson correlations were only significant between the 9-item PAQ results and GPAQ domains of recreational and work/school activities. Spearman correlations showed that the 9-item PAQ results and GPAQ transit activities were significantly and positively correlated, which would suggest that the PAQ does not accurately capture walking as an activity. The strongest correlations between the 9-item PAQ and GPAQ were seen for recreational activities. This finding is not overly surprising given the notion that students tend to recall their engagement in recreational activities relative to their activities at home, work, or school (Dinger, Behrens, & Han, 2006).

Ultimately, this study has also shown that the process of conceptualizing health behaviours and developing concept-based items for examination is a potentially useful approach for developing assessment instruments. The statistical techniques used can also be applied to develop future indicators of underexplored concepts. For example, the findings from the study suggest that sitting behaviour is a potential area for future research. As student life is characterized by extended periods of sitting (e.g., during lecture, while studying), a similar approach incorporating the current literature on sitting and sedentary behaviour could yield an indicator of student sitting behaviour. The addition of sitting behaviour to instruments on physical activity, stress, coping, nutrition, and personal wellbeing would add an extra dimension to omnibus surveys of student health and wellness and benefit health promotion efforts.

2.6 Limitations

This study and the questionnaire that was constructed suffered from numerous limitations, which must be considered. First, the most significant limitation to the present study is the fact that the PAQ cannot be considered a purely behavioural physical activity questionnaire. This is evident when the items are broken down into the following categories: what, why, and barriers/strategies. The aim of the present study was to construct a questionnaire where higher scores corresponded to higher reported physical activity. In this view, an item combination consisting of items tapping into what students do and how often they overcome barriers in doing that activity seemed plausible. However, this approach limited the ability of the PAQ to assess pure behaviours in a direct sense. For example, the item asking students how often they exercise is an item that focused on what they are doing. Given that a group of students respond to this particular item, it can be assumed that the result potentially describes how often they actually exercise, which is an assessment of what they are doing. This information can be

used to directly evaluate how purely active they are. In contrast, when students are asked how often they exercise regardless of their schedule, the response offers insight into their potential determination to be active but does not serve to evaluate a direct behaviour, as the responses are not standardized (i.e., exercising regardless of your schedule is not a direct behaviour but rather how often you overcome a personal barrier to exercise). The question then becomes what the item is theoretically truly assessing. The study suggests that the item is a physical activity item but the structure of the item renders it open to interpretation. This is the ultimate difficulty, in a measurement sense, with the items that were used in the PAQ and must be considered a significant limitation. In addition, the potential difficulty with combining items on what activities are performed, why they are performed, and the overcoming of barriers to activities in a purely behavioural sense is that the inclusion of a non-standardized component potentially impedes the assessment of a direct link between the behaviour and the health benefit across individuals. While not purely behavioural, the inclusion of the schedule item was an attempt by the author to try and gauge how active university students were given that students are usually faced with busy schedules. Ultimately, it must be noted that the combination of items used in the PAQ renders the PAQ a mix of pure and applied behaviours. While this might be feasible in terms of suggesting that the PAQ is a broad indicator of student physical activity where the item responses potentially signify an indication of self-reported activity, it signifies that the PAQ has very limited measurement properties. Therefore, it must be continuously emphasized that the PAQ cannot be called a purely behavioural indicator of physical activity.

A second limitation to the present study and the conclusions drawn from using the PAQ also centers on the inability of the PAQ to be considered a purely behavioural indicator of physical activity. More specifically, it was previously discussed that the PAQ is ultimately a mix

of what, why, and barrier/strategy items. That being said, it must then be noted that presence of any correlation between the PAQ and GPAQ, which specifically measures what activities students report performing, cannot be taken to signify that the PAQ is also a behavioural indicator of physical activity. To accept such a premise would be to accept a spurious relationship. Instead, the correlation might simply show some level of agreement between two different instruments that assess different concepts of activity. Moreover, it must also be noted that there is a potential conflict in the present study as the author first critiqued the use of the GPAQ and then used it to aid in offering validity to the PAQ. A further limitation to the present study and effort to construct a broad indicator of physical activity is the fact that the establishment of themes and selection of items were overly subjective. While themes were chosen that appeared throughout the literature and accepted definition of physical activity, the methodology was open to the potential biases of the author and his supervisors. Additionally, a potentially methodological limitation to the present study was the selection of activity themes over activity types. More specifically, it can be argued that using activity types could have potentially allowed for a more accurate set of behavioural items to be used in constructing the PAQ. For example, items could have been constructed on what students do for strength and flexibility, what they do for aerobic activities, and what they do for lifestyle activities. This grouping might have offered a more focused view of how to develop items as opposed to developing items according to what activities result in bodily movement.

2.7 Conclusion

This study used a conceptual framework to thematically characterize activity behaviours and develop a broad set of 14 questionnaire items. The complete set of items was added to a current omnibus survey of student health and wellness conducted at the University of Alberta,

which included the Global Physical Activity Questionnaire for validation. Data analysis determined that 9 items could effectively be grouped to form a reliable construct. The resulting 9-item physical activity questionnaire showed reasonable correlation when tested against the Global Physical Activity Questionnaire, however this correlation does not imply that the two instruments are practically similar. As the focus of this study centered on the development of a student activity questionnaire for omnibus surveys, the next step is to use the data gathered from the 2014 SLAQ to investigate the associations between health indicators at the student level.

2.8 References

Anshel, M. H., & Seipel, S. J. (2009). Self-monitoring and selected measures of aerobic and strength fitness and short-term exercise attendance. *Journal of Sport Behavior*, *32*(2), 125.

Bauman, A., Phongsavan, P., Schoeppe, S., & Owen, N. (2006). Physical activity measurement-a primer for health promotion. *Promotion & Education*, *13*(2), 92-103.

Baumert Jr, P. W., Henderson, J. M., & Thompson, N. J. (1998). Health risk behaviors of adolescent participants in organized sports. *Journal of Adolescent Health*, *22*(6), 460-465.

Blair, S. N. (2009). Physical inactivity: the biggest public health problem of the 21st century. *British Journal of Sports Medicine*, *43*(1), 1-2.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.

Canter, D. (Ed.). (2012). *Facet theory: Approaches to social research*. Springer Science & Business Media.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Dinger, M. K., Behrens, T. K., & Han, J. L. (2006). Validity and reliability of the International Physical Activity Questionnaire in college students. *American Journal of Health Education*, *37*(6), 337-343.

Downs, A., & Ashton, J. (2011). Vigorous physical activity, sports participation, and athletic identity: Implications for mental and physical health in college students. *Journal of Sport Behavior*, *34*(3), 228.

Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment*, *7*(3), 286.

Garriguet, D., Tremblay, S., & Colley, R. C. (2015). Comparison of Physical Activity Adult Questionnaire results with accelerometer data. *Health reports*, *26*(7), 11-17.

Griffith, L. E., Cook, D. J., Guyatt, G. H., & Charles, C. A. (1999). Comparison of open and closed questionnaire formats in obtaining demographic information from Canadian general internists. *Journal of Clinical Epidemiology*, *52*(10), 997-1005.

Grimstvedt, M. E., Kerr, J., Oswalt, S. B., Fogt, D. L., Vargas-Tonsing, T. M., & Yin, Z. (2010). Using signage to promote stair use on a university campus in hidden and visible stairwells. *Journal of Physical Activity & Health*, *7*(2), 232.

Healy, G. N., Dunstan, D. W., Salmon, J., Cerin, E., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Breaks in sedentary time beneficial associations with metabolic risk. *Diabetes Care*, *31*(4), 661-666.

Hubbs, A., Doyle, E. I., Bowden, R. G., & Doyle, R. D. (2012). Relationships Among Self-Esteem, Stress, and Physical Activity in College Students 1. *Psychological Reports*, *110*(2), 469-474.

Huddleston, S., Mertesdorf, J., & Araki, K. (2002). Physical activity behavior and attitudes toward involvement among physical education, health, and leisure services pre-professionals. *College Student Journal*, *36*(4), 555.

Kilpatrick, M., Hebert, E., & Bartholomew, J. (2005). College students' motivation for physical activity: differentiating men's and women's motives for sport participation and exercise. *Journal of American College Health*, *54*(2), 87-94.

Kline, P. (2014). *An easy guide to factor analysis*. Routledge.

Kowalski, K. C., Crocker, P. R., & Kowalski, N. P. (1997). Convergent validity of the physical activity questionnaire for adolescents. *Pediatric Exercise Science*, *9*, 342-352.

Macfarlane, D. J., Lee, C. C., Ho, E. Y., Chan, K. L., & Chan, D. (2006). Convergent validity of six methods to assess physical activity in daily life. *Journal of Applied Physiology*, *101*(5), 1328-1334.

McDonald, J. H. (2009). *Handbook of biological statistics* (Vol. 2, pp. 173-181). Baltimore, MD: Sparky House Publishing.

Morris, J. N., & Hardman, A. E. (1997). Walking to health. *Sports medicine*, *23*(5), 306-332.

Nunnally, J. C., Bernstein, I. H., & Berge, J. M. T. (1967). *Psychometric theory* (Vol. 226). New York: McGraw-Hill.

Ogilvie, D., Foster, C. E., Rothnie, H., Cavill, N., Hamilton, V., Fitzsimons, C. F., ... & Scottish Physical Activity Research Collaboration. (2007). Interventions to promote walking: systematic review. *British Medical Journal*.

Owen, N., Healy, G. N., Matthews, C. E., & Dunstan, D. W. (2010). Too much sitting: the population-health science of sedentary behavior. *Exercise and Sport Sciences Reviews*, *38*(3), 105.

Philippaerts, R. M., Westerterp, K. R., & Lefevre, J. (1999). Doubly labelled water validation of three physical activity questionnaires. *International Journal of Sports Medicine*, *20*(5), 284-289.

Plasqui, G., & Westerterp, K. R. (2007). Physical activity assessment with accelerometers: an evaluation against doubly labeled water. *Obesity*, *15*(10), 2371-2379.

Prochaska, J. J., Sallis, J. F., Sarkin, J. A., & Calfas, K. J. (2000). Examination of the factor structure of physical activity behaviors. *Journal of Clinical Epidemiology*, *53*(8), 866-874.

Regehr, C., Glancy, D., & Pitts, A. (2013). Interventions to reduce stress in university students: A review and meta-analysis. *Journal of Affective Disorders*, *148*(1), 1-11.

Reilly, J. J., Penpraze, V., Hislop, J., Davies, G., Grant, S., & Paton, J. Y. (2008). Objective measurement of physical activity and sedentary behaviour: review with new data. *Archives of Disease in Childhood*, *93*(7), 614-619.

Reja, U., Manfreda, K. L., Hlebec, V., & Vehovar, V. (2003). Open-ended vs. close-ended questions in web questionnaires. *Developments in applied statistics*, *19*, 159-177.

Sallis, J. F., Frank, L. D., Saelens, B. E., & Kraft, M. K. (2004). Active transportation and physical activity: opportunities for collaboration on transportation and public health research. *Transportation Research Part A: Policy and Practice*, *38*(4), 249-268.

Sallis, J. F., & Saelens, B. E. (2000). Assessment of physical activity by self-report: status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, *71*(sup2), 1-14.

Schutz, Y., Weinsier, R. L., & Hunter, G. R. (2001). Assessment of free-living physical activity in humans: an overview of currently available and proposed new measures. *Obesity Research*, *9*(6), 368-379.

Taylor, H. L., Jacobs, D. R., Schucker, B., Knudsen, J., Leon, A. S., & Debacker, G. (1978). A questionnaire for the assessment of leisure time physical activities. *Journal of Chronic Diseases*, *31*(12), 741-755.

Thomas, J. R., & Thomas, K. T. (2002). Physical activity data: Odd distributions yield strange answers. In G. Welk (Ed.), *Physical Activity Assessments for Health-Related Research* (pp. 73-80). Champaign, IL: Human Kinetics.

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology*, *45*(5), 1761-1772.

Thorp, A. A., Owen, N., Neuhaus, M., & Dunstan, D. W. (2011). Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996–2011. *American Journal of Preventive Medicine*, *41*(2), 207-215.

Tremblay, M. S., Warburton, D. E., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., ... & Duggan, M. (2011). New Canadian physical activity guidelines. *Applied Physiology, Nutrition, and Metabolism*, *36*(1), 36-46.

Vanhees, L., Lefevre, J., Philippaerts, R., Martens, M., Huygens, W., Troosters, T., & Beunen, G. (2005). How to assess physical activity? How to assess physical fitness?. *European Journal of Cardiovascular Prevention & Rehabilitation*, *12*(2), 102-114.

Warburton, D. E., Gledhill, N., & Quinney, A. (2001). Musculoskeletal fitness and health. *Canadian Journal of Applied Physiology*, *26*(2), 217-237.

Welk, G. (Ed.). (2002). *Physical activity assessments for health-related research*. Champaign, IL: Human Kinetics.

Chapter 3: Second Manuscript - Associations between Indicators of Physical Activity and Health in the Canadian University Setting

Abstract

Background: Students in post-secondary education face numerous challenges to their health and wellness, such as stress, unhealthy nutrition behaviours, and lack of sleep. While physical activity has been shown to positively impact health, the associations between university student activity behaviours and health factors have been underexplored. The present study used an omnibus survey of student health and wellness, the Student Life Activity Questionnaire (SLAQ), to describe the associations between self-reported student activity behaviours and health factors.

Methods: The SLAQ was distributed to 4000 random students enrolled at the University of Alberta and included questionnaires on wellness, stress, nutrition, and sleep behaviour. Two physical activity questionnaires were used, the Global Physical Activity Questionnaire (GPAQ) and a 9-question Physical Activity Questionnaire (PAQ) developed specifically for the study.

Results: The SLAQ had a 34% response rate (n = 1366) with a mean respondent age of 24. There were 810 female and 551 male respondents. Pearson analysis showed that the PAQ correlated significantly ($p < 0.01$) with perceived stress ($r = -0.23$), positive nutritional behaviours ($r = 0.39$), personal wellbeing ($r = 0.29$), and sleep quality ($r = 0.11$). Total GPAQ activity scores correlated with only personal wellbeing ($r = 0.07$, $p < 0.05$) and positive nutritional behaviours ($r = 0.12$, $p < 0.01$). Spearman analysis showed an increase in the magnitude of correlations and a similar ordering of associations for both the PAQ and GPAQ.

Conclusion: Physical activity correlated strongest with positive nutritional behaviours and weakest with sleep quality. The association between activity and wellbeing is encouraging and future research could expand on the direction of association observed between activity and stress.

3.1 Introduction

At present, students in higher education face numerous challenges to their health and wellness (Dyson & Renk, 2006; Robotham, 2008). University students, especially those entering into post-secondary institutions, face a challenging transition process where they must balance academic and professional demands as well as adapt to new social settings. Concernedly, the various demands placed on students can induce possible feelings of stress and reduce their wellbeing. Perceived stress has significant implications on student emotional, cognitive, and mental health (Folkman & Moskowitz, 2000) and temporal trends indicate that Canadian university students are feeling unprecedented levels of stress (Brougham, Zail, Mendoza, & Miller, 2009; Campbell, Svenson, & Jarvis, 1992). Problematically, it has been suggested that high levels of self-reported stress are associated with negative health behaviours (Hudd et al., 2000) and disease processes, which include cardiovascular disease, clinical depression, human immunodeficiency virus, and cancer (Cohen, Janicki-Deverts, Miller, 2007).

In addition to stress, factors influencing student health and wellness also include unhealthy nutrition behaviours and lack of sleep. Current studies suggest that university students are consuming high levels of high calorie and low nutrient foods that include: fast foods, convenience products, sugar sweetened beverages, and alcohol (Jackson, Berry, & Kennedy, 2009; Small, Bailer-Davis, Morgan, & Magg, 2013). Furthermore, while it is recommended that adults need seven to eight hours of sleep per night (Altevogt & Colten, 2006), a recent study indicated that three-quarters of post-secondary students from eight post-secondary institutions across Canada had inadequate sleep (Kwan, 2013). In addition to the findings by Kwan (2013), subsequent studies have highlighted inadequate sleep as a problem in the student population

(Buboltz, Brown & Soper, 2001; Coren, 1994; Lund, Reider, Whiting & Prichard, 2010; Oginsaka & Pokorski, 2006).

As unhealthy nutrition behaviours, lack of sleep, and stress are associated with poor health outcomes, regular participation in physical activity has been shown to be positively associated with better quality of life and health outcomes (Penedo & Dahn, 2005; Warburton, Nicol, and Bredin, 2006). In addition, studies suggest that routine physical activity is also associated with reduced stress (Warburton, Gledhill, & Quinney, 2001) and reduced anxiety (Landers & Arent, 2001). Increased amounts of physical activity have also been reported to be associated with increased healthy food choices (Gillman et al., 2001) and it has been further suggested that exercise and sport participation encourage the development of healthy habits and deter health risk behaviours (Pate, Heath, Dowda, & Trost, 1996). In addition, Atkinson and Davenne (2007) suggest that there is a potential relationship between sleep and activity behaviours. While studies examining the associations between self-reported physical activity behaviours to perceived stress (Nguyen-Michel, Unger, Hamilton, & Spruijt-Metz 2006) and nutrition behaviours (King, Mohl, Bernard, & Vidourek, 2007) are available, the exploration of associations between Canadian university student physical activity behaviours and health factors has been limited. Therefore, the purpose of the present study is to examine the potential associations between self-reported indicators of physical activity, perceived stress, nutrition behaviours, sleep, and personal wellbeing among a sample of students at a Canadian university.

3.2 Methods

The present study used findings from the 2014 Student Life Activity Questionnaire (SLAQ) at the University of Alberta to examine the association between physical activity and health factors. The SLAQ is a cross-sectional study of student health that was developed in 2013

as few studies have comprehensively explored the associations between multiple health factors within a sample of university students (Hubbs, Doyle, Bowden, & Doyle, 2012). More specifically, the SLAQ is an omnibus survey that is composed of questionnaires spanning multiple dimensions of health and wellness. The questions used in the SLAQ stem from studies on: personal wellbeing (Cummins, Eckersley, Pallant, Van Vugt, & Misajon, 2003), stress (Cohen, Kamarck, & Mermelstein, 1983), sleep (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), and nutrition (Vidgen & Gallegos, 2012).

3.2.1 Participants

The University of Alberta Registrar was asked to provide 4,000 random student email addresses and first names based on enrollment lists. The student population at the University of Alberta numbers close to 40,000, representing 151 countries, and provides a representative sample of the population at large. There were no restrictions placed on which students could participate in the study and participation was voluntary. Students were invited to participate over email (Appendix B) and were required to complete a consent form prior to participation in the study (Appendix C). Students were offered a $10 credit applicable to their student identification card for their participation. Students were permitted one month (May 2014) to complete the SLAQ.

3.2.2 Assessment Instruments

Personal Wellbeing Index (PWI) – The Personal Wellbeing Index (Cummins, Eckersley, Pallant, Van Vugt, & Misajon, 2003) consists of 7 questions that ask participants to indicate how satisfied they are with their: health, standard of living, what you are achieving in life, personal relationships, feelings of safety, feeling part of a community, and future security. Participants mark their level of satisfaction on an 11-point scale from 0: Completely Dissatisfied to 10:

Completely Satisfied. For each participant, the average of their responses was used to provide a total score of their subjective wellbeing. In a cross-cultural study, reported internal consistency coefficients for the PWI ranged from 0.73 to 0.86 (Lau, Cummins, & McPherson, 2005).

Perceived Stress Scale (PSS) – The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) consists of 10 questions designed to assess the degree to which situations over the past month are appraised as stressful. Participants marked their perceived level of stress on a 5-point scale from 0: Never to 4: Very often. Reverse scoring was used to ensure that the total score calculated reflected higher perceived stress. A literature review conducted by Lee (2012) found 19 studies that evaluated the psychometric properties of the PSS. Reported internal consistency coefficients ranged from 0.78 to 0.91 and test-retest reliability (intra-class coefficients) included 0.86 (1 week), 0.90 (2 weeks), and 0.72-0.88 (4 weeks).

Sleep Quality – The present study used 4 questions modelled from the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), which consists of 19 questions that provide 7 component scores on sleep quality, sleep latency, duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The 4 questions on sleep quality asked participants to: 1) rate their subjective sleep quality on a 5-point scale from 0: Very poor to 4: Excellent, and 2) how often participants had difficulty falling asleep, had difficulty waking up, and felt refreshed in the morning from 0: Never to 4: Always.

Nutritional Behaviours – Five questions were used to assess positive student nutrition behaviours through dietary habits and food literacy (Vidgen & Gallegos, 2012). The questions consisted of how often participants maintained a balanced diet across the four food groups recommended by the Canada Food Guide, ate 5 or more servings of fruits and vegetables, were aware of the ingredients in a food product, budgeted meal purchases accordingly, and set out

time to prepare meals. Participants marked the frequencies of their behaviours on a 5-point scale from 0: Seldom or Never to 4: Very often.

Physical Activity Behaviours (PAQ and GPAQ) – Two methods of physical activity assessment were used. The study used the WHO Global Physical Activity Questionnaire (GPAQ) (Armstrong & Bull, 2006) and a Physical Activity Questionnaire (PAQ) designed specifically for the present study to assess university student activity. The GPAQ is a valid and reliable questionnaire (Bull, Maslin, & Armstrong, 2009) that provides a total score of physical activity based on how often participants engaged in high and moderate intensity activities in three settings: occupation, recreation, and transit (Armstrong & Bull, 2006). Metabolic equivalents (METs) were used to characterize intensity (moderate = 4 METs and high = 8 METs) and provide a relative measure of energy expenditure. Participants inputted how many days per week and minutes per day they engaged in high or moderate intensity activities per each setting. The total score (MET-minutes per week) was calculated as the sum of all activities. Data cleaning for the GPAQ involves removing incomplete activity scores if one of the following conditions is met: activity day = 0 and activity time > 0 or activity day > 0 and activity time = 0. Findings from the 2013 SLAQ showed that the GPAQ had the highest rate of incomplete data and Pearson correlations between the GPAQ and SLAQ instruments proved inconclusive. Potential self-estimation and recall difficulties related to the structure of the GPAQ were estimated to be the cause of the limited associations observed. Similarly, contradictory findings between the PSS and the WHO's International Physical Activity Questionnaire (IPAQ) were observed by a study examining Pearson correlation associations in a sample of university students (Hubbs, Doyle, Bowden, & Doyle, 2012). The potential difficulty observed with self-reported energy expenditure instruments such as the GPAQ and IPAQ led to the construction of

a 9-item Physical Activity Questionnaire (PAQ) for the study. The questions consist of asking participants how often they engaged in activities related to general movement, exercise, fitness, and recreation/sports on a 7-point scale from 0: Never to 6: Very often. Participants were asked how often they: met the Canadian guidelines for physical activity, exercised, made time to exercise regardless of their schedule, actively monitored their fitness, spent their leisure time outdoors, used their academic institution's recreational facilities, performed household maintenance tasks, and took the stairs rather than the elevator or escalator. The PAQ was developed to serve as an indicator of student physical activity where higher outcome scores (i.e., an average of the item total) potentially correspond to students reporting higher activity participation.

3.2.3 Data Analysis

SPSS version 20 was used to analyze the data set. The descriptive statistics included internal consistency scores for each instrument and were tested against the accepted criteria ($\alpha \geq 0.7$). Pearson product-moment correlation coefficients were used to test the associations between physical activity and health indicators at the $p = 0.05$ significance level. Additionally, Spearman correlations were calculated to determine whether the associations between SLAQ health indicators and both physical activity assessment instruments were similar in direction.

3.3 Results

The general demographic characteristics of the study participants are presented in Table 3-1. Of the 4,000 students randomly sampled and contacted, 1366 responded (34%) and the mean age of respondents was 24. The majority of student responses came from undergraduate students (63%). There were 810 female respondents and 551 male respondents. Students who were ≤ 20 years of age comprised 45% of the study sample ($n = 614$). Domestic students

accounted for 77% of the participant pool (n = 1051). Over 60% (n = 912) of the respondents reported living at least half an hour away from the University of Alberta campus. Students on a meal plan made up approximately 17% (n = 230) of the participant pool. Demographic data also showed that of the approximately 47% (n = 648) of students who were employed, 36% (n = 494) of students were employed part-time and 11% (n = 154) were employed full-time.

Table 3-1: General Characteristics of 2014 SLAQ Participants

Variable		n (%)
Gender of Participants		
	Female	810 (59)
	Male	551 (40)
Age		
	≤ 20	614 (45)
	21 – 23	307 (22)
	24 – 26	168 (12)
	27 – 29	117 (9)
	30+	155 (11)
Program		
	Undergraduate	867 (63)
	Graduate	386 (28)
	Open Studies	4 (0.3)
	After-Degree Program	39 (2.9)
	Other	60 (4.4)
International Student		
	Yes	308 (23)
	No	1051(77)
Distance from Campus		
	Live on campus	216 (16)
	Live within walking distance	233 (17)
	Live within 1/2h by vehicle	457 (33)
	Live within 1/2-1h by vehicle	385 (28)
	Live more than 1h by vehicle away	70 (5)
Employment Status		
	Employed Part-Time	494 (36)
	Employed Full-Time	154 (11)
	Not Employed	711 (52)
Meal Plan		
	Yes	230 (17)
	No	1128 (83)

The descriptive statistics for the SLAQ instruments are presented in Table 3-2. Each of the self-report instruments showed acceptable utility ($\alpha \geq 0.70$). A full presentation of the items used to generate each scale along with the SPSS calculation formula is available in Appendix D. There were 166 (12%) students deemed incomplete by the GPAQ scoring algorithm. These students were not included in any GPAQ analyses.

Table 3-2: Descriptive Statistics for the 2014 SLAQ Health Assessment Instruments

Instrument	M	SD	Range	Alpha
Personal Wellbeing Index	7.21	1.41	8.43	0.83
Perceived Stress Scale	2.88	0.69	3.80	0.84
Nutritional Behaviours	3.32	0.88	4.00	0.74
Sleep Quality	3.29	0.77	4.00	0.73
Physical Activity Questionnaire	3.77	1.09	6.00	0.81
Global Physical Activity Questionnaire	3772	4252	33120	

The Pearson product-moment correlation coefficients for the physical activity and SLAQ instruments are presented in Table 3-3. The PAQ showed significant Pearson correlations with the PWI, PSS, NBS, and SQS. The strongest positive correlation observed was between the PAQ and the NBS ($r = 0.39$, $p < 0.01$). The PAQ correlated positively with the PWI ($r = 0.29$, $p < 0.01$) and negatively with the PSS ($r = -0.23$, $p < 0.01$). The findings showed that the magnitude of the positive correlation between the PAQ and PWI (0.29) was similar to the magnitude of the negative correlation between the PAQ and PSS (0.23). A slight positive correlation was observed between the PAQ and SQS ($r = 0.11$, $p < 0.01$). The GPAQ correlated with the NBS ($r = 0.12$, $p < 0.01$) and showed a minimally significant correlation with the PWI ($r = 0.07$, $p < 0.05$).

Table 3-3: Pearson Correlation Coefficients for Physical Activity and SLAQ Instruments

SLAQ Instruments	Physical Activity Instruments	
	PAQ	GPAQ (METtotal)
PWI	0.29**	0.07*
PSS	-0.23**	--
NBS	0.39**	0.12**
SQS	0.11**	--

Note. *p < .05, **p < .01, -- = Not significant
GPAQ = Global Physical Activity Questionnaire, METtotal = Total MET-minutes for the week, NBS = Nutritional Behaviours Scale, PAQ = Physical Activity Questionnaire, PSS = Perceived Stress Scale, PWI = Personal Wellbeing Index, SQS = Sleep Quality Scale

The Spearman correlation coefficients for the physical activity and SLAQ instruments are presented in Table 3-4. Significant correlations ($p < 0.05$) were observed between the GPAQ total activity scores and PWI, PSS, and NBS. No significant Spearman association was observed between the GPAQ to the SQS and PSS ($p > 0.05$). Positive associations were observed between the GPAQ and both the PWI ($r_s = 0.12$, $p < 0.01$) and NBS ($r_s = 0.19$, $p < 0.01$).

Table 3-4: Spearman Correlation Coefficients for Physical Activity and SLAQ Instruments

SLAQ Instruments	Physical Activity Instruments	
	PAQ	GPAQ (METtotal)
PWI	0.29**	0.12**
PSS	-0.20**	--
NBS	0.38**	0.19**
SQS	0.10**	--

Note. **p < .01, -- = Not significant
GPAQ = Global Physical Activity Questionnaire, METtotal = Total MET-minutes for the week, NBS = Nutritional Behaviours Scale, PAQ = Physical Activity Questionnaire, PSS = Perceived Stress Scale, PWI = Personal Wellbeing Index, SQS = Sleep Quality Scale

3.4 Discussion

The present study sought to investigate the potential associations between self-reported physical activity behaviours and health factors such as personal wellbeing, perceived stress, nutritional behaviours, and sleep quality in a sample of Canadian university students. Findings from the study suggest that there is a moderate association between self-reported physical activity and positive nutrition behaviours. The finding is noteworthy considering the lack of association observed between exercise behaviour and healthy eating in a previous study of U.S. university students (King, Mohl, Bernard, & Vidourek, 2007). While it is encouraging to observe a correlation between positive health behaviours, it is important to note that correlation does not imply causation and that the direction of association between factors in the study may be bidirectional. However, the presence of a positive association between physical activity and nutrition behaviours in the current sample does provide evidence for further research into the possible health promoting effects physical activity may have on nutritional behaviours. For example, future longitudinal studies could evaluate whether interventions encouraging Canadian university students to be more active potentially reinforce additional healthy behaviours such as healthy eating.

Findings from the study also suggest that there is a negative association between self-reported physical activity behaviours and perceived stress. As omnibus surveys provide correlation coefficients that are open to bidirectional interpretations, the association observed between activity and stress provides valuable insight for health promotion efforts targeting university students. First, the findings may suggest that increased levels of perceived stress negatively impact physical activity behaviours. The potential negative impact that stress has on physical activity is substantial if the implications are considered. As previously mentioned,

perceived stress has significant implications on student emotional, cognitive, and mental health (Folkman & Moskowitz, 2000). It is therefore problematic if perceived stress further negatively impacts student health by potentially reducing physical activity participation. The present findings, along with a recent review concluding that the experience of stress impairs efforts to be physically active (Stults-Kolehmainen & Sinha, 2014), indicate that university health and wellness initiatives should prioritize interventions that reduce student stress as such efforts would potentially not only improve student mental health but physical health as well. In contrast, the association observed may suggest that increased levels of physical activity reduce perceived stress. While the potential physiological effect physical activity may have on stress is beyond the scope of this study, the findings potentially align with a pattern of evidence suggesting that exercise training recruits a process that confers enduring resilience to stress (Salmon, 2001). Given that physical activity is a modifiable behaviour, the findings from the present study also suggest that student-focused health promotion initiatives might benefit from potentially using physical activity to reduce the impact of perceived stress. However, more research is also needed to determine the influence that physical activity has on stress among university students.

The study findings further suggest that self-reported university student physical activity behaviours are positively associated with subjective personal wellbeing. As the Personal Wellbeing Index used in the study is a widely used instrument for assessing quality of life, the positive association observed between activity and wellbeing provides support and encouragement for the continued promotion of physical activity participation in the student population. However, while an association between activity and wellbeing was observed, there is limited research conceptually describing how physical activity influences wellbeing or quality of life (Gill et al., 2013). As efforts to conceptually model physical activity and quality of life are

currently being developed (Gill et al., 2013), the study findings might aid in the development process by indicating that a significant association between wellbeing and physical activity is also present among university students. In addition to stress, nutrition, and wellbeing, the current study also sought to explore the association between self-reported indicators of physical activity and sleep quality. While a positive association was observed between physical activity and sleep quality, the correlation observed was minimal. This finding was surprising as evidence suggests that regular physical activity is associated with higher sleep quality (Loprinzi & Cardinal, 2011). However, the study conducted by Loprinzi and Cardinal (2011) assessed physical activity objectively through accelerometers whereas the present study utilized subjective instruments.

Finally, the present study also provided the opportunity to compare the findings between two physical activity questionnaires. As the GPAQ is an internationally used activity questionnaire, one of the theoretical benefits of using GPAQ data from a sample of Canadian university students would be that the GPAQ provides a means of comparing the activity levels of university students to various global samples. However, the findings from the present study, in addition to both the results of the 2013 SLAQ and the findings by Hubbs, Doyle, Bowden, and Doyle (2012), suggest that physical activity assessment through energy expenditure may not be ideal for use in omnibus surveys investigating cross-sectional correlations. The findings from the Spearman and Pearson coefficients for both activity instruments suggests that scale score correlation might further suggest that instruments such as the PAQ may be more useful for cross-sectional studies such as the SLAQ. As the PAQ was developed to serve as a general indicator of student physical activity behaviours for use in omnibus surveys, it was encouraging to observe a similar pattern of associations between the PAQ and GPAQ.

3.5 Limitations

There were several limitations to the evaluation of associations in the present study. First, the SLAQ was distributed during May 2014, which is the beginning of the spring semester at the University of Alberta. As the majority of students participating in the SLAQ were undergraduates, the findings may be limited by the fact that data was not collected during standard academic terms. An additional limitation includes the instrument the study used to assess physical activity and evaluate associations. In particular, the 2014 SLAQ data was used to both construct the PAQ and evaluate the associations between physical activity and health for university students. This potentially limits the findings, as the factors that influenced the PAQ are ultimately the same factors that influenced the evaluation of associations between physical activity and health. In addition, it must also be noted that the associations gathered from the PAQ must be considered carefully as the PAQ is not a purely behavioural indicator of physical activity. The PAQ consists of items that are a mix of direct behaviours, such as exercising regularly, and items that assess behaviours related to barriers to activities, such as making time to exercise. The combination of the items provides a mix of concepts that cannot be assumed to be a direct indicator of exactly what students are doing. It might be more reasonable to assume that the results signify the correlations between health scales and an instrument that attempts to provide a very broad sense of how students rate their physical activity. A final limitation includes the fact that students were offered an incentive to participate in the SLAQ. This might have impacted the sample by adding biases.

3.6 Conclusion

The findings from the present study provide new and important results on the associations between self-reported physical activity and health factors in a sample of Canadian

university students. In addition, the findings have direct implications for future research and health promotion. In the current sample, physical activity was observed to correlate strongest with nutritional behaviours and weakest with sleep quality. A positive association was also observed between physical activity and subjective wellbeing. Finally, while the negative significant correlation observed between activity and stress is potentially encouraging, the bidirectional nature of correlations in cross-sectional studies makes it difficult to infer that activity reduces stress. However, the findings provide a potential first step that could lead to the development of future longitudinal studies examining the direct impact that physical activity has on student health and wellness.

3.7 References

Altevogt, B. M., & Colten, H. R. (Eds.). (2006). *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*. Washington, DC: National Academies Press.

Armstrong, T., & Bull, F. (2006). Development of the world health organization global physical activity questionnaire (GPAQ). *Journal of Public Health*, *14*(2), 66-70.

Atkinson, G., & Davenne, D. (2007). Relationships between sleep, physical activity and human health. *Physiology & Behavior*, *90*(2), 229-235.

Bull, F. C., Maslin, T. S., & Armstrong, T. (2009). Global physical activity questionnaire (GPAQ): Nine Country Reliability and Validity study. *Journal of Physical Activity & Health*, *6*(6), 790.

Brougham, R. R., Zail, C. M., Mendoza, C. M., & Miller, J. R. (2009). Stress, sex differences, and coping strategies among college students. *Current Psychology*, *28*(2), 85-97.

Buboltz, W.C., Brown, F.C., & Soper B. (2006) Sleep habits and patterns of college students. *Journal of American College Health,* 50(3):131–135.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.

Campbell, R. L., Svenson, L. W., & Jarvis, G. K. (1992). Perceived level of stress among university undergraduate students in Edmonton, Canada. *Perceptual and Motor Skills*, *75*(2), 552-554.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Journal of the American Medical Association*, *298*(14), 1685-1687.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Coren, S. (1994). The prevalence of self-reported sleep disturbances in young adults. *International Journal of Neuroscience.* 79, 37-73.

Cummins, R. A., Eckersley, R., Pallant, J., Van Vugt, J., & Misajon, R. (2003). Developing a national index of subjective wellbeing: The Australian Unity Wellbeing Index. *Social Indicators Research*, *64*(2), 159-190.

Dyson, R., & Renk, K. (2006). Freshmen adaptation to university life: Depressive symptoms, stress, and coping. *Journal of Clinical Psychology*, *62*(10), 1231-1244.

Folkman, S., & Moskowitz, J. T. (2000). Positive affect and the other side of coping. *American Psychologist*, *55*(6), 647.

Gill, D. L., Hammond, C. C., Reifsteck, E. J., Jehu, C. M., Williams, R. A., Adams, M. M., ... & Shang, Y. T. (2013). Physical activity and quality of life. *Journal of Preventive Medicine and Public Health*, *46*(Suppl 1), S28.

Gillman, M. W., Pinto, B. M., Tennstedt, S., Glanz, K., Marcus, B., & Friedman, R. H. (2001). Relationships of physical activity with dietary behaviors among adults. *Preventive Medicine*, *32*(3), 295-301.

Hubbs, A., Doyle, E. I., Bowden, R. G., & Doyle, R. D. (2012). Relationships Among Self-Esteem, Stress, and Physical Activity in College Students 1. *Psychological Reports*, *110*(2), 469-474.

Hudd, S., Dumlao, J., Erdmann-Sager, D., Murray, D., Phan, E., Soukas, N., & Yokozuka, N. (2000). Stress at college: Effects on health habits, health status and self-esteem. *College Student Journal*.

Jackson, R.A., Berry, T.R., & Kennedy, M.D. (2009). The relationship between lifestyle and campus eating behaviours in male and female university students. *College Student Journal, 43*(3), 860-872.

King, K. A., Mohl, K., Bernard, A. L., & Vidourek, R. A. (2007). Does involvement in healthy eating among university students differ based on exercise status and reasons for exercise. *Californian Journal of Health Promotion*, *5*(3), 106-119.

Landers, D. M., & Arent, S. M. (2001). Physical activity and mental health. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 740-765). Hoboken, NJ: John Wiley & Sons.

Lau, A. L., Cummins, R. A., & McPherson, W. (2005). An investigation into the cross-cultural equivalence of the Personal Wellbeing Index. *Social Indicators Research*, *72*(3), 403-430.

Loprinzi, P. D., & Cardinal, B. J. (2011). Association between objectively-measured physical activity and sleep, NHANES 2005–2006. *Mental Health and Physical Activity*, *4*(2), 65-69.

Lund, H., Reider, B., Whiting, A., & Prichard, J. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of Adolescent Health*, 46(2), 124-132.

Oginska H, Pokorski J. (2006). Fatigue and mood correlates of sleep length in three age-social groups: school children, students, and employees. *Chronobiology International*, 23, 1317-1328.

Pate, R. R., Heath, G. W., Dowda, M., & Trost, S. G. (1996). Associations between physical activity and other health behaviors in a representative sample of US adolescents. *American Journal of Public Health*, *86*(11), 1577-1581.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189-193.

Robotham, D. (2008). Stress among higher education students: Towards a research agenda. *Higher Education*, *56*(6), 735-746.

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: a unifying theory. *Clinical Psychology Review*, *21*(1), 33-61.

Small, M., Bailer-Davis, L., Morgan, N., & Magg, J. (2012). Changes in eating and physical activity behaviours across seven semesters of college: Living on or off campus matters. *Health Education & Behaviour, 40*(4), 453-441.

Stults-Kolehmainen, M. A., & Sinha, R. (2014). The effects of stress on physical activity and exercise. *Sports Medicine*, *44*(1), 81-121.

Vidgen, H. A., & Gallegos, D. (2012). *Defining food literacy, its components, development and relationship to food intake: A case study of young people and disadvantage.* Brisbane, Queensland, Australia, http://eprints.qut.edu.au/53786/: Queensland University of Technology.

Warburton, D. E., Gledhill, N., & Quinney, A. (2001). Musculoskeletal fitness and health. *Canadian Journal of Applied Physiology*, *26*(2), 217-237.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, *174*(6), 801-809.

Chapter 4: Conclusions

4.1 Study Objectives

The objectives of this thesis were to outline the development of a questionnaire that would serve as an indicator of student physical activity and highlight the benefits of health assessment for health promotion purposes.

In 2013, a collection of health related questionnaires were combined to form the Student Life Activity Questionnaire (SLAQ). As an omnibus survey of health and wellness, the SLAQ was used to assess health behaviours among students at the University of Alberta in Canada. In addition, the SLAQ sought to explore associations between health indicators, which were guided by previous research. During analysis, a subsequent area of inquiry arose when the instrument used to assess physical activity appeared to have response and association difficulties. An investigation into the format of the instrument suggested that the use of a complex measurement structure rendered the instrument potentially difficult for use in cross-correlational research such as the SLAQ. A general review of the literature further suggested that similar questionnaires would not improve the issues observed. In addition, a review of the literature also suggested an absence of questionnaires where the outcome of interest was a relative indication of student physical activity with higher scores corresponding to higher self-reported physical activity. Therefore, it was decided to a) construct a simple questionnaire to serve as an indicator of student physical activity and b) use the questionnaire to examine the associations between physical activity and health in a student sample. The first paper in this thesis focused on outlining the development process and included an evaluation of the resulting items grouped to form the questionnaire. The second paper in this thesis focused on the associations between scores derived from the physical activity and health questionnaires included in the 2014 SLAQ.

The associations that this thesis sought to investigate were the association between: 1) physical activity and perceived stress, 2) physical activity and personal wellbeing, 3) physical activity and sleep quality, and 4) physical activity and nutritional behaviours.

4.2 Questionnaire Development

The first paper in this thesis outlined the steps taken in developing a physical activity questionnaire that assessed student activity behaviours. The conceptual framework used to guide item development was inspired by facet theory, which attempts to conceptualize a construct by encouraging the investigator to consider describing the construct through related domains and ranges that provide a means for assessment. As the outcome of interest was an indicator where higher scores corresponded to higher physical activity participation, the range was set to provide an assessment of how frequent activity participation occurred. This was accomplished by setting a 7-point item response range where 0: Never and 6: Very often. Activity themes were used to conceptualize broad domains of student physical activity behaviour. Themes consisted of the components comprising the accepted definition of physical activity (i.e., bodily movement, exercise, and fitness) and groupings relevant to student life (i.e., recreation/sports and sitting). Following, a set of 14 physical activity items was generated to include a broad range of physical activity behaviours, such as how often students reported meeting Canadian physical activity guidelines, exercising, making time to exercise, performing household tasks, sitting for long periods of time, and walking to relax. The set of items were included in the 2014 SLAQ and underwent factor analysis to determine whether a simple questionnaire could be created from a reduced grouping. The SLAQ also included the Global Physical Activity Questionnaire (GPAQ), which allowed the convergent validity of the resulting questionnaire to be evaluated.

It was found that a factor consisting of 9 physical activity items could be extracted from the data to potentially serve as a broad indicator. When scale scored, the resulting 9-item Physical Activity Questionnaire (PAQ) had high internal reliability. Encouragingly, the PAQ and GPAQ physical activity scores showed significant positive Pearson and Spearman correlations. The strongest correlation was observed between the PAQ and recreational activities from the GPAQ, which was not surprising given that the population of interest was university students. The weakest correlations were observed between the PAQ and GPAQ transit scores.

4.2.1 Limitations

Several significant limitations are apparent with in the development study. First and foremost, the developed PAQ is limited by the fact that is not a purely behavioural indicator of physical activity. What this means is that the overall outcome score cannot be considered to be a score of what activities students report doing as the item set included items on why students performed activities and included items on barriers/strategies. Essentially, while the scale score might provide a relative assessment of how often students report doing behaviours, the behaviours are not all molded to capture what they are doing. Second, the study was limited in its ability to determine whether the PAQ actually provided an indication of physical activity. This is because the study utilized convergent validity by comparing the PAQ to the GPAQ. It is important to make the distinction that the presence of correlation does not imply that two instruments provide an assessment of similar behaviours. What this means is that the strong correlations seen by the PAQ to, for example, the GPAQ recreational activities MET-scores cannot be taken to imply that the PAQ provides a strong indication of recreational behaviours as the GPAQ focuses on specific behaviours whereas the PAQ cannot be assumed to do so. Additionally, there were a limited number of items available for inclusion in the SLAQ. As the

SLAQ contains numerous questionnaires, the number of items included in the development process was determined to avoid the possibility of survey fatigue. The inability to include a wider set of items may have contributed to the lack of walking behaviour factor loading on the final questionnaire. In addition, the decision to use activity themes over activity types is a potential methodological limitation. By utilizing activity themes, the activities of interest used to develop items were approach by whether they resulted in, for example, bodily movements. While this approach might still lead to a broad set of items, the use of activity types might have provided a focused outlook for item development. For example, activity types could have been used to separate out aerobic activities from strength activities, which might have provided more student relevant activities. As the number of items was limited, walking behaviour was included under walking for leisure purposes to relax. Given additional items, walking behaviour could have been expanded upon to include additional items on walking for transportation purposes or how often students continuously walk for a given time period. Item wording might have also limited the finalized grouping of items forming the PAQ. For example, the set of items included an item that intended to assess how often students reported limiting their daily activities. The item included a prompt that provided students with a potential cause as to why they would choose to limit their daily activities. A limitation of the item is that it students might not be cognizant of the fact that they are purposefully limiting their daily activities.

4.2.2 Contributions to the Current Literature

To date, few questionnaires have been developed that attempt to broadly assess university student physical activity behaviours. Furthermore, a review of the current literature suggests that the current study might be the first to evaluate physical activity themed items through factor analysis in the Canadian university setting. In addition, the procedure outlined may be applicable

to additional health related behaviours and provide insight for the development of future indicators of health and wellness.

4.2.3 Future Research

Findings from the factor analysis showed that the finalized questionnaire did not include sitting behaviour items, due to the items not meeting the necessary loading criteria. The lack of item loading suggests that future research efforts could be designed to develop an indicator of student sitting behaviour. As student life contains long periods of sitting that includes sitting during classes, studying, working on assignments, and social sitting, the inclusion of an indicator of sitting behaviour would add to the scope of future omnibus surveys of health and wellness, such as the SLAQ. Future research could also further evaluate the validity of the PAQ. As there is no current gold standard for subjective physical activity assessment, convergent validity could only be evaluated with the GPAQ. Additional studies could evaluate the criterion validity of the PAQ through a comparison with objective physical activity instruments, such as doubly labeled water and accelerometers.

4.3 Analysis of Associations in the 2014 SLAQ

The second paper in this thesis focused on presenting the analysis of associations between scores derived from questionnaires in the 2014 SLAQ. More specifically, the associations this thesis sought to investigate involved the associations between physical activity and scale scores derived from questionnaires on perceived stress, nutritional behaviours, sleep quality, and personal wellbeing. An invitation to participate in the SLAQ was sent to 4000 random students enrolled at the University of Alberta. Participation was voluntary and students choosing to participate were provided with a $10 credit on their university identification card.

Students were also provided with information on the project and contact information for the study lead should they have any questions.

The 2014 SLAQ had a 34% response rate (n = 1366) and demographic information showed that the majority of students who participated were undergraduate students. Descriptive analysis showed that each of the questionnaires used in the SLAQ had acceptable internal consistency scores. Similar to the 2013 SLAQ, the Pearson correlation coefficients for the GPAQ were difficult to evaluate. In contrast, Pearson correlational analysis for the PAQ suggested that there is a moderately positive association between physical activity and nutritional behaviours. While the magnitude of correlation between physical activity and nutritional behaviours was the strongest correlation observed, a similarly moderate correlation was observed between physical activity and personal wellbeing. A negative correlation was observed between physical activity and perceived stress that was similar in magnitude to the correlation observed between physical activity and personal wellbeing. A small but positive correlation was also observed between physical activity and sleep quality. Correlational analysis also included evaluating the Spearman coefficients between the physical activity instruments and SLAQ scale scores. For the PAQ, the Spearman correlation coefficients were similar to the Pearson coefficients. For the GPAQ, the Spearman analysis showed that total physical activity scores from the GPAQ positively associated with nutritional behaviours and personal wellbeing. Similar to the PAQ, the strongest association for the GPAQ total physical activity scores was between physical activity and nutritional behaviours. The comparative pattern of associations for both the PAQ and GPAQ were similar as the strongest associations were observed between physical activity and nutrition, followed by physical activity and personal wellbeing, then physical activity and perceived stress, and finally physical activity and sleep quality.

4.3.1 Limitations

There are several limitations to the SLAQ that warrant discussion. First, the SLAQ is a cross-sectional omnibus survey of student health and wellness. As such, the bidirectional interpretation of the associations investigated must be considered. Second, given that the SLAQ is a lengthy collection of questionnaires, students were provided with an incentive in the form of a $10 credit to assist with survey participation. However, the presence of an incentive may have undermined data quality. A further limitation includes the data collection period of the 2014 SLAQ. The SLAQ was distributed during May 2014, which is the beginning of the spring semester at the University of Alberta. As the majority of students participating in the SLAQ were undergraduates, the findings may be limited by the fact that data was not collected during standard academic terms. An additional limitation includes the fact that the 2014 SLAQ data was used to both construct the PAQ and evaluate the associations between physical activity and health for university students. This potentially limits the findings, as the potential factors inherent in the data that might have influenced the PAQ are ultimately the same potential factors that might have influenced the evaluation of associations between physical activity and health.

4.3.2 Contributions to the Current Literature

At present, the omnibus exploration of factors associated with student health outcomes in the Canadian university setting has been underexplored. Furthermore, few studies have attempted to simultaneously investigate the associations between physical activity and various indicators of health in a sample of Canadian university students. Findings from the study offer numerous benefits to public health and health promotion. In addition, the strengths of association observed may direct future research initiatives.

4.3.3 Future Research

The findings from the 2014 SLAQ suggest that future research on the nature of physical activity and stress is warranted. Given that a negative association was observed between physical activity and stress, longitudinal studies evaluating the potential impact of physical activity on stress could provide valuable information for university health and wellness services. As physical activity behaviour is modifiable, evidence supporting physical activity as a means to reduce student stress would prove invaluable to health promotion.

4.4 Concluding Remarks

In summary, the 9-item Physical Activity Questionnaire appears to be a potentially useful indicator of student physical activity. Future research can use, modify, and update the steps outlined in this thesis to develop future questionnaires on a wide array of health behaviours. However, future studies are reminded to consider whether the indicator developed is purely behavioural or an alternative indicator or health as the distinction is an important consideration. The positive associations between physical activity to nutrition, personal wellbeing, and sleep are encouraging and the association between physical activity and perceived stress provides motivation for future research.

References

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., ... & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise*, *32*(9; SUPP/1), S498-S504.

Altevogt, B. M., & Colten, H. R. (Eds.). (2006). *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*. Washington, DC: National Academies Press.

Anis, A. H., Zhang, W., Bansback, N., Guh, D. P., Amarsi, Z., & Birmingham, C. L. (2010). Obesity and overweight in Canada: an updated cost-of-illness study. *Obesity Reviews*, *11*(1), 31-40.

Anshel, M. H., & Seipel, S. J. (2009). Self-monitoring and selected measures of aerobic and strength fitness and short-term exercise attendance. *Journal of Sport Behavior*, *32*(2), 125.

Armstrong, T., & Bull, F. (2006). Development of the world health organization global physical activity questionnaire (GPAQ). *Journal of Public Health*, *14*(2), 66-70.

Atkinson, G., & Davenne, D. (2007). Relationships between sleep, physical activity and human health. *Physiology & Behavior*, *90*(2), 229-235.

Baranowski, T., Mendlein, J., Resnicow, K., Frank, E., Cullen, K. W., & Baranowski, J. (2000). Physical activity and nutrition in children and youth: an overview of obesity prevention. *Preventive Medicine*, *31*(2), S1-S10.

Bauman, A., Phongsavan, P., Schoeppe, S., & Owen, N. (2006). Physical activity measurement-a primer for health promotion. *Promotion & Education*, *13*(2), 92-103.

Baumert Jr, P. W., Henderson, J. M., & Thompson, N. J. (1998). Health risk behaviors of adolescent participants in organized sports. *Journal of Adolescent Health*, *22*(6), 460-465.

Beavers, A. S., Lounsbury, J. W., Richards, J. K., Huck, S. W., Skolits, G. J., & Esquivel, S. L. (2013). Practical considerations for using exploratory factor analysis in educational research. *Practical Assessment, Research & Evaluation*, *18*(6), 1-13.

Biddle, S. J., Gorely, T., Pearson, N., & Bull, F. C. (2011). An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 1.

Bishara, A. J., & Hittner, J. B. (2012). Testing the significance of a correlation with nonnormal data: comparison of Pearson, Spearman, transformation, and resampling approaches. *Psychological Methods*, *17*(3), 399.

Blair, S. N. (2009). Physical inactivity: the biggest public health problem of the 21st century. *British Journal of Sports Medicine*, *43*(1), 1-2.

Booth, M. (2000). Assessment of physical activity: an international perspective. *Research Quarterly for Exercise and Sport*, *71*(sup2), 114-120.

Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *195*(9131/03), 3508-1381.

Brougham, R. R., Zail, C. M., Mendoza, C. M., & Miller, J. R. (2009). Stress, sex differences, and coping strategies among college students. *Current Psychology*, *28*(2), 85-97.

Buboltz, W.C., Brown, F.C., & Soper B. (2006) Sleep habits and patterns of college students. *Journal of American College Health,* 50(3):131–135.

Bull, F. C., Maslin, T. S., & Armstrong, T. (2009). Global physical activity questionnaire (GPAQ): Nine Country Reliability and Validity study. *Journal of Physical Activity & Health*, *6*(6), 790.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.

Byrne, A., & Byrne, D. G. (1993). The effect of exercise on depression, anxiety and other mood states: a review. *Journal of Psychosomatic Research*, *37*(6), 565-574.

Campbell, R. L., Svenson, L. W., & Jarvis, G. K. (1992). Perceived level of stress among university undergraduate students in Edmonton, Canada. *Perceptual and Motor Skills*, *75*(2), 552-554.campus eating behaviours in male and female university students. *College Student Journal, 43*(3), 860-872.

Canter, D. (Ed.). (2012). *Facet theory: Approaches to social research*. Springer Science & Business Media.

Caspersen, C. J., Bloemberg, B. P., Saris, W. H., Merritt, R. K., & Kromhout, D. (1991). The prevalence of selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen Study, 1985. *American Journal of Epidemiology*, *133*(11), 1078-1092.

Cella, D. F., Tulsky, D. S., Gray, G., Sarafian, B., Linn, E., Bonomi, A., ... & Brannon, J. (1993). The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. *Journal of Clinical Oncology*, *11*(3), 570-579.

Chau, J. Y., Van der Ploeg, H. P., Dunn, S., Kurko, J., & Bauman, A. E. (2012). Validity of the occupational sitting and physical activity questionnaire. *Medicine & Science in Sports & Exercise*, *44*(1), 118-125.

Cohen, S., & Rodriguez, M. S. (1995). Pathways linking affective disturbances and physical disorders. *Health Psychology*, *14*(5), 374.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Journal of the American Medical Association*, *298*(14), 1685-1687.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, *22*(1), 1-8.

Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician*, *35*(3), 124-129.

Coren, S. (1994). The prevalence of self-reported sleep disturbances in young adults. *International Journal of Neuroscience.* 79, 37-73.

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295-301.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., & Oja, P. (2003). and the IPAQ Consensus Group and the IPAQ Reliability and Validity Study Group. International Physical Activity Questionnaire (IPAQ): 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*, 1381-1395.

Cummins, R. A., Eckersley, R., Pallant, J., Van Vugt, J., & Misajon, R. (2003). Developing a national index of subjective wellbeing: The Australian Unity Wellbeing Index. *Social Indicators Research*, *64*(2), 159-190.

Daskapan, A., Tuzun, E. H., & Eker, L. (2005). Relationship between physical activity level and health related quality of life among university students. *Saudi Medical Journal*, *26*(6), 1026-1028.

Dawson, K. A., Schneider, M. A., Fletcher, P. C., & Bryden, P. J. (2007). Examining gender differences in the health behaviors of Canadian university students. *The Journal of the Royal Society for the Promotion of Health*, *127*(1), 38-44.

Deslandes, A., Moraes, H., Ferreira, C., Veiga, H., Silveira, H., Mouta, R., ... & Laks, J. (2009). Exercise and mental health: many reasons to move. *Neuropsychobiology*, *59*(4), 191-198.

Dinger, M. K., Behrens, T. K., & Han, J. L. (2006). Validity and reliability of the International Physical Activity Questionnaire in college students. *American Journal of Health Education*, *37*(6), 337-343.

Dipietro, L., Caspersen, C. J., Ostfeld, A. M., & Nadel, E. R. (1993). A survey for assessing physical activity among older adults. *Medicine & Science in Sports & Exercise*.

Downs, A., & Ashton, J. (2011). Vigorous physical activity, sports participation, and athletic identity: Implications for mental and physical health in college students. *Journal of Sport Behavior*, *34*(3), 228.

Dyson, R., & Renk, K. (2006). Freshmen adaptation to university life: Depressive symptoms, stress, and coping. *Journal of Clinical Psychology*, *62*(10), 1231-1244.

Edgell, S. E., & Noon, S. M. (1984). Effect of violation of normality on the t test of the correlation coefficient. *Psychological Bulletin*, *95*(3), 576.

Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment*, *7*(3), 286.

Folkman, S., & Moskowitz, J. T. (2000). Positive affect and the other side of coping. *American Psychologist*, *55*(6), 647.

Fox, K. R. (1999). The influence of physical activity on mental well-being. *Public Health Nutrition*, *2*(3a), 411-418.

Friedenreich, C. M., Courneya, K. S., Neilson, H. K., Matthews, C. E., Willis, G., Irwin, M., Troiano, R., & Ballard-Barbash, R. (2006). Reliability and validity of the past year total physical activity questionnaire. *American Journal of Epidemiology*, *163*(10), 959-970.

Galesic, M., & Bosnjak, M. (2009). Effects of questionnaire length on participation and indicators of response quality in a web survey. *Public Opinion Quarterly*, *73*(2), 349-360.

Giles-Corti, B., Timperio, A., Cutt, H., Pikora, T. J., Bull, F. C., Knuiman, M., ... & Shilton, T. (2006). Development of a reliable measure of walking within and outside the local neighborhood: RESIDE's Neighborhood Physical Activity Questionnaire. *Preventive Medicine*, *42*(6), 455-459.

Gill, D. L., Hammond, C. C., Reifsteck, E. J., Jehu, C. M., Williams, R. A., Adams, M. M., ... & Shang, Y. T. (2013). Physical activity and quality of life. *Journal of Preventive Medicine and Public Health*, *46*(Suppl 1), S28.

Gillman, M. W., Pinto, B. M., Tennstedt, S., Glanz, K., Marcus, B., & Friedman, R. H. (2001). Relationships of physical activity with dietary behaviors among adults. *Preventive Medicine*, *32*(3), 295-301.

Good, P. (2009). Robustness of Pearson correlation. *InterStat*, *15*(5), 1-6.

Griffith, L. E., Cook, D. J., Guyatt, G. H., & Charles, C. A. (1999). Comparison of open and closed questionnaire formats in obtaining demographic information from Canadian general internists. *Journal of Clinical Epidemiology*, *52*(10), 997-1005.

Grimstvedt, M. E., Kerr, J., Oswalt, S. B., Fogt, D. L., Vargas-Tonsing, T. M., & Yin, Z. (2010). Using signage to promote stair use on a university campus in hidden and visible stairwells. *Journal of Physical Activity & Health*, *7*(2), 232.

Haase, A., Steptoe, A., Sallis, J. F., & Wardle, J. (2004). Leisure-time physical activity in university students from 23 countries: associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*, *39*(1), 182-190.

Havlicek, L. L., & Peterson, N. L. (1977). Effect of the violation of assumptions upon significance levels of the Pearson r. *Psychological Bulletin*, *84*(2), 373.

Health Council of Canada. (2007). Why Health Care Renewal Matters: Learning from Canadians with Chronic Health Conditions. Toronto: Health Council. www.healthcouncilcanada.ca.

Healy, G. N., Dunstan, D. W., Salmon, J., Cerin, E., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Breaks in sedentary time beneficial associations with metabolic risk. *Diabetes Care*, *31*(4), 661-666.

Heath, G. W., & Fentem, P. H. (1996). Physical activity among persons with disabilities--a public health perspective. *Exercise and Sport Sciences Reviews*, *25*, 195-234.

Hubbs, A., Doyle, E. I., Bowden, R. G., & Doyle, R. D. (2012). Relationships Among Self-Esteem, Stress, and Physical Activity in College Students 1. *Psychological Reports*, *110*(2), 469-474.

Hudd, S., Dumlao, J., Erdmann-Sager, D., Murray, D., Phan, E., Soukas, N., & Yokozuka, N. (2000). Stress at college: Effects on health habits, health status and self-esteem. *College Student Journal*.

Huddleston, S., Mertesdorf, J., & Araki, K. (2002). Physical activity behavior and attitudes toward involvement among physical education, health, and leisure services pre-professionals. *College Student Journal*, *36*(4), 555.

Irwin, J. D. (2004). Prevalence of University Students' Sufficient Physical Activity: A Systematic Review 1. *Perceptual and Motor Skills*, *98*(3), 927-943.

Jackson, R.A., Berry, T.R., & Kennedy, M.D. (2009). The relationship between lifestyle and campus eating behaviours in male and female university students. *College Student Journal, 43*(3), 860-872.

Jacobs Jr, D. R., Ainsworth, B. E., Hartman, T. J., & Leon, A. S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise*, *25*(1), 81-91.

Jones, L. W., Courneya, K. S., Vallance, J. K., Ladha, A. B., Mant, M. J., Belch, A. R., ... & Reiman, T. (2004). Association between exercise and quality of life in multiple myeloma cancer survivors. *Supportive Care in Cancer*, *12*(11), 780-788. *Journal of Health and Social Behavior*, 385-396.

Karageorghis, C. I., Vencato, M. M., Chatzisarantis, N. L. D., & Carron, A. V. (2005). Development and initial validation of the Brunel lifestyle physical activity questionnaire. *British journal of sports medicine*, *39*(5), e23-e23.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology*, *29*(1), 90-115.

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. *Canadian Medical Association Journal*, *163*(11), 1435-1440.

Keating, X. D., Guan, J., Piñero, J. C., & Bridges, D. M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health*, *54*(2), 116-126.

Kilpatrick, M., Hebert, E., & Bartholomew, J. (2005). College students' motivation for physical activity: differentiating men's and women's motives for sport participation and exercise. *Journal of American College Health*, *54*(2), 87-94.

King, K. A., Mohl, K., Bernard, A. L., & Vidourek, R. A. (2007). Does involvement in healthy eating among university students differ based on exercise status and reasons for exercise. *Californian Journal of Health Promotion*, *5*(3), 106-119.

Kline, P. (2014). *An easy guide to factor analysis*. Routledge.

Kohl III, H. W. (2001). Physical activity and cardiovascular disease: evidence for a dose response. *Medicine & Science in Sports & Exercise*, *33*(6 Suppl), S472-83.

Kohl III, H. W., Fulton, J. E., & Caspersen, C. J. (2000). Assessment of physical activity among children and adolescents: a review and synthesis. *Preventive Medicine*, *31*(2), S54-S76.

Kowalski, K. C., Crocker, P. R., & Kowalski, N. P. (1997). Convergent validity of the physical activity questionnaire for adolescents. *Pediatric Exercise Science*, *9*, 342-352.

Landers, D. M., & Arent, S. M. (2001). Physical activity and mental health. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 740-765). Hoboken, NJ: John Wiley & Sons.

Lau, A. L., Cummins, R. A., & McPherson, W. (2005). An investigation into the cross-cultural equivalence of the Personal Wellbeing Index. *Social Indicators Research*, *72*(3), 403-430.

Lee, I. M., & Skerrett, P. J. (2001). Physical activity and all-cause mortality: what is the dose-response relation?. *Medicine & Science in Sports & Exercise*, *33*(6; SUPP), S459-S471.

Lee Rodgers, J., & Nicewander, W. A. (1988). Thirteen ways to look at the correlation coefficient. *The American Statistician*, *42*(1), 59-66.

Leslie, E., Sparling, P. B., & Owen, N. (2001). University campus settings and the promotion of physical activity in young adults: lessons from research in Australia and the USA. *Health Education*, *101*(3), 116-125.

Loprinzi, P. D., & Cardinal, B. J. (2011). Association between objectively-measured physical activity and sleep, NHANES 2005–2006. *Mental Health and Physical Activity*, *4*(2), 65-69.

Lund, H., Reider, B., Whiting, A., & Prichard, J. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of Adolescent Health*, 46(2), 124-132.

Maddison, R., Mhurchu, C. N., Jiang, Y., Vander Hoorn, S., Rodgers, A., Lawes, C. M., & Rush, E. (2007). International physical activity questionnaire (IPAQ) and New Zealand physical activity questionnaire (NZPAQ): A doubly labelled water validation. *International Journal of Behavioral Nutrition and Physical Activity*, *4*(1), 62.

Macfarlane, D. J., Lee, C. C., Ho, E. Y., Chan, K. L., & Chan, D. (2006). Convergent validity of six methods to assess physical activity in daily life. *Journal of Applied Physiology*, *101*(5), 1328-1334.

Matton, L., Wijndaele, K., Duvigneaud, N., Duquet, W., Philippaerts, R., Thomis, M., & Lefevre, J. (2007). Reliability and validity of the Flemish Physical Activity Computerized Questionnaire in adults. *Research Quarterly for Exercise and Sport*, *78*(4), 293-306.

McDonald, J. H. (2009). *Handbook of biological statistics* (Vol. 2, pp. 173-181). Baltimore, MD: Sparky House Publishing.

McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Leisure-time physical activity in school environments: an observational study using SOPLAY. *Preventive Medicine*, *30*(1), 70-77.

McLafferty, S. L. (2003). Conducting questionnaire surveys. *Key Methods in Geography*, 87-100.

McLean, G., & Tobias, M. (2004). The New Zealand Physical Activity Questionnaires: Report on the validation and use of the NZPAQ-LF and NZPAQ-SF self-report physical activity survey instruments. SPARC.

Morris, J. N., & Hardman, A. E. (1997). Walking to health. *Sports medicine*, *23*(5), 306-332.

Moy, K. L., Scragg, R. K., McLean, G., & Carr, H. (2008). The New Zealand Physical Activity Questionnaires: validation by heart-rate monitoring in a multiethnic population. *Journal of Physical Activity & Health*, *5*, S45.

Myers, J. L., Well, A., & Lorch, R. F. (2010). *Research design and statistical analysis*. Routledge.national index of subjective wellbeing: The Australian Unity Wellbeing Index. *Social Indicators Research*, *64*(2), 159-190.

Nguyen-Michel, S. T., Unger, J. B., Hamilton, J., & Spruijt-Metz, D. (2006). Associations between physical activity and perceived stress/hassles in college students. *Stress and Health*, *22*(3), 179-188.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, *15*(5), 625-632.

Nunnally, J. C., Bernstein, I. H., & Berge, J. M. T. (1967). *Psychometric theory* (Vol. 226). New York: McGraw-Hill.

Ogilvie, D., Foster, C. E., Rothnie, H., Cavill, N., Hamilton, V., Fitzsimons, C. F., ... & Scottish Physical Activity Research Collaboration. (2007). Interventions to promote walking: systematic review. *British Medical Journal*.

Oginska H, Pokorski J. (2006). Fatigue and mood correlates of sleep length in three age-social groups: school children, students, and employees. *Chronobiology International*, 23, 1317-1328.

Owen, N., Healy, G. N., Matthews, C. E., & Dunstan, D. W. (2010). Too much sitting: the population-health science of sedentary behavior. *Exercise and Sport Sciences Reviews*, *38*(3), 105.

Paffenbarger Jr, R. S., Blair, S. N., Lee, I. M., & Hyde, R. T. (1993). Measurement of physical activity to assess health effects in free-living populations. *Medicine & Science in Sports & Exercise*, *25*(1), 60-70.

Pate, R. R., Heath, G. W., Dowda, M., & Trost, S. G. (1996). Associations between physical activity and other health behaviors in a representative sample of US adolescents. *American Journal of Public Health*, *86*(11), 1577-1581.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., ... & Wilmore, J. H. (1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, *273*(5), 402-407.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189-193.

Philippaerts, R. M., Westerterp, K. R., & Lefevre, J. (1999). Doubly labelled water validation of three physical activity questionnaires. *International Journal of Sports Medicine*, *20*(5), 284-289.

Plasqui, G., & Westerterp, K. R. (2007). Physical activity assessment with accelerometers: an evaluation against doubly labeled water. *Obesity*, *15*(10), 2371-2379.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 56.

Prochaska, J. J., Sallis, J. F., Sarkin, J. A., & Calfas, K. J. (2000). Examination of the factor structure of physical activity behaviors. *Journal of Clinical Epidemiology*, *53*(8), 866-874.

Rattray, J., & Jones, M. C. (2007). Essential elements of questionnaire design and development. *Journal of Clinical Nursing*, *16*(2), 234-243.

Regehr, C., Glancy, D., & Pitts, A. (2013). Interventions to reduce stress in university students: A review and meta-analysis. *Journal of Affective Disorders*, *148*(1), 1-11.

Reiff, G. G., Montoye, H. J., Remington, R. D., Napier, J. A., Metzner, H. L., & Epstein, F. H. (1967). Assessment of physical activity by questionnaire and interview. *Journal of Sports Medicine and Physical Fitness*, *7*(3), 135-142.

Reilly, J. J., Penpraze, V., Hislop, J., Davies, G., Grant, S., & Paton, J. Y. (2008). Objective measurement of physical activity and sedentary behaviour: review with new data. *Archives of Disease in Childhood*, *93*(7), 614-619.

Reja, U., Manfreda, K. L., Hlebec, V., & Vehovar, V. (2003). Open-ended vs. close-ended questions in web questionnaires. *Developments in applied statistics*, *19*, 159-177.

Rennie, K. L., & Wareham, N. J. (1998). The validation of physical activity instruments for measuring energy expenditure: problems and pitfalls. *Public Health Nutrition*, *1*(04), 265-271.

Robotham, D. (2008). Stress among higher education students: Towards a research agenda. *Higher Education*, *56*(6), 735-746.

Sallis, J. F., Frank, L. D., Saelens, B. E., & Kraft, M. K. (2004). Active transportation and physical activity: opportunities for collaboration on transportation and public health research. *Transportation Research Part A: Policy and Practice*, *38*(4), 249-268.

Sallis, J. F., Haskell, W. L., Wood, P. D., Fortmann, S. P., Rogers, T., Blair, S. N., & Paffenbarger, R. S. (1985). Physical activity assessment methodology in the Five-City Project. *American Journal of Epidemiology*, *121*(1), 91-106.

Sallis, J. F., Owen, N., & Fisher, E. B. (2008). Ecological models of health behavior. *Health behavior and health education: Theory, research, and practice*, *4*, 465-486.

Sallis, J. F., & Patrick, K. (1994). Physical activity guidelines for adolescents: consensus statement. *Pediatric Exercise Science*, *6*, 302-302.

Sallis, J. F., & Saelens, B. E. (2000). Assessment of physical activity by self-report: status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, *71*(sup2), 1-14.

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: a unifying theory. *Clinical Psychology Review*, *21*(1), 33-61.

Schutz, Y., Weinsier, R. L., & Hunter, G. R. (2001). Assessment of free-living physical activity in humans: an overview of currently available and proposed new measures. *Obesity Research*, *9*(6), 368-379.

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine*, *37*(3), 197-206.

Small, M., Bailer-Davis, L., Morgan, N., & Magg, J. (2012). Changes in eating and physical activity behaviours across seven semesters of college: Living on or off campus matters. *Health Education & Behaviour, 40*(4), 453-441.

Sothern, M. S. (2004). Obesity prevention in children: physical activity and nutrition. *Nutrition*, *20*(7), 704-708.

Sternfeld, B., Ainsworth, B. E., & Quesenberry, C. P. (1999). Physical activity patterns in a diverse population of women. *Preventive Medicine*, *28*(3), 313-323.

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission*, *116*(6), 777-784.

Stults-Kolehmainen, M. A., & Sinha, R. (2014). The effects of stress on physical activity and exercise. *Sports Medicine*, *44*(1), 81-121.

Taylor, H. L., Jacobs, D. R., Schucker, B., Knudsen, J., Leon, A. S., & Debacker, G. (1978). A questionnaire for the assessment of leisure time physical activities. *Journal of Chronic Diseases*, *31*(12), 741-755.

Thomas, J. R., & Thomas, K. T. (2002). Physical activity data: Odd distributions yield strange answers. In G. Welk (Ed.), *Physical Activity Assessments for Health-Related Research* (pp. 73-80). Champaign, IL: Human Kinetics.

Thomas, J. R., Nelson, J. K., & Thomas, K. T. (1999). A generalized rank-order method for nonparametric analysis of data from exercise science: a tutorial. *Research Quarterly for Exercise and Sport*, *70*(1), 11-23.

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology*, *45*(5), 1761-1772.

Thorp, A. A., Owen, N., Neuhaus, M., & Dunstan, D. W. (2011). Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996–2011. *American Journal of Preventive Medicine*, *41*(2), 207-215.

Thune, I., & Furberg, A. S. (2001). Physical activity and cancer risk: dose-response and cancer, all sites and site-specific. *Medicine & science in Sports & Exercise*, *33*(6 Suppl), S530-50.

Topolski, T. D., LoGerfo, J., Patrick, D. L., Williams, B., Walwick, J., & Patrick, M. M. B. (2006). Peer Reviewed: The Rapid Assessment of Physical Activity (RAPA) Among Older Adults. *Preventing Chronic Disease*, *3*(4).

Tremblay, M. S., Warburton, D. E., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., ... & Duggan, M. (2011). New Canadian physical activity guidelines. *Applied Physiology, Nutrition, and Metabolism*, *36*(1), 36-46.

Vancampfort, D., Probst, M., Scheewe, T., Maurissen, K., Sweers, K., Knapen, J., & De Hert, M. (2011). Lack of physical activity during leisure time contributes to an impaired health related quality of life in patients with schizophrenia. *Schizophrenia research*, *129*(2), 122-127.

Vanhees, L., Lefevre, J., Philippaerts, R., Martens, M., Huygens, W., Troosters, T., & Beunen, G. (2005). How to assess physical activity? How to assess physical fitness?. *European Journal of Cardiovascular Prevention & Rehabilitation*, *12*(2), 102-114.

Vidgen, H. A., & Gallegos, D. (2012). *Defining food literacy, its components, development and relationship to food intake: A case study of young people and disadvantage.* Brisbane, Queensland, Australia, http://eprints.qut.edu.au/53786/: Queensland University of Technology.

Vogel, T., Brechat, P. H., Leprêtre, P. M., Kaltenbach, G., Berthel, M., & Lonsdorfer, J. (2009). Health benefits of physical activity in older patients: a review. *International Journal of Clinical Practice*, *63*(2), 303-320.

Warburton, D. E., Gledhill, N., & Quinney, A. (2001). Musculoskeletal fitness and health. *Canadian Journal of Applied Physiology*, *26*(2), 217-237.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, *174*(6), 801-809.

Ware Jr, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical care*, 473-483.

Warren, J. M., Ekelund, U., Besson, H., Mezzani, A., Geladas, N., & Vanhees, L. (2010). Assessment of physical activity–a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. *European Journal of Cardiovascular Prevention & Rehabilitation*, *17*(2), 127-139.

Welk, G. (Ed.). (2002). *Physical activity assessments for health-related research*. Champaign, IL: Human Kinetics.

Wendel-Vos, G. C., Schuit, A. J., Saris, W. H., & Kromhout, D. (2003). Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *Journal of Clinical Epidemiology*, *56*(12), 1163-1169.

Westerterp, K. R. (2009). Assessment of physical activity: a critical appraisal. *European Journal of Applied Physiology*, *105*(6), 823-828.

Wong, S. L., Leatherdale, S. T., & Manske, S. R. (2006). Reliability and validity of a school-based physical activity questionnaire. *Medicine & Science in Sports & Exercise*, *38*(9), 1593-1600.

Yoo, H. L. (2007). *Relationship between physical activity, perceived stress, and the metabolic syndrome in law enforcement officers*. ProQuest.

Appendix A: Complete Set of Developed Physical Activity Items

1. When the weather permits, I spend my leisure time outside rather than inside.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

2. I use my academic institution's recreation facilities.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

3. Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these requirements.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

4. I actively monitor my level of fitness.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

5. I play an organized sport (team or individual).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

6. I spend long periods of time sitting/reclining without feeling the urge to get up and move around.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

7. Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (workout regimen, classes, trainer, etc.).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

8. I make time to exercise regardless of my schedule.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

9. I sit with my computer or watch television to relax.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

10. To avoid fatigue or exhaustion interfering with my personal/professional goals, I regularly limit my daily activities.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

11. I take the stairs rather than the elevator or escalator.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

12. I regularly perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

13. When I want to relax, I go for a walk.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

14. I regularly perform household tasks (cleaning, preparing meals, etc.).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

Appendix B: Student Life Activity Questionnaire (SLAQ) Invitation

Dear [student first name]

You have been randomly selected to participate in a study about your health and well-being on campus!

Participation in the research project is totally voluntary so it's up to you to decide whether or not to participate.

If you're interested, please go to [web address TBA] to learn more about the study and access the survey.

If you do complete the survey, we will provide **you with a $10 credit on your ONEcard account**.

Thanks!

Walie Aktary
Project Coordinator,
School of Public Health, University of Alberta

780-945-1030
waktary@ualberta.ca

Appendix C: Student Life Activity Questionnaire (SLAQ) Study Consent Information

[University of Alberta logo + letterhead]

Title of Project: Student Life Activity Questionnaire Study 2014

Principal Investigator: Dr. Donald Schopflocher, PhD

Phone Number: 780.492.7112

Hi! Welcome to our research project. This project is about student health and well-being at the University of Alberta. **Please read the important information below and decide if you want to take part**!

About the Project
The online survey will take about 20-30 minutes to complete. We will ask you questions about your health, satisfaction with life, levels of stress, coping strategies, and health related activities.

For taking part, we will provide **you a $10 credit on your ONEcard account!** Your email address will not be used for any other purpose, it will not be connected to your answers on the survey, and it will be destroyed at the end of the project. All of your answers to the survey will be anonymous and they will be kept confidential. Survey data will be stored as password-protected electronic files on a secure server at the University of Alberta for 5 years.
You should know that participation in the research project is totally voluntary and it's up to you to decide whether or not to participate. You may withdraw from the project at any time and/or skip any survey questions that you are uncomfortable with.

Risks and Benefits
We hope that you will find the questions in this study interesting. Some people may find answering personal questions about their health and well-being upsetting. If so, the website will provide information about sources of help at the University of Alberta.

Who has approved this study?
The University of Alberta has reviewed this study and given it ethical clearance. If you have any questions or concerns regarding your rights as a participant, or how this study is being conducted, you may contact the Research Ethics Office at 780-492-2615. This office has no affiliation with the study investigators.
Thank you for taking the time to consider this project. If you have any questions, you can contact Ashley Orleski, the project coordinator, at ashley.orleski@ualberta.ca or 780-248-1268.

How can I participate?
IF YOU AGREE TO PARTICIPATE IN THE RESEARCH PROJECT, please check here: ☐
Now click "Next" to begin the survey!

Next →

Appendix D: 2014 SLAQ Health Scale Calculations

Note: The suffix r was added to SLAQ items that were reversed scored.

Perceived Stress Scale

Included items:

1. Please indicate how often in the past 30 days you have felt upset because of something that happened unexpectedly? (PSUPST)
2. Please indicate how often in the past 30 days you have felt nervous and stressed? (PSNRVS)
3. Please indicate how often in the past 30 days you have felt that you have been able to control irritations in your life? (PSCTIR)
4. Please indicate how often in the past 30 days you have felt that you were on top of things? (PSONTP)
5. Please indicate how often in the past 30 days you have felt angered because of things that were outside of your control? (PSANGR)
6. Please indicate how often in the past 30 days you have felt that you could not cope with all the things you had to do? (PSNOCP)
7. Please indicate how often in the past 30 days you have felt unable to control the important things in your life? (PSCTRL)
8. Please indicate how often in the past 30 days you have felt confident about your ability to handle your personal problems? (PSCONF)
9. Please indicate how often in the past 30 days you have felt that things were going your way? (PSTGYW)
10. Please indicate how often in the past 30 days you have felt that difficulties were piling up so high that you could not overcome them? (PSDIFF)

SPSS Formula:

PSS = (PSUPST + PSNRVS + PSCTIR + PSONTPr + PSANGR + PSNOCP + PSCTRL + PSCONFr + PSTGYW + PSDIFF)/10

Nutritional Behaviour Scale

Included items:

1. I am able to maintain a diet that is balanced across the four food groups recommended by the Canada Food Guide. (DIETBAL)
2. I eat 5 or more servings of fruits and vegetables daily. (DIETSRV)
3. I set aside money in my budget to purchase food. (DIETMNY)
4. When I plan my daily activities, I set aside time to prepare food. (DIETTME)
5. When I look at a prepared food, I can identify what ingredients are in it. (DIETINGR)

SPSS Formula:

NBS = (DIETBAL + DIETSRV + DIETMNY + DIETTME + DIETINGR)/5

Sleep Scale

Included items:

1. How would you rate your sleep quality overall? (SLPQLTY)
2. Over the past 30 days, how often have you had difficulty falling asleep? (SLPDFAL)
3. Over the past 30 days, how often have you had difficulty staying asleep? (SLPDSTY)
4. Over the past 30 days, how refreshed do you feel after getting up in the morning? (SLPREFR)

SPSS Formula:

SQS = (SLPQLTY + SLPDFALr + SLPDSTYr + SLPREFR)/4

Personal Wellbeing Index

Included items:

1. How satisfied are you with your standard of living? (SFYSTN)
2. How satisfied are you with your personal relationships? (SFYREL)
3. How satisfied are you with feeling part of your community? (SFYCOM)
4. How satisfied are you with your health? (SFYHTH)
5. How satisfied are you with how safe you feel? (SFYSAF)
6. How satisfied are you with what you achieve in life? (SFYACH)
7. How satisfied are you with your future security? (SFYFUT)

SPSS Formula:

PWI = (SFYSTN + SFYREL + SFYCOM + SFYHTH + SFYSAF + SFYACH + SFYFUT)/7

Physical Activity Questionnaire

Included items:

1. I make time to exercise regardless of my schedule (PATMEEXR)
2. Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these suggested guidelines (PAGDLNES)
3. I actively monitor my level of fitness
4. Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (e.g. workout regimen, classes, trainer, etc.) (PAEXRCSE)
5. I use my academic institution's recreation facilities (PAINSTIT)
6. I play an organized sport (team or individual) (PAORGSPT)
7. When the weather permits, I spend my leisure time outside rather than inside (PATMEOT)
8. I perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep) (PAMNTCTK)
9. I take the stairs rather than the elevator or escalator (PATKSTRS)

SPSS Formula:

PAQ = (PATMEEXR + PAGDLNES + PAMTRFIT + PAEXRCSE + PAINSTIT + PAORGSPT + PATMEOT + PAMNTCTK + PATKSTRS)/9

Global Physical Activity Questionnaire

SCORING:

Domain	**MET value**
Work	Moderate MET value = 4.0 & Vigorous MET value = 8.0
Transport	Cycling and walking MET value = 4.0
Recreation	Moderate MET value = 4.0 & Vigorous MET value = 8.0
Domain	**MET value**
Work	Moderate MET value = 4.0 & Vigorous MET value = 8.0
Transport	Cycling and walking MET value = 4.0
Recreation	Moderate MET value = 4.0 & Vigorous MET value = 8.0

Included items:

Work:

1. In a typical week, on how many days do you do vigorous- intensity activities as part of your work? (PROVGW)
2. How much time in minutes do you spend doing vigorous-intensity activities at work on a typical day? (PROVGD)
3. In a typical week, on how many days do you do moderate- intensity activities as part of your work? (PROMDW)
4. How much time in minutes do you spend doing moderate-intensity activities at work on a typical day? (PROMDD)

Travel to and from places:

1. In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places? (PTNSWB)
2. How much time in minutes do you spend walking or bicycling for travel on a typical day? (PTNWBD)

Recreational activities:

1. In a typical week, on how many days do you do vigorous- intensity sports, fitness or recreational (leisure) activities? (PRCVGW)
2. How much time in minutes do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day? (PRCVGD)
3. In a typical week, on how many days do you do moderate- intensity sports, fitness or recreational (leisure) activities? (PRCMDW)
4. How much time in minutes do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day? (PRCMDD)

SPSS Formula:

(Total Physical Activity MET-minutes/week)
METtotal = [(PROVGW * PROVGD * 8) + (PROMDW * PROMDD * 4) + (PTNSWB * PTNWBD * 4) + (PRCVGW * PRCVGD * 8) + (PRCMDW * PRCMDD* 4)]

(Total Recreational Physical Activity MET-minutes/week)
METrec = [(PRCVGW * PRCVGD * 8) + (PRCMDW * PRCMDD* 4)]

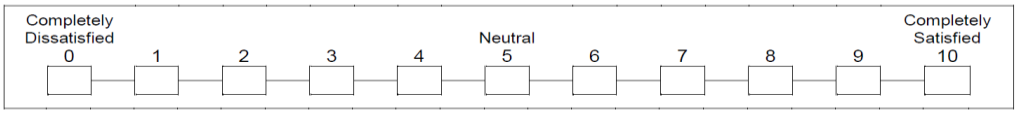
(Total Work/School Physical Activity MET-minutes/week)
METwrk = [(PROVGW * PROVGD * 8) + (PROMDW * PROMDD * 4)]

(Total Transportation Physical Activity MET-minutes/week)
METtransit = [(PTNSWB * PTNWBD * 4)]

Appendix E: 2014 Student Life Activity Questionnaire (SLAQ)

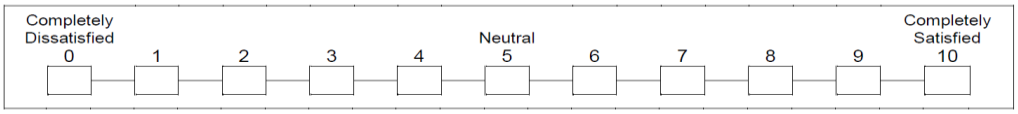
Wellbeing

1. How satisfied are you with your life?

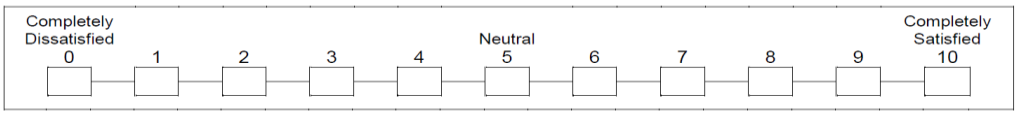


Thinking about your own life and personal circumstances, please indicate how satisfied are you with each of the following…

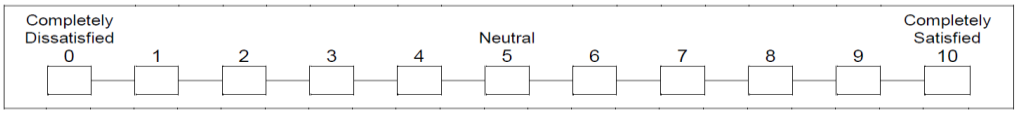
2. your standard of living?



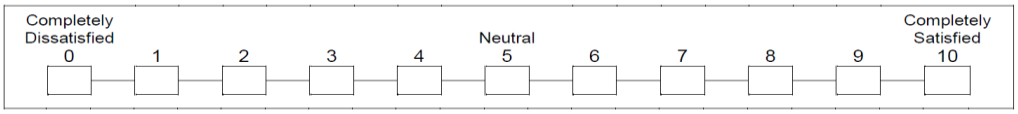
3. your health?



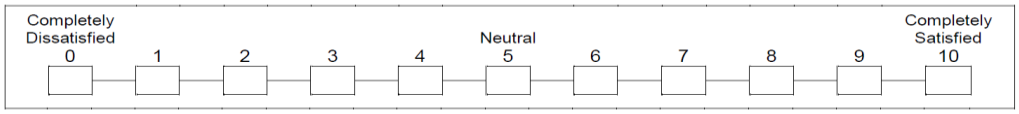
4. what you are achieving in life?



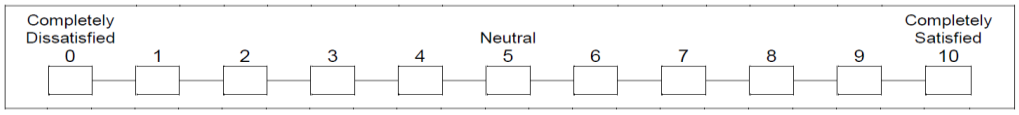
5. your personal relationships?



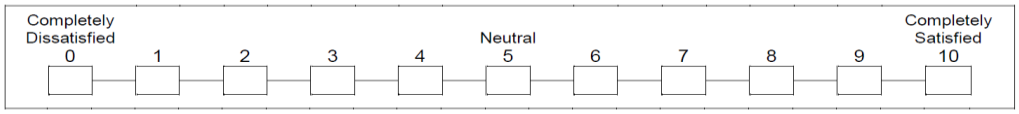
6. how safe you feel?



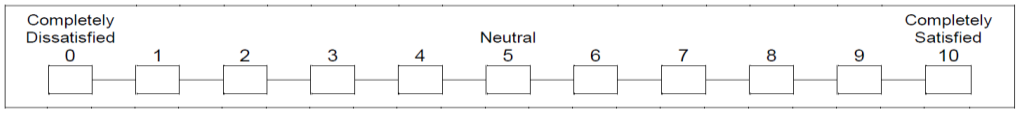
7. feeling part of your community?



8. your future security?



9. your spirituality or religion?



Health

10. In general, would you say your health (by which we mean, not only the absence of disease or injury, but also physical, mental and social well-being) is

0	1	2	3	4
Poor	Fair	Good	Very Good	Excellent

Campus Health Services

11. Are you aware of the services offered by the University Health Centre on campus (e.g. primary care clinic, obstetrics and gynecology, health insurance resources, immunizations, etc.)? Y/N

12. In the past year, how many **times** have you used services at the University Health Centre?

____

13. Are you interested in using services at the University Health Centre in the future? Y/N

Physical Activity

Please answer these questions even if you do not consider yourself to be a physically active person. There are various domains of activity which should be included; *work/school activities* in and around the home (and garden), to get from place-to-place (*transport-related*) and *recreation* (discretionary or leisure-time) exercise or sports activities.

Recreational (Leisure) Activities

14. In a typical week, on how many days do you do **vigorous-intensity sports, fitness or recreational (leisure) activities** that cause large increases in breathing or heart rate like running or playing football for at least 10 minutes continuously?

0	1	2	3	4	5	6	7

15. How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?

└┴┘: └┴┘ hours: minutes

16. In a typical week, on how many days do you do **moderate-intensity sports, fitness or recreational (leisure) activities** that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, or volleyball for at least 10 minutes continuously?

0	1	2	3	4	5	6	7

17. How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?

└┴┘: └┴┘ hours: minutes

Routine Daily Activities at home, work or school

18. In a typical week, on how many days do you do vigorous- intensity activities like carrying or lifting heavy loads, digging, or construction work **as part of your routine daily activities or activities at work/school**?

0	1	2	3	4	5	6	7

19. How much time do you spend doing vigorous-intensity activities on a typical day?

└┴┘: └┴┘ hours: minutes

20. In a typical week, on how many days do you do moderate- intensity activities like brisk walking or carrying light loads?

0	1	2	3	4	5	6	7

21. How much time do you spend doing moderate-intensity activities on a typical day?

└─┴─┘ : └─┴─┘ hours: minutes

Transportation

22. In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?

0	1	2	3	4	5	6	7

23. How much time do you spend walking or bicycling for travel on a typical day?

.
└─┴─┘ : └─┴─┘ hours: minutes

24. How much time do you usually spend sitting or reclining (but not including sleeping) on a typical day?

└─┴─┘ : └─┴─┘ hours: minutes

Nutrition

Please indicate how often you are able to do each of the following…

25. I am able to maintain a diet that is balanced across the four food groups recommended by the Canada Food Guide.

0	1	2	3	4
Seldom or Never				Very Often

26. I eat 5 or more servings of fruits and vegetables daily.

0	1	2	3	4
Seldom or Never				Very Often

27. When I look at a prepared food, I can identify what ingredients are in it.

0	1	2	3	4
Seldom or Never				Very Often

28. I set aside money in my budget to purchase food.

0	1	2	3	4
Seldom or Never				Very Often

29. When I plan my daily activities, I set aside time to prepare food.

0	1	2	3	4
Seldom or Never				Very Often

30. I eat my meals alone.

0	1	2	3	4
Seldom or Never				Very Often

31. It is a challenge for me to get to a grocery store.

0	1	2	3	4
Seldom or Never				Very Often

Please indicate whether you agree or disagree with each of the following…

32. I know how to properly store and prepare the foods I buy.

0	1	2	3	4
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

33. I know how to use basic kitchen equipment, such as a stove top, microwave, or can opener.

0	1	2	3	4
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

34. I know basic food safety handling practices (such as how to assess whether meat is fully cooked by appearance or temperature, or how to thaw frozen meat in the fridge properly by setting it in a dish to catch drippings and placing it on the bottom shelf).

0	1	2	3	4
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

35. I know how to prepare a meal by following recipes.

0	1	2	3	4
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

36. Since I started university my diet

0	1	2	3	4
Is much less Healthy		Has not changed		Is much more healthy

How many times in the last week did you…

37. purchase prepared meals (e.g. fast food, restaurant food, cafeteria food)?

0	1	2	3	4	5	6	7 or more

38. eat meals cooked for you by others (e.g. parents, significant other, housemate)?

0	1	2	3	4	5	6	7 or more

39. prepare and eat meals with ingredients mostly prepared by the manufacturer (examples – canned soups, instant oatmeal, mixes for pancakes/cake/pudding, frozen lasagna, fish sticks, frozen pizza, cold cereal, garlic bread, macaroni dinner)

0	1	2	3	4	5	6	7 or more

40. prepare and eat meals with whole ingredients (examples –vegetables, fruit, meat, fish, kidney beans, plain rice or pasta, flour, rolled oats, cheese, yogurt, milk, eggs)

0	1	2	3	4	5	6	7 or more

Alcohol Use

41. How often in the past 1 year have you had 5 or more drinks on one occasion?

0	1	2	3	4	5
Never	Less than once a month	Once a month	2 to 3 times a month	Once a week	More than once a week

Campus Nutrition Services

42. Are you aware of the Nutrition Counseling services offered by University Health Centre on campus? Y/N

43. In the past year, how many **times** have you used the Nutrition Counseling services?

____

44. Are you interested in using the Nutrition Counseling services in the future?
Y/N

Personal Situation

45. Thinking about the amount of stress in your life, how stressful would you say that most days are?

0	1	2	3	4
Not at all	Not Very	A bit	Quite a bit	Extremely

Please indicate the extent to which each of the following contributes to feelings of stress you may have.

46. School or work?

0	1	2	3	4
Not at all	Not Very	A bit	Quite a bit	Extremely

47. Your personal life?

0	1	2	3	4
Not at all	Not Very	A bit	Quite a bit	Extremely

Please indicate how often in the past 30 days you have felt …

48. upset because of something that happened unexpectedly?

0	1	2	3	4
Never				Very Often

49. nervous and "stressed"?

0	1	2	3	4
Never				Very Often

50. that you have been able to control irritations in your life?

0	1	2	3	4
Never				Very Often

51. that you were on top of things?

0	1	2	3	4
Never				Very Often

52. angered because of things that were outside of your control?

0	1	2	3	4
Never				Very Often

53. that you could not cope with all the things you had to do?

0	1	2	3	4
Never				Very Often

54. unable to control the important things in your life?

0	1	2	3	4
Never				Very Often

55. confident about your ability to handle your personal problems?

0	1	2	3	4
Never				Very Often

56. that things were going your way?

0	1	2	3	4
Never				Very Often

57. that difficulties were piling up so high that you could not overcome them?

0	1	2	3	4
Never				Very Often

Ways of coping

Please indicate how often you engage in each of the following activities when you feel stressed.

58. I work harder at my school and study activities.

0	1	2	3	4
Never				Very Often

59. I talk to my friends or relatives about my worries.

0	1	2	3	4
Never				Very Often

60. I sleep more than usual.

0	1	2	3	4
Never				Very Often

61. I spend more time on the computer and/or watching TV.

0	1	2	3	4
Never				Very Often

62. I go out and have fun with friends.

0	1	2	3	4
Never				Very Often

63. I have a specific strategy for dealing with stress (e.g. exercise, yoga, meditation, etc.)

0	1	2	3	4
Never				Very Often

Campus Mental Health Services

64. Are you aware of the services offered at Mental Health Centre on campus?
Y/N

65. In the past year, how many **times** have you used services at the Mental Health Centre?
____

66. Are you interested in using the Mental Health Centre services in the future?
Y/N

Sedentary Activities

67. How much time do you spend sitting in class or sitting while performing school or work related activities?

Typical Weekday	3 hrs or less	About 4 hrs	About 5 hrs	About 6 hrs	About 7 hrs	About 8 hrs	About 9 hrs	About 10 hrs	About 11 hrs or more
Typical Weekend Day	3 hrs or less	About 4 hrs	About 5 hrs	About 6 hrs	About 7 hrs	About 8 hrs	About 9 hrs	About 10 hrs	About 11 hrs or more

68. How much leisure time do you spend watching TV programs or movies (on television or the computer)?

Typical Weekday	None	15 min or less	30 min	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs +
Typical Weekend Day	None	15 min or less	30 min	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs +

69. How much leisure time do you spend using the computer (surfing the Internet, using social media, etc.)

Typical Weekday	None	15 min or less	30 min	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs +
Typical Weekend Day	None	15 min or less	30 min	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs +

Opinions about Activity

70. I consider myself to be physically active.

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

71. I am concerned that I am too inactive or sedentary at school or work.

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

72. When I want to relax, I go for a walk.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

73. I regularly perform household tasks (cleaning, preparing meals, etc.).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

74. When the weather permits, I spend my leisure time outside rather than inside.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

75. I feel guilty about how inactive I am relative to others/peers.

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

76. I use my academic institution's recreation facilities.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

77. In general, I wish I were less sedentary (that is, able to sit less frequently).

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

78. Current activity guidelines suggest that adults (18-64 years) try to accumulate 150 minutes or more of moderate to vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more. I meet these requirements.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

79. Physical fitness is the ability to perform various vigorous, moderate, and non-vigorous daily activities with ease. I would say that my level of physical fitness is.

0	1	2	3	4	5	6
Very Poor	Poor	Fair	Average	Good	Very Good	Excellent

80. I am proud of my level of physical fitness.

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

81. I actively monitor my level of fitness.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

82. I play an organized sport (team or individual).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

83. I spend long periods of time sitting/reclining without feeling the urge to get up and move around.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

84. Exercise is planned, structured, repetitive, and purposeful physical activity. I follow an exercise routine (workout regimen, classes, trainer, etc.).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

85. I make time to exercise regardless of my schedule.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

86. I sit with my computer or watch television to relax.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

87. To avoid fatigue or exhaustion interfering with my personal/professional goals, I regularly limit my daily activities.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

88. I take the stairs rather than the elevator or escalator.

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

89. I prefer to walk rather than drive or be driven.

0	1	2	3	4	5	6
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

90. I regularly perform maintenance tasks (mowing the lawn, shovelling the sidewalk, general upkeep).

0	1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Frequently	Often	Very often

Sleep

Over the past 30 days,

91. What was your usual bedtime on weeknights?

└┘└┘ : └┘└┘ hour: minute

92. What was your usual getting up time on weekdays?

└┘└┘ : └┘└┘ hour: minute

93. What was your usual bedtime on weekends?

└┘└┘ : └┘└┘ hour: minute

94. What was your usual getting up time on weekends?

└┘└┘ : └┘└┘ hour: minute

95. How would you rate your sleep quality overall?

0	1	2	3	4
Very Poor	Poor	Fair	Good	Excellent

96. For about how many days in the past 30 days have you felt you did not get enough rest or sleep? _____

97. How often have you had difficulty falling asleep

0	1	2	3	4
Never	Rarely	Sometimes	Often	Always

98. How often have you had difficulty staying asleep?

0	1	2	3	4
Never	Rarely	Sometimes	Often	Always

99. How refreshed do you feel after getting up in the morning?

0	1	2	3	4
Not at all refreshed				Completely refreshed

100. How often do you pay attention to your sleep patterns?

0	1	2	3	4
Never	Rarely	Sometimes	Often	Always

Demographics

101. How old were you on your last birthday?

└┘└┘ years

102. I am

☐ Male
☐ Female

103. How tall are you without shoes on?

└┘└┘ : └┘└┘ feet : inches

104. How much do you currently weigh (multiply weight in kg by 2.2 to convert to lbs)

└┘└┘└┘ lbs

105. Compared to September 2013, I am

☐ more than 10 lbs heavier
☐ 6 -10 lbs heavier
☐ 1-5 lbs heavier
☐ about the same
☐ 1-5 lbs lighter
☐ 6 – 10 lbs lighter
☐ more than 10 lbs lighter

106. How far from Campus do you live?

☐ In a residence on campus
☐ Within walking distance of campus
☐ Within 1/2 hour by vehicle or public transportation
☐ Within 1/2 to 1 hour by vehicle or public transportation
☐ More than 1 hour by vehicle or public transportation

107. Which of the following describes your current living arrangements?

☐ Living with peers or roommates
☐ Living with a spouse/partner and no children
☐ Living with spouse/partner and children
☐ Living with parents and/or other family members

- ☐ Living alone (ie without shared cooking facilities)
- ☐ Other

108. Do you pay for board or a meal plan?
- ☐ Yes
- ☐ No

109. Are you
- ☐ A full time student
- ☐ A part time student

110. What is you employment status while a student?
- ☐ Not employed
- ☐ Employed part time
- ☐ Employed full time

111. Are you an International Student?
- ☐ Yes
- ☐ No

112. What is your major/subject of study?
- ☐ Engineering
- ☐ Arts and Humanities
- ☐ Business
- ☐ Social Science
- ☐ Health Science
- ☐ Physical Science
- ☐ Education
- ☐ Other fields

113. What kind of program are you in (check only one):
- ☐ First year of a 4-year bachelor degree
- ☐ Second year of a 4-year bachelor degree
- ☐ Third year of a 4-year bachelor degree
- ☐ Fourth (or greater) year of a 4-year bachelor degree
- ☐ Master's degree
- ☐ Doctoral degree
- ☐ Open studies or Extension Studies
- ☐ After degree program
- ☐ Other