# Characterizing physical activity documentation patterns and curriculum of Canadian family physicians

by

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**ABSTRACT**

Family physicians (FP) can be meaningful advocates to support patients to attain the benefits of physical activity (PA); however, the PA-related documentation FPs make in electronic medical records (EMR) is largely unknown. The purpose of this dissertation was to conduct three studies: to examine the content of PA inputs in FP EMRs, to describe the PA curriculum in family medicine residency programs, and to quantify the association of patient and FP characteristics to PA documentation. Two studies used extracted EMR data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN), which includes ~1,400 sentinel primary care providers from 12 EMR systems and eight provinces. A third study used information from family medicine residency program websites and curriculum experts. **Study 1** selected a random sample of 1,535 patients aged 18-64.9 to understand if PA information was documented in their EMRs and to identify the PA status of patients according to PA guidelines. It found that less than one in 10 patients had any PA information in their EMRs. Where PA information was documented, FPs usually recorded that patients were undertaking discretionary/leisure PA or were inactive. Predominantly insufficient information existed to identify whether a patient was active according to PA guidelines. **Study 2** investigated the extent that Canadian FM residency programs offered PA training. All responding programs stated they provide PA training to some degree. Most included curriculum related to physical inactivity as a risk factor for chronic conditions and resulting discussions on the benefits derived from being physically active. Curriculum about PA guidelines is variable, and few programs taught residents how to document PA in EMR; only one of the 14 programs indicated that residents learn how to document PA in an EMR pertaining to meeting guidelines. **Study 3** used a CPCSSN datacut of 769,185 patients aged 18-64.9 to quantify the association of PA inputs with patient and FP characteristics on a randomly selected encounter date. Of those, 1.9 percent (n = 14,828) of patients had PA documented in their FPs EMR. Older than mean patient age, having fewer comorbidities, younger than mean FP age, academic teach sites, and select EMR systems were statistically significant predictors of PA documentation. In particular, patients visiting academic teaching sites were much more likely to have PA recommendations documented in their records. The findings from this dissertation demonstrate that while most family medicine residency programs provide general training on PA, patient PA is documented infrequently within EMRs.

**PREFACE**

This dissertation used secondary data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) and primary data collected from family medicine websites and program curriculum experts. Studies 1 and 3 use 2019 Q2 CPCSSN (data as of June 30, 2019), which is a composite of electronic medical record data (EMR) from eight provinces and territories. Study 2 used information from Canadian family medicine residency programs. I developed the research questions and conceptualized the studies. I was responsible for CPCSSN data acquisition, data collection for the curriculum expert survey in Study 2, all analysis, writing the manuscripts, and knowledge translation activities. The following document includes an introduction to the work and the rationale for the formulation of the three studies (Chapter 1). Studies 1-3 are included as Chapters 2-4, and this is followed by a general discussion chapter (Chapter 5). Appendices are included to provide further information including a literature review that informed the three studies (Appendix G).

Study 1 (Chapter 2) of this work has been published as Lindeman, C., Klein, D., Stickland, M., Drummond, N., Kim, Y.-B., Lamboglia, C. G., Mangan, A. J., Affleck, E., Garrison, S., Sargent, R., & Spence, J. C. (2022). Content of physical activity documentation in Canadian family physicians' electronic medical records. *Applied Physiology, Nutrition, and Metabolism*, 99(5) 1-6. doi:10.1139/apnm-2021-0643.

This thesis attained ethics approval from the University of Alberta Research Ethics Board for Study 1 and Study 3 (Pro00096027) and Study 2 (Pro00109157).

# DEDICATION

To Kendra.

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# GLOSSARY OF KEY TERMINOLOGY

*Adult*: Individuals between the ages of 18 to 64.9 years.

*Body mass index:* Height in meters divided by weight in kilograms squared.

*Electronic health record*: A record of information between health care providers and patients across health care organizations.

*Electronic medical record*: A digital version of the paper charts in a clinician's office that contain notes and treatment history of the patients in one's practice.

*Exercise*: Bodily movement produced by skeletal muscle that results in energy expenditure, which is positively correlated with physical fitness, but is planned, structured, and involves bodily movement, where the objective is to improve or maintain physical fitness components.

*Family physician*: A medical specialty devoted to comprehensive health care for people of all ages. Family physicians are also commonly referred to as general practitioners or primary care physicians.

*Leisure-time physical activity*: Physical activity during one's disposable, discretionary time.

*Patient*: A recipient of health care services provided by a healthcare provider.

*Physical activity:* Any movement produced by skeletal muscles that results in energy expenditure and is positively correlated with physical fitness. It includes activities in multiple domains such as work, home, transport, and discretionary (leisure).

*Physical activity guidelines for adults***:** According to Canada's physical activity guidelines, adults (aged 18 to 64 years) should accumulate at least 150 minutes of moderate-to-vigorous intensity aerobic activities such that there is an accumulation of 150 minutes per week, muscle strengthening activities using major muscle groups at least twice per week, physical activities that challenge balance, and several hours of light physical activities including standing.

*Physically inactive:* A description for those who do not meet Canada's physical activity guidelines.

*Physically active:* A description for those who meet or exceed Canada's physical activity guidelines.

*Primary care provider*: An umbrella term for family physicians and allied health care providers including nurse practitioners and family physicians.

# ACRONYMS

BMI = Body Mass Index

CACMS = Committee on Accreditation of Canadian Medical Programs

CPCSSN = Canadian Primary Care Sentinel Surveillance Network

EHR = Electronic health record

EIM = Exercise is Medicine

EIMC = Exercise is Medicine Canada

EMR = Electronic medical records

EVS = Exercise Vital Sign

FP = Family physician

GPPAQ = General Practice Physical Activity Questionnaire

MVPA = Moderate-to-vigorous physical activity

PA = Physical activity

PAVS = Physical Activity Vital Sign

QALY = Quality-adjusted life-year

SAPCReN = Southern Alberta Primary Care Research Network

SBAS = Stanford Brief Activity Survey

SNAP = Speedy Nutrition and Physical Activity Assessment

UTOPIAN = University of Toronto Practice Based Research Network

WHO = World Health Organization

# CHAPTER 1: Introduction

It is a paradox that Canadians are living longer but have more multimorbidity than ever before (Statistics Canada, 2018; Lebenbaum, Zaric, Thind, & Sarma, 2018). One in three Canadians (33.7%) are estimated to have at least one chronic disease, namely cardiovascular diseases, cancer, diabetes, chronic respiratory disease, or a mood and/or anxiety disorder (Canadian Chronic Disease Indicators Steering Committee, 2018). Such a high prevalence of chronic disease places stress on an already belaboured health care system that costs $264 billion (2019) per year, and accounts for 11.6% of Canada's gross domestic product (Canadian Institute for Health Information, 2019). Fortunately, there is evidence to support preventative approaches to both reduce the risk and improve the management of chronic diseases.

Physical activity (PA) is an effective mode of prevention and treatment for over 30 chronic conditions (Booth, Roberts, Thyfault, Ruegsegger, & Toedebusch, 2017; Gonzalez, Fuentes, & Marquez, 2017; Thornton et al., 2016). However, estimates suggest that only 45% of Canadian adults achieve the minimum threshold of 150 minutes of moderate-to-vigorous PA (MVPA) per week (Clarke, Colley, Janssen, & Tremblay, 2019), and few participate in muscle strengthening activities twice per week (Ross et al., 2020). Insufficient levels of PA are not unique to Canada; the World Health Organization (WHO) ranks physical inactivity as the fourth leading risk factor for mortality, globally (World Health Organization, 2011). According to Lear et al. (2017), achieving the guideline minimum threshold is associated with a reduction in both mortality (HR 0.80; 95% CI: 0.74-0.87) and cardiovascular disease (HR 0.86; 95% CI: 0.78-0.93). Further, the combination of low PA (less than 150 MVPA minutes per week) and high sitting time (greater than 36 hours per week) compound to result in a 40% higher risk of cardiovascular disease and 140% higher risk of metabolic syndrome compared to those who engage in more than 150 minutes of MVPA and less than 36 hours of sitting time per week (Engelen et al., 2017).

Primary care providers, an umbrella term for family physicians (FP) and allied health care providers including nurse practitioners operating in general practice settings, are ideally positioned to deliver preventative interventions and care to the general public for several reasons. Most Canadians (84.2%) are attached to a primary care provider (Statistics Canada, 2017), the majority are satisfied with the care they receive from primary care providers (Szafran, Kennett, Bell, & Green, 2018), and the general public trusts the lifestyle advice and information provided by FPs, who are also referred to as family doctors, primary care physicians, or general practitioners (Hesse et al., 2005; Weiler, Chew, Coombs, Hamer, & Stamatakis, 2012). The College of Family Physicians of Canada detail the role of FPs to deliver health promotion and disease prevention; elicit patients' history of health; perform physical exams; select appropriate investigations; and interpret results for the purpose of diagnosis and disease management, disease prevention, and health promotion (College of Family Physicians of Canada, 2017). Thus, discussing lifestyle behaviour, making referrals to allied health care providers and community programs, and providing PA-related advice are within the purview of FPs.

## Gaps in the Literature

Many unknowns and discrepancies exist in the literature related to the PA advice provided by FPs. Some issues emerge from the structure of studies, others relate to their findings. Primary care researchers have used a myriad of interventions and approaches in an effort to increase the proportion of patients meeting PA guidelines, which has had mixed results (Lamming et al., 2017; Orrow, Kinmonth, Sanderson, & Sutton, 2012). Little is known about the PA-focused advice that primary health care providers deliver outside of structured interventions in specific situations. For example, of 15 randomized control trials in a meta-analysis of PA promotion based in primary care, several incorporated support that may not be considered typical or widely available in primary care resulting in a number needed to treat of 12 for inactive adults to meet recommended PA levels (Orrow et al., 2012). One of the included studies in the Orrow review examined the impact of telephone 'health checks' by health promotion specialists designed to motivate inactive patients to exercise at two, six, ten, 18, 26, and 34 weeks post-baseline (Hillsdon, Thorogood, White, & Foster, 2002), while another study included patients recruited by primary care practitioners who received eight telephone counselling sessions over 12 weeks by an exercise counsellor (Kolt, Schofield, Kerse, Garrett, & Oliver, 2007). It is questionable whether these designs could be scalable. In order to determine a more realistic estimate of the effectiveness of PA advice in primary care from FPs, an understanding of both ongoing practice and an understanding of the significant predicting factors of PA counselling is needed to inform interventions.

Although 87% of FPs self-report that they provided counselling about regular PA and 85% ask patients about their PA level (Petrella, Lattanzio, & Overend, 2007), the amount and thoroughness of PA documentation in electronic medical records (EMR) and the content of that documentation is not well known (Lindeman et al., 2020). As well, little information is available about the nature of PA relative to the EMR system interface capabilities (e.g., drop-down menus, structured entry templates, open-text fields), embedded prompts within the clinic workflow, or the EMR system used (Lindeman et al., 2020).

Information is limited about the knowledge FPs gain through their medical program education such as their family medicine residency training. National audits of PA-related curriculum have been completed for undergraduate medical degree programs in Australia

(Strong et al., 2017), Canada (Cumming, 1972), the United States (Stoutenberg et al., 2015), and the United Kingdom (Weiler, Chew, et al., 2012). The Canadian audit reported that half of the universities had one to two hours of PA lectures and no course in 'general sports medicine' (Cumming, 1972). As of 1993, no family medicine residency program in Canada had a mandatory 'sports medicine experience' (Wiley, Strother, & Lockyer, 1993). To date, the only systematic review of PA counseling training in primary care residency programs includes three studies from the United States and one from Israel (Wattanapisit, Tuangratananon, & Thanamee, 2018). This review did not included reference to Canadian research. The most recent investigation of PA in Canadian family medicine curriculum was a survey conducted in 2017 that explored whether curriculum directors believe there is enough PA training and online resources, and if there were plans to add to curriculum (Thornton, Khan, Weiler, Mackie, & Petrella, 2021). This study did not ask curriculum directors whether FPs learn how to assess, prescribe, or refer PA, and/or how to document PA in EMRs.

**Purpose and Data Sources**

The purpose of this dissertation is to conduct three studies to investigate the content and characteristics of PA documentation in FP EMRs and to describe the PA-related curriculum in Canadian family medicine residency programs. Studies 1 and 3 are based on a large dataset from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN), which includes EMR data from participating primary care providers. These providers, or 'sentinels', volunteer to have their EMR data extracted on a biannual basis for health services, epidemiological, and quality improvement research (Canadian Primary Care Sentinel Surveillance Network, 2019). Since 2008, CPCSSN has extracted data from eight provinces and territories to create a longitudinal data set that is stored in a central secure, de-identified, data repository (Canadian Primary Care

Sentinel Surveillance Network, 2019). As of December 1, 2018, CPCSSN had extracted and standardized fields from 12 EMR systems. Data are cleaned and processed by data managers who then generate calculated fields from original FP inputs and compute validated chronic disease case definitions (Williamson et al., 2014). However, CPCSSN has not developed a comprehensive process to categorize PA-related information even though national research organizations have inquired about including PA in their analyses to better inform pan-Canadian trials and interprovincial epidemiological research studies (Drummond, N., Personal Communication, March 23, 2020).

Study 1 analyzed the content of PA-recorded inputs in a representative sample of CPCSSN patient EMRs (n = 1,535) to determine whether the inputs describe PA levels, PA domain, purpose of the input, activity type, and if there is mention of PA in the context of Canadian guidelines. Further, Study 1 determined the CPCSSN fields that capture PA information and provides a recommendation of whether there is sufficient information in CPCSSN data to identify if a patient is physically inactive.

Study 2 collected information obtained from a cross sectional survey of family medicine residency program websites and curriculum experts in Canada (n = 14). The experts responded to survey questions by videoconference and/or email. Topics included current PA training, PA-related curriculum content, time allotted for teaching about the importance of PA, and education related to strategies to document PA information in EMRs.

Study 3 used the entire national CPCSSN dataset (769,185 adults aged 18-64.9) to examine the conditions and demographic characteristics of patients who have PA recorded in their primary care EMRs. Patient and FP characteristics were analyzed to determine the association of a patient having PA documented and the variance that is accounted for by these factors.

**Significance of the Research**

The rationale underlying this research is the need to identify and probe gaps in knowledge and literature from public health, medicine, sport science, and health psychology. The three studies provide insight into the knowledge FPs acquire in family medicine residency programs and the nature of FP-inputted PA documentation in EMRs. Because there are no studies of PA documentation in EMRs across multiple Canadian provinces and EMR systems (Lindeman et al., 2020), this work will provide a much needed insight into the status of PA advice and documentation in Canada.

The three studies respond to calls for the need to enhance the evaluation and tracking of PA-related information (ParticipACTION, 2019), and may be used to inform patient assessment and counselling initiatives aimed to promote an increase in PA and a reduction in sedentary behaviour (World Health Organization, 2018). The proposed research aligns with Canadian recommendations that PA should be required in medical and allied health processional medical curriculum (ParticipACTION, 2019), national initiatives to increase PA and reduce sedentary living as outlined in *A Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada: Let's Get Moving* (Health Canada, 2018), and the WHO *Global Action Plan on Physical Activity 2018-2030* recommendations that medical and allied health professionals ensure effective integration of the health benefits of PA into formal training on prevention and management of non-communicable diseases and the promotion of community health and well-being (World Health Organization, 2018).

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# CHAPTER 2: Study 1

Content of physical activity documentation in Canadian family physicians' electronic medical records

Cliff Lindeman, Doug Klein, Michael K. Stickland, Neil Drummond, Yeong-Bae Kim, Carminda Lamboglia, Aime Mangan, Ashley McCurdy, Ewan Affleck, Scott Garrison, Randall Sargent, & John C. Spence

## Abstract

The purpose of this study was to examine the content of physical activity inputs in Canadian family physicians' electronic medical records. Of 1,225,948 patients aged 18-64.9, a sample of 1,535 patients' charts were reviewed. A minority (n = 148; 9.6%) of patients had at least one mention of physical activity at any time. Insufficient information existed to determine physical activity domain (21.6%), purpose (50.0%), or meeting of guidelines (98.1%).

## Introduction

Physical activity (PA) is a complex behaviour that is influenced by an interplay of individual, social, and environmental factors (Spence & Lee, 2003). It has discernable health benefits if undertaken regularly (Ross et al., 2020). Yet this knowledge has not translated into populations being active, especially in more developed countries (Guthold, Stevens, Riley, & Bull, 2018). As a result, approximately 3.2 million deaths are attributed to physical inactivity worldwide each year (World Health Organization, 2011).

The health sector, particularly primary care, is increasingly recognized as an important avenue to promote, identify, counsel, and refer PA for patient care (World Health Organization, 2018). This coincides with evidence that providing PA advice is cost effective (Singh et al., 2018) and leads to gains in quality-adjusted life-years (Anokye, Lord, & Fox-Rushby, 2014). Further, professional organizations and regulatory bodies agree that it is the role of family physicians (FP) to provide public health education to patients (College of Family Physicians of Canada, 2005).

Discrepancies exist between the frequencies of PA advice patients report receiving, the advice physicians report providing, and what chart audits substantiate. Among Canadian adults, 40% heard about PA from a health professional in the past 12 months (ParticipACTION, 2019), whereas, of 13,166 primary care physicians, 85.2% self-reported that they asked patients about PA and 87.2% self-reported they counselled their patients about it (Petrella, Lattanzio, & Overend, 2007). An audit of 439 patient medical records from Quebec found that 51.9% of patients had their PA level assessed in the previous 18 months (Baillot et al., 2018).

Electronic medical records (EMR) are a source of longitudinal patient data to discover whether health care practitioners discuss or recommend PA to their patients (Canadian Primary Care Sentinel Surveillance Network, 2020). According to a recent scoping review, only a few studies have examined EMRs to determine how often PA is documented by FPs and the frequency of notations ranged from 0.4% to 87.7% (Lindeman et al., 2020). The Canadian Primary Care Sentinel Surveillance Network (CPCSSN) is the largest pan-Canadian repository of primary care EMR data. It includes information from 13 regional primary care practice-based research networks across Alberta, British Columbia, Manitoba, Newfoundland and Labrador, Nova Scotia, Ontario, and Quebec comprising over ~1,350 primary care providers and data from approximately 2 million Canadians (Canadian Primary Care Sentinel Surveillance Network, 2019). To date, no study has analyzed the content of national CPCSSN data to discern what PA information is being documented. The purpose of this study was to analyze data from a sample of CPCSSN patients to understand what PA information was documented in EMRs and, if information exists in those records, to identify the PA status of patients according to guidelines.

## Methods

### Inclusion Criteria and Data Characteristics

The selection of cases was based on a random sample of CPCSSN records from patients (aged 18-64.9 years) proportionately stratified by EMR system and CPCSSN network, as of June 30, 2019. CPCSSN patient IDs are assigned in a non-random fashion and in the order that the patients are drawn from the EMR. This study further randomized patient IDs by randomly drawing CPCSSN patient IDs without replacement until exhaustion. To determine sampling, we first stratified the entire national CPCSSN dataset in patients 18-64.9 by EMR and CPCSSN network then allotted the same proportion for the sample. This was done using the first study-specific randomly generated patient IDs by each CPCSSN network and EMR. The goal in selecting patients was to achieve a representative sample of the CPCSSN patient population within a +/-2.5% confidence interval by unique patient ID. Since 1,225,948 patients met the age requirement, 1,535 were sampled. Thus, sampling was based on achieving representativeness of patients in relation to EMR and CPCSSN network as opposed to typical sociodemographic (e.g., age) or morbidity characteristics.

The CPCSSN networks ranged from 4,098 to 217,578 patients. The data included disease status according to validated case definition criteria (Williamson et al., 2014), information describing the reason for encounter, and information including examinations (e.g., height, weight), diagnoses, and lifestyle factors were included. Risk factor data included smoking, obesity, alcohol use, exercise, diet, and psychological stress. Other tables provided information about referrals, family history, and patient and provider demographic characteristics. Except for the risk factor table, all data were in standardized form (e.g., examinations using the same measure). From the risk factor table, both the original unprocessed text and standardized text risk factor data were included. More information describing CPCSSN data can be found from the data dictionary (Canadian Primary Care Sentinel Surveillance Network, 2020) and data resource profile (Garies, Birtwhistle, Drummond, Queenan, & Williamson, 2017).

**Procedure**

Ethics approval was received from the University of Alberta (Pro00096027). Based on feedback from primary care physicians, a codebook was developed (Appendix A) which captured information pertaining to the extraction of EMR PA data and its categorization by PA domain, purpose, and status according to Canadian guidelines (Ross et al., 2020). The lead author reviewed each CPCSSN record for every visit in the included sample. All identifying information (e.g., patient name) was manually removed. The lead author then coded all mentions of PA and a combination of four other co-authors independently replicated this coding (each reviewed 25% of the sample PA mentions). All discrepancies were resolved through discussion between all the coders. Demographic characteristics (i.e., age, sex) of patients and FPs are presented as frequencies (%). Input frequencies were computed by PA-content finding (Appendix A: items 8-11).

## Results

The sample included data from 792 FPs (female = 52.6%, $p = .142$; average age = 49.6, SD = 11.1). The 1,535 patients (female = 56.6%, $p < .001$; average age = 46.9, SD = 15.4) are similar in age and sex distributions to patients in the national CPCSSN data set (female = 56.1%; average age = 46.5, SD 15.4). In total, there were 205 unique mentions of PA among 148 (9.6%) patients. More female patients had at least one PA input (54.1%, $p = .324$) and the range of mentions in the sample was between 0-10 per patient. Most inputs were found in the risk factor table (97.6%) in unstandardized text, specifically under the category 'exercise' (87.7%), 11 (5.4%) were in the smoking category, and 9 (4.4%) had no category label. In addition, 3 of the inputs were found in the health condition table under the ICD-9 code V65.4 denoting exercise counselling, 1 entry (0.5%) was found in the referral table, and another was found in the encounter diagnosis table under the ICD-9 code V65.41.

Most inputs (75.0%) were characterized as discretionary or leisure/exercise (e.g., “treadclimber 1/2 hour 5-6x/week"). Six mentions (2.9%) described work-related PA, and 1 (0.5%) described "yard work". Forty-five (21.6%) provided insufficient detail to determine PA domain. In most instances this was because the input was describing 'walking', which could have been in relation to any of the domain categories. No mention was made of PA in the context of active transportation (Table 2.1).

Half of the mentions had insufficient information to indicate the purpose of the input. For example, "once a week, jogging and treadmill" could refer to the patients' behaviour or to the FP's prescription. It was also difficult to discern whether the FP was documenting current, past, or future behaviour; for example, "Physical Activity Rarely" could indicate that the patient currently rarely engaged in PA or that he or she rarely did so in the past. Instances where such ambiguity was not present include "*Exercise Status [exercises once per week: has puppy]", was categorized as recording current behaviour. Referral (1.9%), education counselling (0.5%), and recording contraindications to PA (0.5%) were infrequently documented (Table 2.1).

The PA mentions were categorized by PA guidelines (Ross et al., 2020), which consisted of both an aerobic component (>= 150 minutes of MVPA per week) and a strength component (muscle and bone strengthening activities that use major muscle groups at least two days per week). The majority of inputs did not indicate whether a patient was meeting either the minimum aerobic component (85.9%) or the minimum strength component (95.6%). Out of the 205 mentions, 201 (98.1%) provided insufficient information to determine if the individual met both components of the guideline. Indications of meeting the aerobic component often did not accompany information about weekly strength PA and mentions of strength PA did not coincide with indications of aerobic PA (Table 2.1).

## Discussion

This study found that less than one in 10 patients had any PA information in their EMR, whatsoever. Although it is recommended that all Canadian primary care physicians include PA assessment and prescription as part of routine healthcare for all patients (Thornton et al., 2016), little information is available about the extent to which this is being practiced. When PA information was documented, FPs usually recorded that patients were undertaking discretionary/leisure PA or were inactive. Insufficient information existed to identify whether a patient was inactive according to PA guidelines (Ross et al., 2020).

To date, the only study that considered PA in CPCSSN, used data from one network and three EMRs to compare the documentation of common screening procedures (e.g., blood pressure, A1c) and the presence of lifestyle information (Kalia et al., 2017). Though the authors reported 15% of patients had exercise data in the risk factor table, the purpose of exercise inputs was not noted. If the current study was restricted to the three EMRs used in Kalia et al (2017), we would have found that 10.9% of patients had a PA input compared to the 9.6% across the pan-Canadian data. Thus, our study adds further evidence that the frequency of documentation of PA in primary care EMRs is poor.

To our knowledge, no professional body in Canada regulates the structure and functionality of EMRs for FPs use, except for privacy parameters. Therefore, the EMR interfaces are likely variable for PA documentation. The solution to increasing PA documentation frequency may require structured PA fields embedded in EMR systems. In a study following 1.5 years of embedding "Exercise as Vital Sign" (EVS) within primary care EMRs in the United States, 86% (n = 1,537,798) of patients had EVS data entered (Coleman et al., 2012). Another study evaluated whether EVS could be used to systematically ascertain patient-reported exercise levels at the beginning of each outpatient visit in four medical centres in the United States (Grant, Schmittdiel, Neugebauer, Uratsu, & Sternfeld, 2014). Exercise information was recorded in a medical record by medical assistants during 73.9% of eligible patient visits; 83.4% had exercise data collected during at least one visit. The adjusted odds of exercise documentation in primary care provider progress notes increased by 12% in clinics that had implemented EVS compared to practices without EVS (Grant et al., 2014).

Another explanation for infrequent PA documentation may relate to the training of FPs. However, there are no current estimates of PA training information in Canadian FP pre-service (i.e., medical school, family medicine residency) curriculum. The most recent Canadian medical school curriculum review of PA was conducted in 1972 (Cumming, 1972), and the only family medicine residency review of PA was conducted in 1993 with a focus on sports medicine electives (Wiley, Strother, & Lockyer, 1993).

**Future Directions**

This is the most comprehensive study conducted to date into the recording of PA by FPs in Canada. We found that FPs infrequently document PA in their EMRs. Furthermore, FPs are most often documenting leisure and discretionary PA and are rarely documenting PA in relation to Canadian PA guidelines (Ross et al., 2020). Thus, we do not currently have sufficient EMR information to identify the PA status of Canadians receiving primary care by FPs, likely because it is not inputted.

While the majority of PA information was found in the CPCSSN risk factor table, it is possible that CPCSSN was unable to extract data from disease specific EMR tools or other custom forms and fields. Additional studies are needed to better understand if and how PA is incorporated into prevention and chronic disease care plans and how PA documentation differs across diseases and demographic characteristics.

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**Competing interests statement**

The authors report no conflicts of interest.

**Funding statement**

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**Data availability statement**

Receipt of the CPCSSN data used in this study requires approval from the CPCSSN Steering Committee and therefore will not be released by this study team. CPCSSN data is available for use by researchers upon application.

Table 2.1 Physical activity inputs pertaining to domain, purpose, and guideline concordance

| **Domain** | **Inputs (%)** |
|---|---|
| Work | 6 (2.9) |
| Transportation | 0 (0.0) |
| Domestic | 1 (0.5) |
| Discretionary | 156 (75.0) |
| Insufficient detail | 45 (21.6) |
| **Purpose** | **Inputs (%)** |
| **Any referral** | 4 (1.9) |
| Referral to allied health provider | 0 (0.0) |
| Referral to a facility | 4 (1.9) |
| **Education counselling** | 1 (0.5) |
| **Any recording behaviour** | 98 (47.1) |
| Recording current behaviour | 37 (17.8) |
| Recording past behaviour | 3 (1.4) |
| Recording future behaviour | 2 (0.9) |
| Recording behaviour; insufficient detail[1] | 56 (26.9) |
| **Recording contraindication** | 1 (0.5) |
| **Insufficient detail[2]** | 104 (50.0) |
| **Guideline** | **Inputs (%)** |
| **Aerobic guideline component** | |
| Meetings aerobic guideline[3] | 20 (9.8) |
| Does not meet aerobic guideline | 9 (4.4) |
| Insufficient detail | 176 (85.9) |
| **Strength guideline component** | |
| Meets strength guideline[4] | 9 (4.4) |
| Does not meet strength guideline | 0 (0.0) |

| | |
|---|---|
| Insufficient detail | 196 (95.6) |
| **Reference to guideline** | 0 (0.0) |
| **Meeting the Canadian physical activity guideline**[5] | |
| Meets aerobic and strength guidelines | 3 (1.5) |
| Meets aerobic but not strength | 0 (0.0) |
| Meets strength but not aerobic | 1 (0.5) |
| Does not meet strength nor aerobic guideline | 0 (0.0) |
| Insufficient detail | 201 (98.1) |

1. Behaviour is recorded; however, there is insufficient information as to denote as current, past, or future.
2. Insufficient information to list one of the above input purposes.
3. >= 150 of moderate-to-vigorous aerobic physical activity per week
4. Muscle and bone-strengthening activities that use major muscle groups at least two days per week
5. This section describes content describing meeting both the strength and the aerobic guideline components. Inputs that did not include both components are considered 'insufficient detail'.

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# CHAPTER 3: Study 2

Canadian family medicine residency survey of physical activity curriculum content

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## Abstract

### Background

Physical activity (PA) is an important contributor to the health of Canadians. However, the extent that PA is included in family medicine residents' education is largely unknown. This study surveyed curriculum experts in Canadian family medicine residency programs to understand what residents learn about PA and to what extent this varies across programs.

### Methods

Seventeen family medicine residency program websites were reviewed for information pertaining to their PA curriculum. Additionally, curriculum experts were asked to complete a survey to better understand the extent that PA curriculum is included in their programs.

### Results

Most (82.4%) of the eligible programs responded to the survey; of which, the majority (92.9%) indicated that residents learn that physical inactivity is a risk factor for chronic conditions, to incorporate into patient care plans, and to recommended PA as prevention for chronic diseases. However, half (50.0%) of the programs stated that they believe residents will be sufficiently prepared to incorporate PA in the care they provide patients, less than half (42.9%) teach PA guidelines, and few (21.4%) teach about PA referral to an allied health care provider or community program.

### Interpretation

The instruction about PA that family physicians receive in Canadian residency programs varied depending on the program. A standard to ensure residents are sufficiently and competently

prepared to recommend and advise physical activity as treatment and prevention is needed. Additional studies are needed to understand the opinions and teachings of preceptors who may have an influence over the residency training of Canadian family physicians.

# Introduction

Physical activity (PA) is an important contributor to the prevention of and treatment for chronic conditions (Pedersen & Saltin, 2015; Posadzki et al., 2020; Warburton & Bredin, 2016). Though primary care providers are recognized as occupying an important role to promote, identify, counsel, and refer for PA (College of Family Physicians of Canada, 2005; World Health Organization, 2018), a systematic review and meta-analysis of the effectiveness of behaviour change interventions for promoting patient PA in primary care found small positive effects at 6-months follow-up (0.04, 95% CI -0.06 to 0.14) and 12-months follow up (0.20, 95% CI 0.04 to 0.36) (van der Wardt, di Lorito, & Viniol, 2021). A recent report card graded Canada a "C-" for PA in primary care settings citing that only 23% of adults indicate that they have sought advice from a health-care professional about becoming more active within the past year, and 34% of adults aged 25-44 have heard about PA from a health care professional in the previous 12 months (Canadian Fitness and Lifestyle Research Institute, 2018; ParticipACTION, 2019). These findings may, in part, be due to the lack of PA-related education that FPs receive during residency training (Albert, Crowe, Malau-Aduli, & Malau-Aduli, 2020; Hebert, Caughy, & Shuval, 2012; Nawaz et al., 2016).

Reviews of medical programs have cited many barriers to incorporating PA into the curriculum, including a lack of time (Cullen, McNally, Neill, & Macauley, 2000; Strong et al., 2017), no formal or structured curriculum (Cardinal, Park, Kim, & Cardinal, 2015; Cullen et al., 2000), and a lack of local expertise (Cullen et al., 2000; Strong et al., 2017). Other shortcomings noted were not teaching about PA guidelines (Weiler, Chew, Coombs, Hamer, & Stamatakis, 2012) and variability across programs (Cullen et al., 2000). For instance, the proportion of medical school students in the United Kingdom and Ireland that taught sport and exercise medicine ranged from 10% to 100% (Cullen et al., 2000). To uncover detailed information about medical programs, curriculum experts can offer insight into the extent PA is included in their programs. A 2017 evaluation of Australian medical school curricula found that only 42.9% of medical education program leaders believed their program sufficiently prepared students to provide PA counselling to future patients (Strong et al., 2017).

The essential skills and competencies that Canadian family medicine (FM) residents are expected to have by the end of their training are outlined in the College of Family Physicians of Canada's (CFPC), *Assessment Objectives for Certification in Family Medicine* (College of Family Physicians of Canada, 2020). Exercise or PA is listed 12 times across the 105 priority topic areas including osteoporosis, chronic obstructive pulmonary disease, disability, heart failure, in children, ischemic heart disease, lifestyle, low-back pain, and obesity (College of Family Physicians of Canada, 2020). Skills that list PA or exercise include clinical reasoning, communication, a patient-centred approach, and selectivity by phases of clinic encounters (College of Family Physicians of Canada, 2020). This guidance further outlines that PA should be learned in relation to treatment, hypothesis generation, diagnosis, follow-up, investigation, and history taking (College of Family Physicians of Canada, 2020) (Appendix B). Therefore, when FM residents complete their programs, there is specific PA-related knowledge they should be able demonstrate.

The only systematic review of PA counseling training in primary care residency programs included three studies from the United States and one from Israel (Wattanapisit, Tuangratananon, & Thanamee, 2018). These studies found that including PA counseling was often a component of training for obesity and lifestyle counseling, which improved residents' knowledge but did not improve attitudes towards, and perceived professional norms for, PA counselling (Wattanapisit et al., 2018); suggesting that this education was ineffective. Though the review did not include reference to Canadian research, a recent investigation of PA in Canadian FM curriculum explored whether curriculum directors believe there is enough PA training, online resources, planning to add PA to curriculum, and general teaching about PA (Thornton, Khan, Weiler, Mackie, & Petrella, 2021). However, it did not probe curriculum directors about the need for FPs to learn how to assess, prescribe, or refer to PA resources, nor how to document PA in electronic medical records (EMR) and the barriers therein. The study concluded that there are significant gaps between PA recommendations and curriculum content in FM residency programs. We therefore explored the current PA curriculum in Canada's FM residency programs to answer two research questions: what proportion of FM residency programs offer PA training; and what are the characteristics of PA-related content in FM residency programs?

## Methods

### Design

This is a cross-sectional survey of the 17 FM residency programs in Canada (College of Family Physicians of Canada, 2019). We followed the STROBE guidelines for reporting observational studies (von Elm et al., 2007).

### Settings and participants

Information was extracted in the fall of 2020 from the 17 FM residency program websites to identify the content of PA-related curriculum. This included extracting course descriptions of PA as treatment or as disease prevention, and the extent to which counselling skills and knowledge were taught in relation to assessment, prescription, referral, PA guidelines, and documentation in EMRs. Contact information for program curriculum directors or their equivalent was also extracted. The website data extraction form is provided as Appendix C. Once all program websites were reviewed, the curriculum directors were contacted between May to October 2021 and asked to respond to a survey examining what FM residents learn about PA. If the curriculum director was unavailable, personnel designated by the program as being knowledgeable of its curriculum completed the survey.

**Data sources**

Surveys were either completed with member(s) of the study team through a videoconference meeting or submitted through email as a written document. During videoconference meetings, information extracted from the programs' website was reviewed and the experts were asked to add or clarify relevant content that was missed during the initial website scan. All revisions from the curriculum experts were accepted to avoid misrepresenting the organization. The survey asked curriculum questions pertaining to PA-related content: whether residents learned about the benefits and importance of PA; how to assess, prescribe PA, refer PA to an allied health care provider or community resource, and how to document PA in EMRs. The experts were asked if PA guidelines were in the required curriculum (Ross et al., 2020). We explored more specifically the muscle strengthening component. Experts were asked if residents ever requested PA training, if PA is taught as a risk factor for chronic conditions and as prevention as well as and treatment, and to estimate the number of hours allocated to teaching PA. Although most medical education programs place more of an emphasis on competences rather than total hours, questions about the number of hours were posed in order to compare with other PA medical curriculum questionnaire studies (e.g., Stoutenberg, et al., 2015). The curriculum experts were asked to discuss any barriers that may exist to incorporating PA in their program, if their program intends to increase content or hours for PA-related education, and in their opinion whether, when residents complete their program, they believe residents will be sufficiently prepared to incorporate PA into the care FPs provide. The meeting concluded by asking the experts if there was another person in the organization who could describe PA training in their program (Appendix D).

**Analysis**

Results are presented as frequencies and percentages and include key quotes from curriculum experts stated in the videoconference meeting or as text if provided in writing. The quotes are presented to describe individual and/or shared perspectives.

**Ethics approval**

Ethics approval was received from the University of Alberta (Pro00109157).

## Results

Of the 17 Canadian FM programs, 14 (82.4%) responded to the request to provide information about their PA curriculum content. The three non-responding programs indicated that they sent documentation (i.e., findings from the website extraction) to their curriculum committee(s), but there was no further response to the request. All participating FM residency programs stated that they included PA within their curriculum to some extent. The majority (92.9%) indicated that the curriculum included content about physical inactivity as a risk factor for chronic conditions, how to incorporate PA into care plans (92.9%), and to recommend PA as a prevention strategy for non-communicable chronic conditions (92.9%). One respondent emphasized that PA training is a focus when learning how to care for patients with chronic conditions "... in all of the chronic diseases teaching cases... in clinical family medicine rotations"; another shared that "most of us are on this bandwagon". In six of the 14 programs (42.9%), there was a stated focus on the CFPC priority topic areas, one expert disclosing that however "their (residents') experiences can be very different. We have no standardized assessment beyond the CFPC exam." Most respondents indicated that, to their knowledge, residents have not requested training in PA-related topics (64.3%). Eight programs (57.1%) provided an estimation of total hours focused on PA-related topics, which averaged 7.4 hours (range 1 to 20 hours). Curriculum related to general lifestyle behaviours (e.g., smoking, alcohol use, diet) averaged 17.1 hours (range 4 to 60 hours). No respondent indicated that their program plans to decrease the level of PA training offered; 35.7% stated there are plans to increase the hours of PA training in the near future.

Table 3.1 provides a summary of PA-related counselling curriculum. The most common responses were that students learn about PA benefits (63.4%), to conduct PA assessments (42.9%), and strategies for prescribing PA regimes and general advice (50.0%). However, few FM programs teach residents to refer PA (e.g., to allied health care providers, community programs) (28.6%), or that referral is site-dependent (28.6%). Questions related to PA documentation in EMRs revealed that this does not occur (42.9%), one expert explained that "...the EMR functionality differs significantly across EMR systems" (Table 3.1). Less than half (42.9%) of the programs could confirm that their program teaches PA guidelines, while 28.6% explained that PA guidelines are not taught. When asked specifically about the strength component of the PA guidelines, less than a quarter (21.4%) could confirm that this content is covered (Table 3.2).

Most programs (78.6%) indicated the two-year duration of FM programs as a key barrier to incorporating PA into their programs. Other barriers included inability to find local expertise (28.6%), variability by clinical teaching site (21.4%) as one expert shared, "we don't dictate to the sites what they must teach.", and variability by preceptor (14.3%) as one curriculum expert described "in the preceptor model there are one or two people who really shape the resident's education." (Table 3.3). Half of programs (50.0%) indicated that once residents complete their program, they are prepared to competently incorporate PA in the care they provide patients, but three programs indicated that residents would not be prepared (21.4%). One expert stated "we do not do a good job with preparing our residents to incorporate physical activity in the care they provide patients. I have no illusions that we do a good job in this." Others indicated that residents would know the basics of PA (7.1%) and how to promote PA guidelines (7.1%). Some respondents felt graduates 'might' be sufficiently prepared to incorporate PA into their practice (7.1%) or that a FPs preparedness would depend on their previous training (e.g., undergraduate medical education curriculum) (7.1%); as one respondent stated, "I think it would depend on the medical school they went to initially".

## Discussion

This study found that the delivery of PA-related education offered to Canadian FM trainees varies by program; however, all programs stated that some PA training is provided. Most include education outlining that physical inactivity is a risk factor for chronic conditions and discuss the benefits derived from being physically active**.** When curriculum experts were asked to provide more specific information about PA education such as guidelines and how to document PA in EMRs, only one of the 14 programs explained that residents learn how to document PA in an EMR pertaining to meeting guidelines.

Based on data collected in 2017, Thornton et al. (2021) reported that 44% of Canadian FM residency programs instruct on how to provide PA counselling to patients. We found that all FM programs provide some instruction on PA counselling to patients. On the question of teaching about PA guidelines, Thornton et al. reported that 80% of programs taught PA guidelines and we found that 43% of programs did so. These discrepancies may be due to the curriculum expert's familiarity with PA content in their program. Unique to our study is that many Canadian FM programs explained they teach specifically to the CFPC priority topic areas and that some residents learn the benefits of PA, how to assess PA, prescribe PA, refer for PA, and document PA information in EMRs. The latter is especially novel as we can identify no survey of medical schools or FM residency programs investigating whether they teach to document PA information in EMRs. Considering that the CFPC provide the example that an 'ideal' panel size for a typical full-time FP may be approximately 2,200 (College of Family Physicians of Canada, 2012), it is improbable for a FP to recall specific details of PA advice or prescription provided to patients if it is not documented in their EMRs in a way that can be easily accessed. If PA advice is not documented, follow-up is unlikely.

An important finding in our study was that the PA-related education is often dependent on the site and preceptor during clinical rotations and that programs may not ensure preceptors are teaching a standard curriculum. Many (57%) FM programs indicated that PA education 'depends on the preceptor'; however, to our knowledge, there has been no examination of the role of the preceptor in encouraging PA in FP practice. As a future direction, it would be useful to assess preceptors' beliefs and attitudes related to FPs' roles and knowledge needs for health promotion advocacy, specifically the extent to which they think residents should learn the benefits of PA and how to assess, prescribe, refer, and document PA in EMRs as regular practice.

Four programs (28.6%) indicated that PA referral to an allied health care provider or community program is site dependent. This often pertained to potentially unequal resources available to the resident or FP in their primary care network or the limitation that financial costs that may be transferred to the patient (e.g., costs to attend a fitness facility). Residents must learn to be aware of inexpensive or already subsidized resources in their communities including virtual sources so that all patients have the opportunity to increase PA levels, regardless of their socioeconomic status.

During the interviews it was evident that some FM programs may be receptive to receiving documentation and materials about PA, as two (13.3%) programs asked to be provided with PA-related resources that they could share with their curriculum committees. Thus, an opportunity exists for Canadian PA-advocacy organizations (e.g., ParticipACTION, Canadian Society for Exercise Physiology) to work with FM programs and provide evidence-based training and resources to ensure residents are sufficiently prepared to incorporate PA in the care they provide patients. FPs should incorporate existing PA resources from health services and in the community as regular practice (Lion et al., 2019).

This study was limited to responses to questions about PA in FM programs that were either provided in writing or through a single interview. It is possible that the respondents could not recall all details about their program. Additionally, three of the 17 programs declined to participate in this study, and as a result, our findings are not inclusive of all Canadian FM programs. However, our response rate was similar to that of Thornton et al. (2021).

In summary, all participating FM programs offered some form of PA training to their residents. There was general agreement that FM programs teach about the benefits of PA, specifically regarding prevention and treatment of chronic conditions. We found variability in instruction about PA guidelines and how to assess, prescribe, refer, and document PA in EMRs. Four programs noted that a lack of PA-content experts was a barrier, even though their universities have departments or faculties of kinesiology. Thus, PA-content experts in kinesiology programs should be encouraged to work with FM programs through lectures and providing relevant evidence-based materials. These findings can contribute to a call to action for collaboration between university faculties to prepare FM residents to be able to engage in PA health promotion.

**Conflict of interest notification**

ND is employed by the University of Calgary Department of Family Medicine and CL, DK, and ND are employed by the University of Alberta Department of Family Medicine. The authors have no conflicts of interest to disclose. No curriculum expert or program identifying information will be disclosed in this manuscript or any other forum. Findings are presented as totals or anonymous quotes. This study was not funded.

Table 3.1 Education of the benefits, assessment, prescription, referral, and documentation of physical activity in electronic medical records

| **Describe whether programs teach residents the benefits of physical activity** | **n** | **%[1]** |
| --- | --- | --- |
| Students learn the benefits of physical activity | 9 | 64.3 |
| Residents are expected to already have knowledge about the benefits of physical activity from their undergraduate medical program | 2 | 14.3 |
| Whether residents learn the benefits of physical activity is preceptor-dependent | 1 | 7.1 |
| Residents are expected to supplement their learning of the benefits of physical activity through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| Residents learn the benefits of their own physical activity (i.e., pertaining to the resident's own wellness) | 1 | 7.1 |
| The benefits of physical activity are 'likely' taught during clinical lectures | 1 | 7.1 |
| **Describe whether programs teach residents about physical activity assessment** | **n** | **%[1]** |
| Residents learn physical activity assessment | 6 | 42.9 |
| Residents do not learn how to assess physical activity | 5 | 35.7 |
| Learning how to assess physical activity is preceptor-dependent | 1 | 7.1 |
| Learning how to assess physical activity is site-dependent | 1 | 7.1 |
| Residents are expected to supplement their learning of physical activity assessment through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| It is unclear whether residents learn how to assess physical activity | 1 | 7.1 |
| **Describe whether programs teach residents about physical activity prescription** | **n** | **%[1]** |
| Residents learn how to prescribe physical activity | 7 | 50.0 |

| | | |
|---|---|---|
| Learning how to prescribe physical activity is preceptor-dependent | 3 | 21.4 |
| It is site-dependent whether residents learn how to prescribe physical activity | 2 | 14.3 |
| Residents are expected to already have knowledge of how to prescribe physical activity from their medical school program | 1 | 7.1 |
| Physical activity “prescription pads" were used in the past but are now irrelevant with use of electronic medical records | 1 | 7.1 |
| Residents are expected to supplement their learning of physical activity prescription through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| **Describe whether programs teach residents about physical activity referral (e.g., to an allied health care provider or community program)** | **n** | **%[1]** |
| Residents do not learn to how to refer physical activity | 4 | 28.6 |
| Physical activity referral is site-dependent | 4 | 28.6 |
| Residents learn how to refer physical activity | 3 | 21.4 |
| Residents are expected to supplement their learning of physical activity referral through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| Residents are expected to take part in physical activity referral during their clinical exposure | 1 | 7.1 |
| 'It varies' whether residents learn how refer physical activity | 1 | 7.1 |
| Physical activity referral depends on the local resources available in the clinics' region | 1 | 7.1 |
| Physical activity referral is preceptor-dependent | 1 | 7.1 |
| **Describe whether programs teach residents to document physical activity (e.g., in electronic medical record systems)** | **n** | **%[1]** |
| Residents do not learn to document physical activity in electronic medical records | 6 | 42.9 |

| | | |
|---|---|---|
| Learning how to document physical activity in electronic medical records is preceptor-dependent | 1 | 7.1 |
| Learning how to document physical activity in electronic medical records is site-dependent | 1 | 7.1 |
| Residents learn how to document physical activity in electronic medical records during clinical teaching | 1 | 7.1 |
| Residents are expected to supplement their learning of documenting physical activity in EMRs through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| It is our expectation that residents will take part in physical activity prescription during their clinical exposure | 1 | 7.1 |
| Residents use a 'social habits' field in most electronic medical records with a standardized category | 1 | 7.1 |
| Residents learn to document physical activity in free-text Subjective, Objective, Planning, and Assessment (SOAP) notes | 1 | 7.1 |
| Unsure whether residents learn how to document physical activity in their electronic medical records | 1 | 7.1 |
| Residents use an electronic medical record that has a dichotomous field to indicate meeting physical activity guidelines and an open-text notes field | 1 | 7.1 |

1. Percent is calculated out of the 14 responding family medicine residency programs. Programs may indicate more than one response.

Table 3.2 Physical activity guideline education

| **Are Canadian physical activity guidelines included in your curriculum?** | **n** | **%[1]** |
|---|---|---|
| Physical activity guidelines are taught | 6 | 42.9 |
| Physical activity guidelines are not taught | 4 | 28.6 |
| Residents are expected to supplement their learning of physical activity guidelines through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| It is our expectation that residents will take part in learning about physical activity guidelines during their clinical exposure | 1 | 7.1 |
| American sources are taught as there is a larger primary care literature than from Canada | 1 | 7.1 |
| The curriculum is not written to a level of granularity where it would be possible to specify if physical activity guidelines are taught | 1 | 7.1 |
| Teaching physical activity guidelines is preceptor-dependent | 1 | 7.1 |
| **Are strength training physical activity guidelines included in your curriculum?** | **n** | **%[1]** |
| Physical activity strength guidelines are not taught | 5 | 35.7 |
| Physical activity strength guidelines are taught | 3 | 21.4 |
| Physical activity strength guidelines are taught for older populations | 1 | 7.1 |
| Learning about physical activity strength guidelines are site-specific | 1 | 7.1 |
| The curriculum is not written to a level of granularity where it would be possible to specify if physical activity strength guidelines are taught | 1 | 7.1 |

| | | |
|---|---|---|
| Residents are expected to supplement their learning of physical activity strength guidelines through self-study if they have not adequately encountered it in their clinical exposure | 1 | 7.1 |
| It is our expectation that residents will take part in physical activity strength training guidelines during their clinical exposure | 1 | 7.1 |
| Physical activity strength guidelines are taught for conditions such as osteoarthritis | 1 | 7.1 |
| Physical activity strength guidelines are 'likely' taught | 1 | 7.1 |

1. Percent is calculated out of the 14 responding family medicine residency programs. Programs may indicate more than one response.

Table 3.3 Barriers to incorporating physical activity into family medicine residency programs

| **What are the barriers to incorporating physical activity into programs?** | **n** | **%[1]** |
|---|---|---|
| There is limited time in the curriculum | 11 | 78.6 |
| Unable to find local expertise to teach physical activity | 4 | 28.6 |
| There is variability by site | 3 | 21.4 |
| There is variability by preceptor | 2 | 14.3 |
| There is not a lot of literature about how family physicians should discuss exercise | 1 | 7.1 |
| There are no standardized tools | 1 | 7.1 |
| There is a traditional focus on pharmalogical and surgical interventions rather than preventative approaches (i.e., physical activity) | 1 | 7.1 |
| There are no barriers to incorporating physical activity in the curriculum | 1 | 7.1 |
| It is assumed residents already know about physical activity from previous training | 1 | 7.1 |
| Unsure what the physical activity competencies are | 1 | 7.1 |

1. Percent is calculated out of the 14 responding family medicine residency programs. Programs may indicate more than one response.

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# CHAPTER 4: Study 3

Predicting family physician physical activity electronic medical record inputs

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## Abstract

Family physicians are key primary care advocates for physical activity, which is a significant modifiable behaviour for the treatment and prevention of chronic illnesses. We used family physician electronic medical record data from the Canadian Primary Care Sentinel Surveillance Network to compare patient and provider characteristics on a visit selected at random by billing date. The dataset included 769,185 patients, of whom 14,828 (1.9%) had physical activity information documented. Male patients, aged 25-34.9, without comorbidities prior to the random visit date, with moderate or elevated blood pressure risk categories prior to the random visit date, the least materially deprived quintile, and with median body mass index in the normal category prior to the random visit date had the most physical activity mentions. The sample included 879 family physicians, but just over half (56.1%) had documented physical activity at least once. More female physicians and physicians who practised in teaching sites documented physical activity. In a two-level logistic model predicting the presence of documented physical activity, older than mean patient age, having fewer comorbidities, younger than mean family physician age, academic teaching sites, and certain electronic medical record systems were statistically significant covariates. This work adds to existing literature by describing the frequency and the patient and family physician characteristics of physical activity documentation in the Canadian primary care context. Overall, patient physical activity was rarely documented in electronic medical records by family physicians.

## Introduction

Physical activity (PA) has health benefits regardless of age, sex, race, ethnicity, or body size (Piercy et al., 2018). Higher levels of PA is associated with a reduced risk for all-cause mortality and chronic medical conditions (e.g., cardiovascular disease, all-cause mortality, type 2 diabetes, hypertension, cancers) (Warburton & Bredin, 2017). However, adults in most countries are considered physically inactive or struggle to meet PA recommendations (World Health Organization, 2018). For instance, only 45% of Canadian adults (Clarke, Colley, Janssen, & Tremblay, 2019) and 53.3% of adults in the United States (Centers for Disease Control and Prevention, 2021a) are estimated to achieve the minimum requirements for aerobic PA. Clearly, improvement in population PA levels is needed.

The potential for public health contributions by family physicians (FP) are substantial because they can modify the health of a large sector of the population (Grandes et al., 2009). For example, ~85% of Canadians received care from their primary care doctor or FP (Canadian Institute for Health Information, 2016). Specifically, the role of FPs is to provide health promotion and disease prevention; elicit patients' history of health; perform physical exams; select appropriate investigations; and interpret results for the purpose of diagnosis and disease management, disease prevention, and health promotion (College of Family Physicians of Canada, 2017). FPs occupy a critical role as important influencers of patient behaviour and can influence large proportions of the population, especially pertaining to population PA levels (Global Advocacy for Physical Activity the Advocacy Council of the International Society for Physical & Health, 2012; Lion et al. 2019).

The majority (82.4%-89.9%) of FPs use an electronic medical record (EMR) systems (Canadian Medical Association, 2017; Centers for Disease Control and Prevention, 2021b) to document patient and encounter information such as billing, patient history, patient demographics, physical measurements (e.g., height, weight, blood pressures), prescribed medications, symptoms, problem list (e.g., indication of patient conditions, risk factors, and diseases), and laboratory results (Canadian Primary Care Sentinel Surveillance Network, 2019). Although adult patients self-reported that 35.9% received PA advice from healthcare providers (Smith & Ylitalo, 2021) and FPs self-reported that they regularly (85.2%) ask patients about their PA levels and offer verbal counselling (69.8%) (Petrella, Lattanzio, & Overend, 2007), little is known about the characteristics of patients and of providers as related to PA documentation in EMRs. A recent scoping review found few articles that examined PA information documented in FP EMRs (Lindeman et al., 2020). Specifically, the frequency of PA inputs varied from as low as 0.4% of patients with documentation of PA health promotion inputs to a high of 87.8% of patients with exercise or PA status recorded. According to a recent content analysis of the records of 1,535 adult patients in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN), 148 (9.6%) ever had PA documented in their EMR and insufficient information existed to categorize PA domain (21.6%), purpose (e.g., noting advice, PA level, PA prescription) (50.0%), or meeting PA guidelines (98.1%) (Lindeman et al., 2022).

There is some evidence that PA is documented less often than other lifestyle behaviours such as smoking (Ludt et al., 2012). Male patients have PA documented more often than female patients (van Lieshout et al., 2012) and there is more documentation related to patients with chronic conditions such as obesity (Mattar et al., 2017). Regarding differences across provider demographic characteristics, female physicians were more likely to ask about PA levels, provide verbal counselling, and provide written prescriptions, whereas male providers were more likely to assess patient fitness (Petrella et al., 2007). Provider age was another predictor since physicians over the age of 35 are more likely to ask about PA levels, offer verbal counselling, and write written prescriptions while providers over the age of 55 are more likely to assess patient fitness levels (Petrella et al., 2007). According to a study using PA information from a chart audit of 439 patients in Quebec, 34% of the variance in PA counselling was explained by assessment of PA level, overweight or obese status, type 2 diabetes or prediabetes, less FP experience, lower patient annual family income, more nurse encounters, a higher patient physical component summary of quality of life (Baillot et al., 2018). In addition, 21.6% of the patients had documentation of PA counselling in the previous 18 months (Baillot et al., 2018). Given the limited information in the literature, more research is needed using large datasets to better understand what factors predict PA documented in primary care EMRs. Therefore, this study had two objectives: to describe the difference between patients with and without PA noted, and to determine the extent to which patient and FP characteristics predict EMR documentation.

## Methods

### Design

This study used a cross-sectional design of secondary data.

### Data source

The CPCSSN launched in 2008 with a mandate to build a repository of de-identified primary care EMR data available for research and health surveillance. CPCSSN extracts EMR data from ~1,400 sentinel primary care practices across Canada from 12 EMR systems and include patient demographics, physical measurements (e.g., height, weight, blood pressure), prescribed medications, symptoms and diagnoses recorded during patient visits, billing claims, provider data, and laboratory results. Since EMRs are designed for patient care and not for surveillance and research, extensive cleaning, coding, and processing algorithms have been created to assess various aspects of the EMR record and to develop valid case definitions for chronic conditions (Canadian Primary Care Sentinel Surveillance Network, 2019, 2020; Williamson et al., 2014). CPCSSN data includes all provider EMR data unless specifically excluded for CPCSSN studies (e.g., the provider indicated that the patient is choosing to withdraw from CPCSSN extractions); imaging data; and subjective, objective, assessment, and procedure (SOAP) notes which are not collected as they may contain identifying information. To inform this study, a data extraction of FP CPCSSN data as of June 30, 2019, was used.

**Selection of CPCSSN data**

All FPs with billing date data were included in this study and a single date was selected at random using the 'runiform' STATA command for each patient who aged 18 to 64.9 at any time. Random dates ranged from 1990 to 2019, but were mostly 2008 onwards. The age range was selected to match the adult age category for PA guidelines (Ross et al., 2020). The decision to select a single date for each patient was informed by advice from CPCSSN data mangers who explained to the authors that it is challenging to distinguish data between patient visits since patient data for a single visit may be inputted on multiple dates (Cummings M., personal communication, May 13, 2020). The randomly selected billing date was merged with each patient's demographic data (i.e., age, sex, material deprivation quintile), health status prior to the randomly selected date (i.e., BMI, blood pressure, chronic disease status), and the patient's FP data (i.e., EMR system, clinic type, FP age, FP sex).

**Physical activity**

Using the randomly selected date, all fields in each patient's EMR were assessed for any documented PA information. The PA selection criteria was informed by a CPCSSN PA content analysis as it indicated what CPCSSN tables and fields included PA information (Lindeman, et al., 2022). The process of identifying PA data is included as Appendix E. Whether PA was documented on the randomly selected date was the dichotomous outcome variable.

**Predictors**

Variables under consideration for the model were patient variables: sex, age, count of chronic disease prior to selection date (i.e., chronic kidney disease, chronic obstructive pulmonary disease, dementia, diabetes, hypertension, and osteoarthritis), material deprivation quintile (Pampalon, Hamel, Gamache, & Raymond, 2009), BMI category prior to selection date (World Health Organization, 2022), and blood pressure risk category prior to selection date; as well as FP variables: sex, age, clinic type (i.e., academic/teaching sites and community sites), and EMR system.

**Model development and analysis**

To determine which variables are associated with PA documentation, the purposeful selection process for logistic regression was followed to build a parsimonious model (Bursac, Gauss, Williams, & Hosmer, 2008; Hosmer, Lemeshow, & Sturdivant, 2013). Some important decisions were made in the development of the main effects model. First, the CPCSSN datacut included several EMR systems with few (i.e., <10) FPs, which were excluded from the study. This restricted the analysis to four EMR systems. Second, clinic type was recoded to compare community sites to both hospital-based and community teaching sites. Last, one EMR system that was solely in hospital-based teaching sites did not have material deprivation data. We included this EMR in the sample as it had at least some data across all other covariates. Variables that are not significant at 0.05 are included in the model because they either improved the model fit as determined by a likelihood ratio significance test and/or the removal of the variable changed the remaining coefficients by +/- 20%.

Frequencies and descriptive statistics were used to compare PA across patient and FP characteristics. Categorical variable associations were examined with chi squares. In the model, predictors were kept as fixed effects and odds ratios are presented describe to what extent they significantly contribute to the prediction of PA notation (coefficients are included as Appendix F). Analysis was computed with STATA 14.2 (StataCorp, 2020). The study received approval from the Research Ethics Board at the University of Alberta: Pro00096027 and followed the RECORD statement checklist for observational studies (Benchimol et al., 2015).

## Results

The sample included 769,185 patient visits that satisfied the age criteria of 18-64.9 at any time. Of those, 1.9 percent (n = 14,828) of patients had PA documented in their FPs EMR on the randomly selected date.

### Objective 1: describe the difference between patients and FPs with and without PA noted

Significantly ($p < .001$) more male patients had PA information documented (2.2%) than female patients (1.7%). The age group with the highest proportion of PA were patients aged 25-34.9 (2.2%). Patients with none of the six comorbidities prior to the randomly selected date had PA documented in their EMR most often (2.1%) as did patients with moderate (2.3%) or elevated (2.3%) blood pressure, and a BMI considered to be normal weight (2.4%). Patients in the lowest materially deprived quintile (i.e, the quintile with the fewest unemployed, highest average household income, and highest high school graduation) had the highest proportion of PA across all the patient level indicators (3.3%). The lowest proportion of PA information for each patient predictor was 'sex not listed' (0.9%), the oldest age category 55-64.9 (1.7%), no blood pressure measurements (1.4%), no material deprivation data (1.7%), no BMI data (1.7%) was slightly greater than patients with a median BMI of class 3 obese (1.6%) (Table 4.1).

There were 879 FPs for the 769,185-patient sample. Of these, 56.1 percent documented PA for at least one patient included in the random sample. Provider sex was similar (female providers 57.1%; male providers 56.6%) and the difference was not statistically significant ($p = .740$). The median age of FPs in the sample averaged across all random clinic dates was 44.8 ($SD = 11.3$) years. The median age of FPs that have documented PA was 45.0 ($SD = 11.3$), which was similar to FPs who have never documented PA 44.6 ($SD = 11.0$). The clinic type was significantly different ($p < .001$) with community clinics having less than half of documented PA (44.2%) compared to academic FPs practicing within teaching hospital sites (89.6%). The documentation of PA across EMR systems did not significantly vary ($p = .491$) which ranged between 53.3% to 59.6% (Table 4.2).

**Objective 2: determine the extent to which patient and FP characteristics predict EMR documentation**

While building the model, we tested to see if a null model with FP as the second level better predicted PA compared to a single level null model. This was tested as every patient is nested by a single FP. The ICC was 0.74, and the likelihood ratio was statistically significant ($p < .001$), providing evidence to proceed with a two-level model instead of a single level model. The purposeful selection process resulted in a model that included all patient and provider predictors except for provider sex (Table 4.3). The direction of predictors in the main effects model found an increase odds of PA inputs for: male patients (p = .069), older than mean patient age (p < .001), fewer chronic condition count (p < .001), less than mean BMI (p = .494), most materially deprived quintile (p = .116), and moderate (p = .379) or elevated blood pressure risk (p = .430). For provider predictors, the odds of documented PA increased with younger than mean FP age (p < .001), increased for teaching clinic sites (p < .001), and varied based on the providers EMR (p-value range from .002, .930) (Table 4.3).

In the main effects model, one of the strongest predictors was clinic type as teaching clinic sites had an OR of 44.01, 95% CI [22.025, 87.816]. Because of this, we ran two additional models to compare the difference in predictor estimates for community sites compared to teaching sites and the main effects model. This involved repeating the purposeful selection process for both site types. For community sites, all variables fit into the model except for patient and provider sex. Compared to the main effects model, the community model differed in effect estimate direction for two patient predictors: younger than mean age (p = .497) and the least materially deprived quintile (p = .152) predicted PA but were not significant. For provider variables in the community model the only difference in direction from the main effects model was older than mean age predicated an increased the odds of documented PA (p = .585). The teaching site model compared to the main effects model differed in the direction of effect for one EMR system (p = .483) (Table 4.3).

Considering the main effects model, which consisted of community clinics and teaching clinics, compared to the intercept only null model the ICC dropped from 0.74, 95% CI [0.71, 0.77] to 0.70, 95% CI [0.61, 0.77] with the addition of patient variables. The BIC and AIC also decreased from 106,594.8 to 5,877.1 and 106,617.9 to 106,617.9, which indicates the model fit improved. The addition of patient and provider predictors further dropped the ICC to 0.26, 95% CI [0.16, 0.39] as well as the BIC 4,386.5 and AIC 4,523.7.

## Discussion

In the EMRs of Canadian FPs, our univariate descriptive statistics showed that patients with PA documented were more often male and aged 25-34. Prior to the randomly selected visit date more often patients did not have comorbidities, had moderate or elevated blood pressure risk categories, had a BMI in the normal category, and were in the least materially deprived quintile. FPs were more often female, practiced in academic sites, and varied depending on their EMR system. Our two-level main effects model found that the documentation of PA was statistically significantly predicted by older than mean patient age, patients with fewer comorbidities, younger than mean FP age, academic teaching sites, and by differing EMR system.

Similar to previous research (Baillot et al., 2018), PA EMR documentation is in part explained by patients who had diabetes as we found a significant univariate effect (Table 4.1). However, unlike Baillot et al., who found that overweight or obesity increased PA counseling notations, our descriptive statistics found that patient mean BMI in the normal category had the most PA mentions rather than overweight or obese (Table 4.1) and less than mean BMI increased odds of PA in all three models (Table 4.3). In another example, research conducted by Kaiser Permanente in the United States (n = 1,537,798), reported that patients with an exercise screen in the EMR were mostly aged 50-64 years old which generally aligns with our findings in the main effects model (Coleman et al., 2012); however, our findings differ as we did not find a significant effect for patient sex or patients who have greater than mean BMI in the two-level model. Interestingly our study and Coleman et al. found that most patients with fewer chronic conditions had PA data in the EMR. Thus, it may be that healthier patients are having conversations with their FP about PA and then FPs subsequently choose to document information about those conversations in their EMR.

Teaching sites showed a large association with PA documentation. We speculate that the higher frequency of documentation of PA information in teaching sites compared to community clinics may be due to the FP payment model. Teaching site preceptors are often paid salaries or clinical alternative relationship plans while community FPs are generally fee-for-service in Canada. Inclusion in the study was based on a random billing date for each patient, and in teaching sites billing may be assigned to resident physicians to provide them with learning experiences, for which we do not have data to determine; whereas community providers may not have the time to document all pertinent information in EMRs, such as PA. Relatedly, authors have recommended that teaching how to document in EMRs should be formally taught (Niedermier, 2017) as training appears to be varied and is often constrained (White, Anthony, WinklerPrins, & Roskos, 2017).

As far as the authors are aware, no professional body regulates the design parameters of virtual care systems such as EMRs in Canada. This lack of regulation means that EMRs may or may not have inputs fields or areas to document PA information. The result is that "... without defined and standardized design parameters that support quality care, virtual care can be deployed haphazardly, sometimes inappropriately, and in a manner that may not support the best interests of the patient, provider, or health system" (Alberta Virtual Care Working Group, 2021). More research is needed to understand, from the FPs perspective, whether the EMR systems they use allows for sufficient documentation of PA and/or if EMR systems should include a template and structured fields so that PA conversations and related advice could be easily captured. If

EMR systems are found to be insufficient FP-users, patients, and health organizations could co-develop PA EMR tools such as templates and/or fields and embed them into EMR systems (Clark et al., 2021). Since estimates suggest that primary care physicians spend more than half of their workday interacting with electronic health record systems (Arndt et al., 2017), processes should be improved in an effort to reduce provider burnout (Tajirian et al., 2020). Structured fields may also improve data quality as studies have found that when forms like the General Practice Physical Activity Questionnaire is embedded in EMRs, an increase occurs in PA information noted (e.g., Heron, Tully, McKinley, & Cupples, 2014).

We found that patients with any of the six chronic conditions included in this study had less PA documentation (0.9% to 1.6%) than patients without any of the chronic conditions (2.1%). It is well known that PA is beneficial across all the chronic conditions investigated in this study as a mode of, or alongside, additional treatments. For example, a 2015 review that found benefits of exercise as medicine in 26 chronic conditions (Pedersen & Saltin, 2015). In patients with chronic obstructive pulmonary disease who were provided with supervised and recreational PA experienced improved fitness and clinically important benefits for dyspnea, fatigue, and emotional functioning (Pedersen & Saltin, 2015). Clinical practice guidelines for chronic diseases need to be followed to benefit patients with evidence-based care, and there is a tremendous amount of evidence that PA can improve outcomes and quality of life (Warburton & Bredin, 2016).

The Accuro EMR system was a statistically significantly covariate in the main effects model OR = 86.7, $p = .002$, 95% CI [5.2, 1,453.1]. Accuro explains in their promotional material that they have over 5,000 forms and that users can quickly customize forms (Accuro, 2022). One of the forms is a preventative screen band of 12 maneuvers, including exercise assessment 'exercise >150 min /week' categorized as 'sedentary', 'low', 'moderate', or 'high' (Alberta Doctors, 2022). This screen band, which is a structured field when selected in Accuro EMRs, may be why we found Accuro to support FPs to document PA more often. However, as CPCSSN does not have access to the front-end user interface detailing how FPs inputted information, this assumption requires further research.

This study has several limitations that should be acknowledged. First, it only includes data CPCSSN extracted from participating FP EMRs and excludes SOAP notes and imaging data as well as unique templates embedded within EMRs. It is possible that FPs inputted PA information that CPCSSN is unable to extract and process. Second, as patients are identified in CPCSSN by a randomly generated number unique to the provider, it is possible that a patient is within the CPCSSN dataset if they received care by providers from different clinics. However, based on experience with CPCSSN data in the southern Alberta network, we believe this is a rare occurrence. Last, FPs may have had conversations with the patients about PA but did not record information about this in their EMR. In this instance, CPCSSN would not be able to extract that information.

In summary, this study identifies both patient and FP predictors of PA information in EMRs. In a two-level model we found that patient age, pre-existing comorbidities, FP age, clinic site type, and select EMR systems are statistically significant predictors of PA documentation. In particular, patients visiting academic teaching sites are much more likely to have PA recommendations documented in their records. Future work is needed to ensure that EMR systems allow for comprehensive documentation of PA within the FPs existing workflow. The secondary use of EMR system data offers an important resource to better understand the role of FPs for promoting PA.

**Keywords**

- Exercise
- Family physician
- Electronic medical records
- Primary care

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**Disclosure of potential and real conflicts of interest**

The authors have no potential or real conflicts to declare.

**Author contributions**

**Cliff Lindeman:** conceptualization, data curation, analysis, writing - original draft; **Richard Golonka:** conceptualization, analysis, methodology, writing - review and editing; **Doug Klein:** conceptualization, writing - review and editing; **Michael K. Stickland:** conceptualization, writing - review and editing; and **John C. Spence:** conceptualization, data curation, funding acquisition, supervision, writing - original draft

**Consent to participate**

Participating CPCSSN primary care providers consented to have their electronic medical record data extracted for research and quality improvement purposes.

**Consent for publication**

Not applicable, there are no individual data or images in this manuscript.

**Data availability**

Access to the CPCSSN data used in this study requires approval from the CPCSSN Steering Committee and therefore will not be released by this study team. CPCSSN data is available for use by researchers upon application.

Table 4.1 Patient characteristics and frequency of physical activity

| | Frequency | PA (%) | No PA (%) | p-value |
|---|---|---|---|---|
| Patient demographic characteristics | | | | |
| Patients | 769,185 | 14,828 (1.9) | 754,357 (98.1) | |
| **Patient sex** | | | | <0.001 |
| Female | 429,938 | 7,471 (1.7) | 422,467 (98.3) | |
| Male | 338,912 | 7,354 (2.2) | 331,558 (97.8) | |
| Sex not listed | 335 | 3 (0.9) | 332 (99.1) | |
| **Age group**[1] | | | | <0.001 |
| Age 18-24.9 | 120,455 | 2,195 (1.8) | 118,260 (98.2) | |
| Age 25-34.9 | 162,428 | 3,549 (2.2) | 158,879 (97.8) | |
| Age 35-44.9 | 153,857 | 3,253 (2.1) | 150,604 (97.9) | |
| Age 45-54.9 | 152,393 | 2,832 (1.9) | 149,561 (98.1) | |
| Age 55-64.9 | 180,052 | 2,999 (1.7) | 177,053 (98.3) | |
| **Disease status prior to selection date** | | | | |
| Chronic kidney disease | 5,048 | 65 (1.3) | 4,983 (98.7) | 0.352 |
| Chronic obstructive pulmonary disease | 10,271 | 106 (1.0) | 10,165 (99.0) | <0.001 |
| Dementia | 1,969 | 18 (0.9) | 1,951 (99.1) | 0.048 |
| Diabetes | 44,028 | 579 (1.3) | 43,449 (98.7) | 0.013 |
| Hypertension | 86,816 | 1,361 (1.6) | 85,455 (98.4) | <0.001 |
| Osteoarthritis | 37,142 | 520 (1.4) | 36,622 (98.6) | 0.457 |
| **Count of comorbidities prior to selection date** | | | | <0.001 |
| 0 | 536,907 | 11,478 (2.1) | 525,429 (97.9) | |
| 1 | 175,157 | 2,664 (1.5) | 172,493 (98.5) | |
| 2 | 44,295 | 549 (1.2) | 43,746 (98.8) | |
| 3 | 10,514 | 107 (1.0) | 10,407 (99.0) | |

| | | | | |
|---|---|---|---|---|
| 4 | 2,011 | 27 (1.3) | 1,984 (98.7) | |
| 5 | 281 | 3 (1.1) | 278 (98.9) | |
| 6 | 20 | 0 (0.0) | 20 (100.0) | |
| **Median blood pressure status category prior to selection date** | | | | 0.027 |
| Low risk[2] | 186,905 | 4,034 (2.2) | 182,871 (97.8) | |
| Moderate risk[3] | 239,006 | 5,439 (2.3) | 233,567 (97.7) | |
| Elevated risk[4] | 54,911 | 1,249 (2.3) | 53,662 (97.3) | |
| No blood pressure measurements | 288,363 | 4,106 (1.4) | 284,257 (98.6) | |
| **Median body mass index category prior to selection date** | | | | <0.001 |
| Underweight[5] | 5,331 | 106 (2.0) | 5,225 (98.0) | |
| Normal weight[6] | 97,097 | 2,374 (2.4) | 94,723 (97.6) | |
| Overweight[7] | 95,189 | 2,169 (2.3) | 93,020 (97.7) | |
| Obese Class 1[8] | 53,325 | 1,156 (2.2) | 52,169 (97.8) | |
| Obese Class 2[9] | 23,305 | 442 (1.9) | 22,863 (98.1) | |
| Obese Class 3[10] | 18,562 | 291 (1.6) | 18,271 (98.4) | |
| No BMI measurements | 476,376 | 8,290 (1.7) | 468,086 (98.3) | |
| **Material deprivation quintile** | | | | <0.001 |
| 1 (least deprived) | 30,177 | 996 (3.3) | 291,181 (96.7) | |
| 2 | 31,808 | 928 (2.9) | 30,880 (97.1) | |
| 3 | 28,601 | 710 (2.5) | 27,891 (97.5) | |
| 4 | 31,519 | 773 (2.5) | 30,746 (97.6) | |
| 5 (most deprived) | 30,238 | 836 (2.8) | 29,402 (97.2) | |
| No material deprivation quintile data | 616,842 | 10,585 (1.7) | 606,257 (98.3) | |

1. Age as of the randomly select encounter date.

2. Low risk is defined as median sbp < 120 & median dbp < 80

3. Moderate risk is defined as median sbp 120-139.9 & median dbp 80-90

4. Elevated risk is defined as median sbp >140 & dbp >90

5. Underweight is defined as median bmi <18.5

6. Normal weight is defined as median bmi 18.5-24.9

7. Overweight is defined as median bmi 25.0-29.9

8. Obese Class 1 is defined as median bmi 30-34.9

9. Obese Class 2 is defined as median bmi 35.0-39.9

10. Obese Class 3 is defined as median bmi >40.0

Table 4.2 Family physician characteristics, clinic type, and electronic medical record physical activity documentation

| | Frequency | PA (%) | No PA (%) | p-value |
|---|---|---|---|---|
| Providers | 879 | 493 (56.1) | 386 (43.9) | |
| **Provider sex** | | | | 0.740 |
| Female | 487 | 281 (57.7) | 206 (42.2) | |
| Male | 373 | 211 (56.6) | 162 (43.4) | |
| Sex not listed | 19 | 1 (5.6) | 18 (94.4) | |
| **Clinic type** | | | | <0.001 |
| Community | 489 | 216 (44.2) | 273 (55.8) | |
| Academic clinic | 342 | 234 (68.4) | 108 (31.6) | |
| Academic hospital | 48 | 43 (89.6) | 5 (10.4) | |
| **EMR system** | | | | 0.491 |
| Accuro | 240 | 143 (59.6) | 97 (40.4) | |
| Med Access | 160 | 89 (55.6) | 71 (44.4) | |
| Oscar | 141 | 81 (57.4) | 60 (42.6) | |
| Practice Solutions | 338 | 180 (53.3) | 158 (46.7) | |

Table 4.3 Mixed effect multilevel regression modeling physical activity inputs in the sample, in community clinics alone, and teaching clinics alone

| | Main effects model | | | Community clinic model | | | Academic clinic model | | |
|---|---|---|---|---|---|---|---|---|---|
| | Odds ratio (95% CI) | Std Err. | p-value | Odds ratio (95% CI) | Std Err. | p-value | Odds ratio (95% CI) | Std Err. | p-value |
| *Fixed Effects* | | | | | | | | | |
| Constant | 0.003 | 0.001 | <0.001 | 0.0006 | 0.000 5 | <0.001 | 0.135 | 0.026 | <0.001 |
| Patient level predictors | | | | | | | | | |
| Female | 0.844 (0.703-1.013) | 0.079 | 0.069 | NA | NA | NA | 0.832 (0.687-1.007) | 0.081 | 0.059 |
| Patient age[1] | 1.020 (1.012-1.028) | 0.004 | <0.001 | 0.992 (0.969-1.015) | 0.012 | 0.497 | 1.024 (1.016-1.032) | 0.004 | <0.001 |
| Chronic condition count | 0.658 (0.563-0.768) | 0.052 | <0.001 | 0.791 (0.434-1.444) | 0.243 | 0.446 | 0.643 (0.548-0.754) | 0.052 | <0.001 |
| Body mass index[1] | 0.996 (0.984-1.008) | 0.006 | 0.494 | 0.944 (0.896-0.995) | 0.025 | 0.033 | 0.999 (0.988-1.012) | 0.006 | 0.939 |
| Material deprivation quintiles | | | | | | | | | |
| Material deprivation Q1[2] | 0.804 (0.612-1.056) | 0.112 | 0.116 | 1.90 (0.790-4.565) | 0.850 | 0.152 | 0.713 (0.536-0.950) | 0.104 | 0.021 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Material deprivation Q2[2] | 0.906 (0.693-1.185) | 0.124 | 0.471 | 1.462 (0.604-3.541) | 0.660 | 0.400 | 0.857 (0.646-1.136) | 0.123 | 0.282 |
| Material deprivation Q3[2] | 0.830 (0.628-1.096) | 0.118 | 0.189 | 0.503 (0.160-1.579) | 0.294 | 0.239 | 0.875 (0.656-1.166) | 0.128 | 0.361 |
| Material deprivation Q4[2] | 0.903 (0.696-1.173) | 0.120 | 0.445 | 0.365 (0.108-1.236) | 0.227 | 0.105 | 0.958 (0.733-1.252) | 0.131 | 0.755 |
| Blood pressure categories | | | | | | | | | |
| Moderate risk blood pressure[3] | 1.097 (0.892-1.350) | 0.116 | 0.379 | 1.149 (0.584-2.259) | 0.396 | 0.687 | 1.100 (0.886-1.366) | 0.122 | 0.387 |
| Elevated risk blood pressure[3] | 1.126 (0.839-1.512) | 0.169 | 0.430 | 1.717 (0.667-4.423) | 0.829 | 0.262 | 1.108 (0.814-1.508) | 0.174 | 0.515 |
| Provider level predictors | | | | | | | | | |
| Provider sex | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Provider age[1] | 0.958 (0.936-0.981) | 0.011 | <0.001 | 1.020 (0.950-1.095) | 0.037 | 0.585 | 0.975 (0.953-0.998) | 0.011 | 0.033 |
| Academic clinic[4] | 44.007 (22.0253-87.816) | 15.513 | <0.001 | NA | NA | NA | NA | NA | NA |
| Electronic medical record system | | | | | | | | | |
| Accuro[5] | 86.743 (5.175-1,453.090) | 124.765 | 0.002 | 111.305 (1.813 - 6,834.617) | 233.829 | 0.025 | NA | NA | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Oscar[5] | 0.973 (0.529-1.791) | 0.303 | 0.930 | 0.305 (0.023-3.974) | 0.399 | 0.365 | 1.171 (0.754-1.818) | 0.263 | 0.483 |
| Practice Solutions[5] | 0.772 (0.347-1.715) | 0.314 | 0.525 | 1.048 (0.237-4.638) | 0.795 | 0.950 | NA | NA | NA |
| *Random effects* | | | | | | | | | |
| Provider | 1.150 (0.638-2.071) | 0.345 | NA | 4.360 (1.860-10.218) | 1.895 | NA | 0.387 | 0.157 | NA |

1. Grand centre mean
2. Q5, the most materially deprived quintile, is the refence category
3. Low risk blood pressure is the reference category
4. Community clinic is the reference category
5. Med Access is the reference category

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# CHAPTER 5: General Discussion

A literature review (Appendix G) and a scoping review (Lindeman et al., 2020) were undertaken prior to the design of the three studies. The reviews determined that little research has been conducted pertaining to the documentation of physical activity (PA) in family physician (FP) electronic medical records (EMR) and, at the time, there was no literature outlining if Canadian FPs learn how to document PA in their EMRs in their FM residency training. Thus, the purpose of these studies included a series of preliminary and explorative objectives to understand the role of FPs in documenting PA in EMRs, with a focus on the Canadian context. The objectives of the studies were to:

1. Analyze data from a sample of CPCSSN patients to understand what PA information was documented in EMRs;
2. Identify the PA status of patients according to guidelines;
3. Determine the proportion of Canadian FM residency programs that offer PA training;
4. Describe the characteristics of PA-related content in FM residency programs;
5. Determine the extent to which patient and FP characteristics predict EMR documentation; and
6. Describe the difference between patients with and without PA noted in EMRs.

## Overview of Findings

The studies offer unique insights into how FPs include PA within their practice and the degree to which FM residency training prepares them to document PA in EMRs. Studies 1 and 3 assessed the quality and existence of unedited text from their EMRs and Study 2 provided further in-depth feedback of FM curriculum experts than what was previously known (Thornton, Khan, Weiler, Mackie, & Petrella, 2021; Wattanapisit, Tuangratananon, & Thanamee, 2018). Analysis of the EMR PA input content (Study 1) revealed that what FPs document about PA is often indiscernible as it was largely unclear to the content analysis reviewers whether the notation pertained to PA level or PA prescription. It was especially difficult to categorize PA level corresponding to PA guidelines. The survey of FM curriculum experts (Study 2) provided key findings; most residents do not learn how to document PA in EMRs during residency, apart from one program that described documenting PA guidelines in EMRs. Training about PA appears to be generally taught but was also reported to be variable and based on the preceptor's habits and what they feel is important to impart to residents. This variability is often unchecked by many FM residency programs, as it was explained by some programs that they do not want to micro-manage preceptors by evaluating what they teach residents. The multilevel logistic models (Study 3) revealed that there is a stark difference between documentation of PA in community clinics compared to teaching sites where the adjusted odds of PA documentation in teaching sites was 44 times that of community clinics. Additionally, patient (older patients, fewer comorbidities) and provider (younger providers, in teaching sites, and some EMR systems) variables were significant predictors of PA EMR documentation across community and teaching clinic sites.

Overall, the findings reveal that FPs largely do not document PA in their EMRs and FM residency programs do not prioritize training in this area for their residents. It may be that FPs instead value the documentation of other aspects of care such as billing and general notes and/or their EMR system lacks the functionality to document PA in a format that is embedded in their current workflow. Most of the current literature of FPs and PA pertain to their role as PA advocates (Lobelo & de Quevedo, 2016) and includes recommendations that FPs should be encouraged to include PA as health promotion and disease prevention for their patients and for specific conditions (Aerts et al., 2021). This research presents evidence describing how PA is currently documented in EMRs and identifies that action is needed to support FPs to incorporate PA in the care they provide and the need for specific education about recording PA in EMRs in FM residency programs.

The Petrella et al. survey that found 85.2% of FPs self-reported that they asked patients about PA and 87.2% self-reported they counselled their patients about it (Petrella, Lattanzio, & Overend, 2007), which is much higher than the 1.9% found in Study 3 and the 9.6% found in Study 1. There are three potential explanations. It may be that FPs regularly discuss PA with their patients, but do not document that information in their EMRs. FPs do document the information, but it is not included in the information CPCSSN is able to extract. FPs may be overestimating how often they have conversations with patients about PA; they may have these discussions with some patients, but this is quite evidently not a clinical norm.

**Methodological Implications**

Study 1 developed an algorithm that identified where PA information is stored in CPCSSN data. This algorithm can serve as a resource for future studies to identify PA notations and compare documentation practices over time. For example, it could be used to track the PA documentation patterns of FPs and select FPs that do not document PA and invite them to participate in continuing education credits focused on EMR PA documentation practices. Another possibility is to use this algorithm to identify patients who had information documented of sedentary behaviour or no PA to encourage those patients to participate in studies aiming to increase PA levels in the general public and/or patients who have chronic diseases or specific attributes such as elevated BMI categories. The latter example should operate with the knowledge of the sparseness of PA inputs we found.

Study 3 found that patients in CPCSSN are clustered by their FP. Future studies that aim to analyze CPCSSN data should consider whether a multilevel model significantly accounts for the variability in the outcome variable under assessment. Additionally, consideration should be made in future studies as to whether to include both community clinics and teaching clinics or to restrict analysis by clinic type. Clinic type was found to be a strong predictor of PA documentation, but this may be due to differing priorities where teaching sites are focused on providing residents with learning opportunities whereas community clinics were likely fee-for-service and thus are not incentivized to document each encounter comprehensively.

**Implications for Existing Policy Calls to Action**

Many PA advocacy and healthcare organizations have highlighted the role of FPs to promote PA. The *Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada: Let's Get Moving* indicated that health care providers can emphasize PA as a mode of disease prevention through low-cost PA opportunities in their communities and can also work in collaboration with PA providers (e.g., kinesiologists, exercise physiologists) and municipalities to connect their clients to accessible, quality PA programming in their locales (Health Canada, 2018). The call to action from the *Common Vision* echoes that of the WHO's *Global Action Plan for Physical Activity 2018-2030* that primary health care providers can help individuals of all ages become more active and prevent noncommunicable diseases and also as a mode of rehabilitation and recovery (World Health Organization, 2018). In addition, the *ParticipACTION Report Card on Physical Activity for Adults* states that PA counseling should be considered by health-care providers as a good investment of time for their patients' health

(ParticipACTION, 2019). Together, these policy documents support the role of health care providers to promote PA to patients. Since Study 1 found that 9.8% of patients in the sample ever had PA in their EMR, Study 2 found that documenting PA is vaguely taught and documentation of PA in EMRs is rarely taught to FM residents, and Study 3 found that in a random visit sample of 769,185 patient visits less than two per cent (1.9%) have PA documented, the inaction of FPs to regularly incorporate PA into the care they provide Canadian adults is evident.

**Strengths**

A key strength of these studies was the large number of patients and FPs within the CPCSSN database as well as many EMR systems across several provinces. CPCSSN has been in operation since 2008 and includes regional nodes with dedicated staff (Canadian Primary Care Sentinel Surveillance Network, 2019) who regularly produce case definitions and work to improve data quality (Canadian Primary Care Sentinel Surveillance Network, 2020; Williamson et al., 2014). These case definitions are developed through manual CPCSSN chart review to determine case-ness as the gold standard for comparison to test against developed algorithms. Algorithms that demonstrate sufficient validity are used for epidemiological purposes, as was done in Study 3. A simple example of data cleaning includes patient height. CPCSSN receives patient height data as centimeters, inches, feet, and meters. Data managers clean data across EMR systems by computing all patient heights as centimeters to allow for easy comparison. Without the CPCSSN infrastructure Studies 1 and 3 would not have been possible. As a result, to the author's knowledge, Study 3 includes one of the largest samples to-date examining PA in Canadian primary care.

A strength of Study 2 was the response rate (82.3%), and the openness of curriculum experts to explain to what degree their training program includes PA information in their curriculum. During the videoconference meetings, it was often restated to the curriculum experts that their program, university, or any other identification information would not be released in any document or any forum. Specifically, at the beginning of meetings, it was indicated that the meetings were not video or audio recorded, instead notes would be taken of their responses to questions and the discussion overall. This provided an open environment for curriculum experts to share their opinions, especially when identifying barriers to incorporating PA in curriculum and to the extent they believed that FPs will be able to competently include PA in the care they provide patients. For example, the statement "we do not do a good job with preparing our residents to incorporate physical activity in the care they provide patients. I have no illusions that we do a good job in this" clearly identified that curriculum experts felt comfortable to acknowledge that there is scope for improvement.

**Limitations**

The EMR data CPCSSN extracts are secondary data as they are primarily documented to capture information about patient encounters and not for research or quality improvement initiatives. They include the records of information FPs choose to document and believe record and are relevant to capture for their practice. If future studies discover that FPs do regularly document PA in their EMRs, our findings indicate that CPCSSN was unable to extract it in its current format. Future studies using CPCSSN data should be conducted with the understanding of the PA data unavailability and the limitations our studies found. Furthermore, nationally CPCSSN does not extract SOAP notes which may be where FPs are documenting PA. Study 1 inputs were found to be entirely self-reported inputs either as open text (e.g., 90-120 mi [sic] running per week, used to be 150 min) or structured drop-down entries (e.g., Exercise ~150 min mod. aerobic /wk + 2x/wk muscle strengthening ex.). We found no indication that objective inputs from sources such as PA wearable technologies to document objective data such as step averages or minutes of moderate-to-vigorous PA per week. It is possible that objectively captured PA information may be more accurate data for the FP to consider, when determining the need and/or scope for PA prescription; however, there is a need to incorporate such EMR functionality in the future.

Study 2 was limited to information captured from responses to questions about PA in FM training programs that were either provided in writing or through interviews and from FM training program websites. This study did not conduct a complete audit of all lectures and materials provided to residents; it was, in most instances information from a single 45 to 60-minute videoconference call with a curriculum expert discussing PA-related information supplemented with what programs post on their website. Therefore, it is possible that the respondents could not recall all related details about their programs and Study 2 findings should be considered preliminary/exploratory and as an indication of feedback received from FM program websites and the curriculum expert meetings.

**Challenges Experienced**

The data cut request from CPCSSN resulted in an eight-month delay between the submission of data application forms to the receipt of the data. This delay was in part because the request included many data fields that are infrequently released for research. The issue was that we requested original text fields from the risk factor table that did not undergo usual processing; we required risk factor data verbatim. If we did not receive these original fields, Study 1 would not have been able to move forward because instead of details of the inputs, a generic label of 'exercise' would have replaced the original text. CPCSSN has not yet developed, computed, or standardized processing to list patients categorically as physically active or inactive and therefore would have labelled any PA information as a default input. Study 1 found that 87.7% of PA inputs were correctly labeled as 'exercise' but there were other PA mentions in CPCSSN labeled as smoking in the risk factor table and in the health condition table. This information has been shared with CPCSSN data managers so that they can work to improve PA data quality.

Another challenge was a change in scope for the curriculum study. The initial plan was to survey all medical schools and FM curriculum programs in Canada (n = 34). Although an invitation to participate was sent to all 17 medical programs, only one responded to our request. The other 16 schools indicated that they would not participate in this study or ignored our requests. A supplementary request was sent to the Association of the Faculties of Medicine of Medicine of Canada chair, but this was also ignored. Because the study team was satisfied with the response rate from FM programs (82.3%), the study focused solely on these programs.

Last, it was brought to our attention when the datacut was provided by CPCSSN that it is somewhat tenuous to consider separate visit dates as unique visits. Currently, there is no sufficient and reliable function to compute visit date, meaning we could not proceed with the initial strategy of analyzing PA inputs over time as we would have required an indication of visit date frequency to be used as denominators. If this was possible, Study 3 would have determined if the number of PA inputs increased over time and produced an estimate of PA documentation over 10 years for patients aged 18-64.9 in our sample, which would have included ~400,000 patients and would have been one of the largest longitudinal studies of PA data in Canada to date. Because of this limitation, we made the decision to select a date at random to determine PA and its association with patient and provider variables as a cross sectional design.

**Future Research**

The studies in this dissertation have revealed several topics that require further research. We found that PA is infrequently inputted in EMRs, thus the next step is to survey or interview FPs to understand whether the EMR systems they use satisfy their PA documentation needs or whether they prefer a different imputation format to improve their PA-related EMR documentation processes. It may be that FPs feel that they already adequately document the PA information in their current system even if they document PA in SOAP notes, which is often a single text field similar to Microsoft Notepad. However, if it is learned that FPs are frustrated with their EMR system as it relates to documenting information such as PA, understanding what the ideal format would consist of and what information those fields capture (e.g., assessment, prescription, contraindications) needs to be determined.

Much as Clarke et al. (2021) recommended, EMR tools and functionalities need to be co-designed with the users of these systems (e.g., FPs) to ensure it supports existing clinical workflow. As Study 3 found that PA is not often documented in community clinics, future PA tools should be designed with FPs from both teaching sites and community clinic sites. Different tool options may need to be developed and then compared as a trial to determine the format that increases documentation frequency and quality, as well as reduces FP documentation time and improves satisfaction with their EMR system. There is evidence that a co-developed approach to creating the EMR interface and to trainer users of these products is insufficient (Greiver, 2015; Greiver, Barnsley, Glazier, Moineddin, & Harvey, 2011) and many physicians report to be unhappy with their EMRs (Overhage & McCallie, 2020; Robertson, Robinson, & Reid, 2017; Tajirian et al., 2020).

Study 2 identified that the PA-related education FM residents receive depend on their preceptor, and comprehensive evaluations of the content preceptors teach residents does not appear to be regularly conducted by FM program curriculum committees. In exploring the related literature, we found no study that surveyed or interviewed FM preceptor's opinions about the role of FPs as PA-advocates, specifically whether they feel that residents should ask, discuss, or advise PA for their patients. Therefore, we recommend surveying or interviewing FM program preceptors to learn more about their PA-related instruction they provide to residents.

One solution to assist FPs to document PA in EMRs is to include input features that capture the lifestyle information that FPs are inputting. Study 1 found a range of documentation purposes including capturing patients' work-related PA, description/leisure PA, referral to community resource, recording behaviour (current, past, and future), PA contraindications, and PA guidelines. The study found that inputs were distinct and often did not capture multiple purposes. Therefore, an electronic form/template in the EMR should be embedded to capture this information. There are existing questionnaires that capture PA level such as the exercise as a vital sign (EVS), but it asks about minutes engaged in recent exercise. If it was included in EMRs alone it would not capture PA referral to community resources, work-related PA, PA contraindications. Another commonly used questionnaire is the general practice physical activity questionnaire (GPPAQ), which captures information about work-related PA, discretionary PA, active transportation, activities of daily living but does not include PA referral, work-related PA, or PA contraindications. Although there are many existing PA questionnaires, none are comprehensive enough to capture all the PA documentation purposes found in the content analysis. Research is needed to develop such a form that achieves sufficient validity and reliability metrics before piloting in EMRs.

The purpose of the EMR is to document and consolidate a patient's medical chart into a single digital system to access and input health information for easy access and record keeping. In a study using CPCSSN data to rank association in common primary care screens in 92,140 patients in or around Toronto, Canada (Kalia, et al., 2017), the study team used the presence of lifestyle, vitals, and laboratory data in the previous two years. Some (15%) of patients had exercise information in the summary profile. This was among the lowest of the nine screens apart from waist circumference (12%) and diet information (4%). Most patients had blood pressure measured (82%), or smoking status listed (80%) (Kalia, et al., 2017). This variation is likely because PA screening in primary care is unstandardized (Clark et al., 2021), especially in EMRs (Lindeman et al., 2020). This adds to the evidence that a standard, comprehensive template embedded in the EMR to capture the PA information that FPs feel is relevant is needed.

Finally, the Canadian Institute for Health Information (CIHI) publishes a list of data elements that primary health care EMRs should include. As of 2022, there have been four iterations of the list with the most recent including 45 core elements (e.g., lab test result unit of measure, diagnostic test ordered date) and 61 supplementary elements (e.g., highest level of patient education, patient housing status). The most recent version does not include PA or exercise; however, the EMR-related indications in v1, published in 2006, lists physical inactivity under health risk screening category. Thus, the only PA-related a data element was removed as a CIHI EMR minimum data element. Of note, these data elements are recommendations, not requirements, and stakeholders (e.g., EMR vendors) are "encouraged to adopt the minimum set of data elements in their EMR system requirements to enable the collection of comparable data for point-of-care dashboards within EMR systems" (Canadian Institute for Health Information, 2020). In fact, to our knowledge there is no requirement for EMR developers and vendors to include any of the CIHI data elements apart from privacy considerations. This is a missed opportunity to encourage primary care providers to document the PA information of their patients and as a resource to inform national PA initiatives. Therefore, we recommend that PA be included within CIHI's EMR minimum dataset moving forward. As well, there needs to be a governing body of health care providers, vendors, patients, health care regulators, and governments that set minimum standards that EMR vendors must adhere to instead of the loose CIHI recommendations.

**Conclusion**

Few mentions of PA are found in CPCSSN extracted EMRs, and most FM residents do not learn how to document PA in EMRs. These facts should be used as basis for action to further examine if FM residency programs are adequately preparing residents to interact with virtual care technologies such as EMRs overall and whether EMR systems should have basic PA input requirement standards.

The findings from this dissertation should serve as a strong call to action with clearly required next steps. First, PA assessment and prescription experts in Canadian Faculties of Kinesiology must work with departments of family medicine curriculum committees to ensure that family medicine residents are meeting the CFPC priority topic objectives. Second, the CIHI must include PA assessment, prescription, and referral within CIHI's EMR minimum dataset moving forward as data (at least supplementary) elements for EMRs. Lastly, FPs must learn about of the range of PA resources that are available in the communities in which they practise including low-cost/no cost allied health care providers for PA-related counseling.

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# Appendix A: Data Extraction Codebook

## Characteristics of the EMR input

1. PatientID
2. CPCSSN table
3. CPCSSN field
4. EMR
5. Date of entry
6. Input text

## Characteristics of physical activity documentation

7. Activity level
   - 7.1. Inactive
   - 7.2. Insufficiently active
   - 7.3. Sufficiently meets minimum duration
   - 7.4. Insufficient detail

8. Domain
   - 8.1. Work
   - 8.2. Transportation
   - 8.3. Domestic
   - 8.4. Discretionary (leisure)
   - 8.5. Insufficient detail

9. Purpose of input
   - 9.1. Referral - health care provider
   - 9.2. Referral – facility
   - 9.3. Education/ Counselling
   - 9.4. Recording behaviour
     - 9.4.1. Current behaviour
     - 9.4.2. Past behaviour
     - 9.4.3. Recording behaviour; however, there is insufficient detail to denote as past or current
   - 9.5. Recording contraindication

9.6. Insufficient detail

10. Activity type
    - 10.1. Exercise documented
    - 10.2. Physical activity documented
    - 10.3. Insufficient detail

11. Aerobic physical activity guideline
    - 11.1. Meets aerobic physical activity guideline
    - 11.2. Does not meet aerobic physical activity guideline
    - 11.3. Insufficient detail

12. Strength physical activity guideline
    - 12.1. Meets strength physical activity guideline
    - 12.2. Does not meet strength physical activity guideline
    - 12.3. Insufficient detail

13. Reference to physical activity guidelines
    - 13.1. Yes
    - 13.2. No

14. Meeting Canadian physical activity guidelines
    - 14.1. Meets all components of the Canadian physical activity guidelines
    - 14.2. Meets aerobic criteria but not strength component
    - 14.3. Meeting strength component but not aerobic criteria
    - 14.4. Does not meeting aerobic nor strength criteria
    - 14.5. Insufficient detail

*Below are operational definitions for the inputs 7-14:*

| **7. Activity Level** | **Definition** |
|---|---|
| 7.1 Inactive | No or very limited physical activity at work, at home, for transport, and/or in discretionary time. |
| 7.2 Insufficiently active | Doing some activity but for less than 150 minutes of moderate-intensity* or 60 minutes of vigorous-intensity* physical activity a week |

| | |
|---|---|
| | accumulated across work, home, transport, or discretionary domains. |
| 7.3 Sufficiently meets minimum duration | At least 150 minutes of moderate-intensity* physical activity or 60 minutes of vigorous-intensity* physical activity a week accumulated across work, home, transport, or discretionary domains, which approximately corresponds to current recommendations in many countries. |
| 7.4 Insufficient detail | Insufficient information to list one of the above activity levels. |

*For reference, examples of moderate and vigorous intensity are provided here: https://www.hsph.harvard.edu/obesity-prevention-source/moderate-and-vigorous-physical-activity/

| **8. Domain** | **Definition** |
|---|---|
| 8.1 Work | On the job or work-related physical activity (e.g., walking required in retail employment). |
| 8.2 Transportation | Physical activity as a mode of transportation from two points (e.g., riding a bike to work). |
| 8.3 Domestic | Physical activity in including activities of daily living (e.g., cleaning the house). |
| 8.4 Discretionary (leisure) | Physical activity undertaken in one's free time such as sport or exercise (e.g., walking the dog). |
| 8.5 Insufficient detail | Insufficient information to list one of the above domains. |

| 9. Purpose of Input | Definition |
| --- | --- |
| 9.1 Referral - health care provider | Referral to an allied health care provider (e.g., exercise professional). |
| 9.2 Referral - facility | Referral to an exercise or recreation facility or program. |
| 9.3 Education/ Counselling | Advice offered to the patient including exercise prescription. |
| 9.4.1 Recording current behaviour | Recording current behaviour. |
| 9.4.2 Recording past behaviour | Recording past behaviour. |
| 9.4.3 Recording future behaviour | Recording future behaviour. |
| 9.4.3 Recording behaviour; insufficient detail | Behaviour is recorded; however, there is insufficient information as to denote as past or current. |
| 9.5 Recording contraindication | Recording contraindication(s) for exercise or physical activity. |
| 9.6 Insufficient detail | Insufficient information to list one of the above input types. |

| 10. Activity type | Definition |
| --- | --- |
| 10.1 Exercise documented | Form of leisure-time physical activity that is planned, structured, and repetitive to improve or maintain physical fitness. Inputs under an EMR umbrella category of 'exercise' are denoted as 'exercise documented'. |
| 10.2 PA documented | All leisure and non-leisure body movement produced by the skeletal muscles which result in a substantial increase in resting energy expenditure. Inputs not clearly stated as exercise, nor as physical activity that is planned, structured, and involving repetitive bodily |

| | |
|---|---|
| | movements; undertaken to improve or maintain physical fitness are considered to be 'PA documented'. Sport is an example of PA unless stated as undertaken to improve or maintain physical fitness. |
| 10.3 Insufficient detail | Insufficient detail to delineate as physical activity or Exercise. |

| **11. Aerobic guideline** | **Definition** |
|---|---|
| 11.1 Meeting aerobic PA guideline | ≥ 150 min of moderate* to vigorous intensity* aerobic physical activity per week. |
| 11.2 Does not meet aerobic PA guideline | < 150 min of moderate* to vigorous intensity* aerobic physical activity per week. |
| 11.3 Insufficient detail | Insufficient detail to determine meeting aerobic guideline. |

*For reference, examples of moderate and vigorous intensity are provided here: https://www.hsph.harvard.edu/obesity-prevention-source/moderate-and-vigorous-physical-activity/

| **12. Strength guideline** | **Definition** |
|---|---|
| 12.1 Meets strength guideline | Muscle- and bone-strengthening activities that use major muscle groups, ≥ 2 days per week. |
| 12.2 Does not meet strength guideline | Muscle- and bone-strengthening activities that use major muscle groups, < 2 days per week. |
| 12.3 Insufficient detail | Insufficient detail to determine meeting strength guideline. |

| 13. Reference to guideline | Definition |
|---|---|
| 13.1 Yes | Input describes or makes direct reference to Canada's physical activity guideline for adults. |
| 13.2 No | Input does not describe nor makes direct reference to Canada's physical activity guideline for adults. |

| 14. Meeting guideline | Definition |
|---|---|
| 14.1 Meets guideline | Meets all components of the Canadian physical activity guidelines for adults. |
| 14.2 Meets aerobic but not strength | Meets aerobic criteria but not strength component. |
| 14.3 Meets strength but not aerobic | Meeting strength component but not aerobic criteria. |
| 14.4 Does not meet strength nor aerobic guideline | Does not meet aerobic nor strength criteria. |
| 14.5 Insufficient detail | Insufficient detail to determine if a patient meets the Canadian physical activity guidelines. |

## Appendix B: Exercise and Physical Activity Across the 105 College of Family Physicians of Canada Priority Topics Objectives

| **Priority Topic Area** | **Key Feature** | **Skill** | **Phase** |
|---|---|---|---|
| Osteoporosis | Counsel all patients about primary prevention of osteoporosis (i.e., dietary calcium, **physical activity**, smoking cessation), especially those at higher risk (e.g., young female athletes, patients with eating disorders). | Clinical Reasoning Communication | Treatment |
| Chronic Obstructive Pulmonary Disease | In all patients presenting with symptoms of prolonged or recurrent cough, dyspnea, or **decreased exercise tolerance**, especially those who also have a significant smoking history, suspect the diagnosis of chronic obstructive pulmonary disease (COPD). | Clinical Reasoning | Hypothesis generation Diagnosis |
| Disability | In patients at risk for disability (e.g., those who do manual labour, the elderly, those with mental illness), recommend primary prevention strategies (e.g., **exercises**, braces, counselling, work modification). | Clinical Reasoning<br>Patient-centred Approach | Treatment |
| Heart Failure | For patients with heart failure ensure you offer patient education and self-monitoring, such as routine self-weighing, healthy diet, medication adherence, smoking cessation, and **exercise**, to minimize exacerbations. | Clinical reasoning<br>Patient-centred Approach | Treatment<br>Follow-up |
| Hypertension | Suggest individualized lifestyle modifications to patients with hypertension. (e.g., weight loss, **exercise**, limit alcohol consumption, dietary changes). | Clinical Reasoning<br>Patient-centred Approach | Treatment |
| In Children | As children, especially adolescents, generally present infrequently for medical care, take advantage of visits to ask about:<br>• unverbalized problems (e.g., school performance) | Clinical Reasoning<br>Patient-centred Approach | History<br>Treatment |

| | | | |
|---|---|---|---|
| | • social well-being (e.g., relationships, home, friends)<br>• modifiable risk factors (e.g., **exercise**, diet)<br>• risk behaviours (e.g., use of bike helmets and seatbelts). | | |
| Ischemic Heart Disease | In a patient presenting with symptoms suggestive of ischemic heart disease but in whom the diagnosis may not be obvious, do not eliminate the diagnosis solely because of tests with limited specificity and sensitivity (e.g., electrocardiography, **exercise stress testing**, normal enzyme results). | Selectivity<br>Clinical Reasoning | Diagnosis<br>Investigation |
| Lifestyle | In the ongoing care of patients, ask about behaviours that, if changed, can improve health (e.g., diet, **exercise**, alcohol use, substance use, safer sex, injury prevention (e.g., seatbelts and helmets). | Patient-centred Approach Communication | History |
| Lifestyle | Explore a person's context (e.g., poverty) before making recommendations about lifestyle modification (e.g., healthy eating choices, **exercise suggestions**) so as to avoid making recommendations incompatible with the patient's context. | Patient-centred Approach | Treatment<br>History |
| Low-back pain | In all patients with mechanical low back pain, discuss **exercises** and posture strategies to prevent recurrences. | Clinical reasoning<br>Patient-centred Approach | Treatment |
| Obesity | Advise the obese patient seeking treatment that effective management will require appropriate diet, **adequate exercise**, and support (independent of any medical or surgical treatment) and facilitate the patient's access to these as needed and as possible. | Clinical Reasoning | Treatment |
| Obesity | In managing childhood obesity, challenge parents to make appropriate family-wide changes in diet and **exercise**, and to avoid | Clinical Reasoning Communication | Treatment |

| | | | |
|---|---|---|---|
| | counterproductive interventions (e.g., berating or singling out the obese child). | | |

https://www.cfpc.ca/CFPC/media/Resources/Examinations/Assessment-Objectives-for-Certification-in-FM-full-document.pdf

## Appendix C: Website Extraction Template

1. University:
2. Program:
3. URL:
4. Date website accessed:
5. Program curriculum specialist(s):

**Summary of the course(s):**

6. Course description
7. Number of course hours
8. Instructional approach (clinical, lecture, or modular)
9. Required or elective course
10. PA guidelines are taught (yes/no)
11. Does the course teach PA as treatment for an existing chronic condition (yes/no)
12. Does the course teach PA as a preventative treatment (yes/no)
13. Are counseling skills taught (documentation, assessment, prescription, or referral)

## Appendix D: Medical Program & Family Medicine Residency Curriculum Survey

Name:
Position:
University:
Program:
Date:

Corrections from the website extraction:

Notes:

1. *Describe how the (institution) teaches (program) residents the benefits of physical activity.*

Notes:

2. *Describe how the (institution) teaches (program) residents about physical activity assessment.*

Notes:

3. *Describe how the (institution) teaches (program) residents about physical activity prescription.*

Notes:

4. *Describe how the (institution) teaches (program) residents about physical activity referral.*

Notes:

5. *Describe how the (institution) teaches (program) residents to document physical activity (e.g., in electronic medical record systems).*

Notes:

6. *Do residents at your medical program request training in physical activity-related topics?*

Notes:

7. *Are Canadian physical activity guidelines included in your curriculum? If not, explain why.*

Notes:

8. *Are strength training physical activity guidelines included in your curriculum? If not, explain why.*

Notes:

9. *Are residents taught that physical inactivity is risk factor for chronic conditions? If not, explain why.*

Notes:

10. *Are residents taught to incorporate physical activity into care plans for patients with noncommunicable chronic conditions? If not, explain why.*

Notes:

11. *Are residents taught to incorporate physical activity into care plans as prevention for noncommunicable chronic conditions? If not, explain why.*

Notes:

*12. Are residents taught about the importance of physical activity? If not, explain why.*

Notes:

*13. How many hours are dedicated to training about physical activity during each year of (program)?*

Year 1:
Year 2:
Year 3:
Year 4:

Notes:

*14. Are these identified courses required, parallel, or elective?*

Year 1:
Year 2:
Year 3:
Year 4:

Notes:

*15. In which modules, classes, or sessions does this teaching occur:*

Notes:

*16. What are the barriers to incorporating physical activity into programs?*

Notes:

17. *Does (institution) plan to increase, decrease, or maintain the level of physical activity training offered?*

Notes:

18. *When residents complete their program, do you think they are sufficiently prepared to incorporate physical activity into the care they provide patients?*

Notes:

19. *Is there anything more you would like to disclose about the physical activity curriculum in your institution?*

Notes:

20. *Is there another person in your institution who should also complete this survey?*

Notes:

# Appendix E: Physical Activity Data Extraction

## Risk factor table

The data cut for studies 1 and 3 included original (orig) and calculated (calc) fields for the categories: 'exercise' 'smoking' 'alcohol use' 'diet' and 'psychological stress'. As study 1 found that physical activity existed in categories that were not 'exercise', the entire risk factor table name_orig and value_orig were searched for the following key words with the STATA strpos command, which selected all instances of the terms anywhere in the name_orig and value_orig string fields. All entries in the exercise category were thought to pertain some physical activity information. The following terms were informed by study 1 as key words that indicated physical activity. Note that each term was tested for upper- and lower-case lettering as strpos is case sensitive: exercise, physical activity, walk, physically active, gym, jogging, treadmill, yoga, minutes, hockey, and sport. As example:

*gen PA =1 if name_calc == "Exercise"*

*replace PA = 1 if strpos (name_orig, "Exercise")*

*replace PA = 1 if strpos (value_orig, "Exercise")*

*replace PA = 1 if strpos (name_orig, "exercise")*

*replace PA = 1 if strpos (value_orig, "exercise")*

## Health condition table

Study 1 found instances of 'exercise counselling' in the diagnosistext_calc field. All instances of 'exercise counselling' notations were extracted.

## Encounter diagnosis table

Study 1 found instances of "V65.41" which is 'exercise counselling' in ICD-9. All instances of 'exercise counselling' notations were extracted.

**Notes**

- In study 3, the outcome of physical activity was determined by summing physical activity inputs across the risk factor, health condition, and encounter diagnosis table.
- Instances where physical activity in risk factor table were on the same date as health condition or encounter diagnosis were considered the same visit and were not double counted.

**Appendix F: Model Coefficients**

| | Main effects model | | | Community clinic model | | | Academic clinic model | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient (95% CI) | Std Err. | p-value | Coefficient (95% CI) | Std Err. | p-value | Coefficient (95% CI) | Std Err. | p-value |
| *Fixed Effects* | | | | | | | | | |
| Constant | -5.888 | 0.371 | <0.001 | -7.372 | 0.948 | <0.001 | -2.005 | 0.196 | <0.001 |
| Patient level predictors | | | | | | | | | |
| Female | -0.170 (-0.353-0.013) | 0.093 | 0.069 | NA | NA | NA | -0.184 (-0.376-0.007) | 0.098 | 0.059 |
| Patient age[1] | 0.020 (0.012-0.027) | 0.004 | <0.001 | -0.008 (-0.032-0.015) | 0.012 | 0.497 | 0.023 (0.015-0.031) | 0.004 | <0.001 |
| Chronic condition count | -0.419 (-0.574--0.264) | 0.079 | <0.001 | -0.234 (-0.836-0.368) | 0.307 | 0.446 | -0.442 (-0.602--0.282) | 0.082 | <0.001 |
| Body mass index[1] | -0.004 (-0.016-0.008) | 0.006 | 0.494 | -0.057 (-0.110--0.005) | 0.027 | 0.033 | -0.0004 (-0.013-0.012) | 0.006 | 0.939 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Material deprivation quintiles | | | | | | | | | |
| Material deprivation Q1[2] | -0.218 (-0.491-0.054) | 0.139 | 0.116 | 0.642 (-0.235-1.518) | 0.447 | 0.152 | -0.338 (-0.624--0.051) | 0.146 | 0.021 |
| Material deprivation Q2[2] | -0.098 (-0.367-0.170) | 0.137 | 0.471 | 0.380 (-0.505-1.265) | 0.451 | 0.400 | -0.155 (-0.436-0.127) | 0.144 | 0.282 |
| Material deprivation Q3[2] | -0.187 (-0.465-0.092) | 0.142 | 0.189 | -0.687 (-1.831-0.457) | 0.584 | 0.239 | -0.134 (-0.421-0.153) | 0.147 | 0.361 |
| Material deprivation Q4[2] | -0.102 (-0.362-0.159) | 0.133 | 0.445 | -1.009 (-2.230-0.212) | 0.623 | 0.105 | -0.042 (-0.310-0.225) | 0.137 | 0.755 |
| Blood pressure categories | | | | | | | | | |
| Moderate risk blood pressure[3] | 0.093 (-0.114-0.300) | 0.106 | 0.379 | 0.139 (-0.537-0.815) | 0.345 | 0.687 | 0.096 (-0.121-0.312) | 0.111 | 0.387 |
| Elevated risk blood pressure[3] | 0.119 (-0.176-0.413) | 0.150 | 0.430 | 0.541 (-0.405-1.487) | 0.483 | 0.262 | 0.102 (-0.206-0.411) | 0.157 | 0.515 |
| Provider level predictors | | | | | | | | | |
| Provider sex | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Provider age[1] | -0.042 (-0.066--0.019) | 0.012 | <0.001 | 0.020 (-0.051-0.090) | 0.036 | 0.585 | -0.025 (-0.048--0.002) | 0.012 | 0.033 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Academic clinic[4] | 3.784 (3.093-4.475) | 0.353 | <0.001 | NA | NA | NA | NA | NA | NA |
| Electronic medical record system | | | | | | | | | |
| Accuro[5] | 4.463 (1.644-7.282) | 1.438 | 0.002 | 4.712 (0.595-8.830) | 2.101 | 0.025 | NA | NA | NA |
| Oscar[5] | -0.027 (-0.637-0.583) | 0.311 | 0.930 | -1.188 (-3.755-1.380) | 1.310 | 0.365 | 0.158 (-0.283-0.598) | 0.225 | 0.483 |
| Practice Solutions[5] | -0.259 (-1.057-0.540) | 0.407 | 0.525 | 0.047 (-1.440-1.534) | 0.759 | 0.950 | NA | NA | NA |
| *Random effects* | | | | | | | | | |
| Provider | 1.150 (0.638-2.071) | 0.345 | NA | 4.359 (1.860-10.218) | 1.895 | NA | 0.387 | 0.157 | NA |

1. Grand centre mean

2. Q5, the most materially deprived quintile, is the refence category

3. Low risk blood pressure is the reference category

4. Community clinic is the reference category

5. Med Access is the reference category

# Appendix G: Literature Review

Review of related literature as of December 22, 2020.

This literature review focuses on research about the content, frequency, predictors, and training related to physical activity (PA) documentation in family physician (FP) electronic medical records (EMR) and identifies gaps in clinical practice to better inform research and policy initiatives. It begins with an examination of the relationship between PA and health benefits and the determinates and correlates of PA. Then it discusses studies related to the role of health care providers, the PA-curriculum used in medical programs and family medicine residency programs, and how PA is measured in health care settings. This is followed by literature related to the perspectives of FPs as health care providers tasked to deliver PA-related advice and the effectiveness of that advice. Then the review examines studies concerning the use of EMRs in Canada including the transition from paper records to electronic systems, and the scope of CPCSSN, Canada's first interprovincial primary care EMR database. Finally, literature pertaining to PA documentation in FP EMRs including the proportions and the characteristics of patients who receive PA-related documentation is reviewed.

## Health Benefits of Physical Activity

**Relationships between physical activity and fitness.** All forms of PA provide health benefits if undertaken regularly (World Health Organization, 2018). The extent of the benefit derived from engaging in PA can be significant, since those who achieve the MVPA component of the 24-hour movement guideline's (Ross et al., 2020) recommendations have been shown to reduce all-cause mortality by 31% (Moore et al., 2012). This approaches a PA-related risk reduction (39%) observed when engaging in three times the standards set in the PA guideline

(Moore et al., 2012). While there is no evidence of increased mortality attributable to high levels of PA in generally healthy individuals (Thornton et al., 2016), PA energy expenditure that exceeds 3,000 kcal per week provides less of a risk reduction for cardiac events such as stroke, when compared to less than 3,000 kcal per week; which suggests a U-shaped curve of PA-related benefits (Lee & Paffenbarger, 1998). The PA dose-response relationship illustrates that the largest health benefit occurs when moving from an inactive state to a more active state (Warburton & Bredin, 2018) is associated with reduced morbidity and mortality independent of demographic characteristics (Physical Activity Guidelines Advisory Committee, 2018; Ross et al., 2020).

**Physical activity and chronic disease.** Meeting PA guidelines is associated with substantial reductions in the risk of chronic disease incidence (Warburton & Bredin, 2016). The available data indicate a dose-response relationship between PA and health with 20 to 30% risk reductions for premature mortality and chronic disease in those who meet or exceeded PA guide recommendations and was a well-established primary and secondary preventative strategy against at least 25 chronic medical conditions (Moore et al., 2012; Warburton & Bredin, 2016, 2017). It is estimated that each additional 15 minutes of daily PA (up to a maximum of 100 minutes a day) provides an additional risk reduction of 4% for all-cause and 1% for all-cancer mortality (Warburton & Bredin, 2016), while longer durations of regular PA resulted in increased cardiorespiratory fitness, increased muscular strength, decreased depressive symptoms, and sustained reduction in blood pressure, accrued over months or years of PA (Piercy et al., 2018).

There are notable positive outcomes derived from PA below guideline levels. Compared to less than one hour of leisure time PA per week, engaging in no leisure time PA had a 17%

increased all-cause mortality risk (HR 1.17, 95% CI 1.10–1.24) and an 11% increased cancer mortality risk (HR 1.11, 95% CI 1.01–1.22) (Wen et al., 2011). Likewise, 75 minutes of brisk walking per week results in 1.8 years of life gained while greater durations lead to greater benefits; brisk walking at least 450 minutes per week led to a 4.5-year life expectancy gain (Moore et al., 2012). Even people who engaged in some PA, below the minimum recommended amount, had significantly lower levels of coronary heart disease (Sattelmair et al., 2011). Due to the potential benefits of sub-guideline levels of PA, some dispute exists about the PA guideline thresholds in the context of specific medical conditions. As a result, some authors advocated caution related to the arbitrary application of generic PA recommendations in clinical practice (Warburton & Bredin, 2016; Wen et al., 2011) and recommended PA levels according to the evidence related by disease or condition (Centre for Active Living, 2020).

The effectiveness of PA interventions rivals the efficacy of pharmaceutical interventions for patients with chronic conditions. Patients with coronary heart disease had a reduced mortality ratio when treated with statins (OR = 0.82, 95% CI [.75, .90], β blockers (OR = 0.85, 95% CI [.78, .92], angiotensin converting enzyme inhibitors (OR = 0.83, 95% CI [.72, .96], and antiplatelets (OR = 0.83, 95% CI [.74, .93] had comparable effect reduction with exercise interventions (OR = 0.89, 95% CI [.76, 1.04] (Naci & Ioannidis, 2013). Researchers found no statistical difference between exercise and drug interventions on mortality (Naci & Ioannidis, 2013) suggesting that exercise and some drug interventions were often potentially similar in terms of their mortality benefits. Exercise interventions may be considered a viable alternative to, or used alongside, drug therapy. More research in this area is needed.

There are PA-derived benefits for patients with existing chronic diseases. An observational study of 18,028 adults with type 1 diabetes who self-reported engaging in PA at least once or twice per week had better glycemic control, related comorbidities, and cardiovascular risk factors without an increase in adverse events compared to those who did not (Bohn et al., 2015). Because of this benefit, medical organizations recognized the effectiveness and importance of PA promotion as a primary prevention and secondary treatment for various diseases appearing in 39 British guidelines (Weiler, Feldschreiber, & Stamatakis, 2012). The favorable effect of regular PA on cardiovascular risk factors explained a significant portion of its impact including increasing high-density lipoprotein cholesterol, reducing BMI, improving insulin sensitivity, and reducing blood pressure, thus significantly reducing risk at the population level (Lobelo, Stoutenberg, & Hutber, 2014). Although the exact mechanisms behind PA as an independent modifiable risk factor remained incompletely interpreted, strong evidence suggested that regular PA slows and may reverse adverse vascular remodeling associated with aging, a central factor in cardiovascular disease (Lobelo et al., 2014).

**Benefits by demographic characteristic.** Regular PA results in health benefits regardless of demographic characteristics including sex, race, age, ethnicity, or body size (Piercy et al., 2018; Wen et al., 2011). The benefits are realized by children as it leads to healthy growth and social development, and adults enjoy reduced risk of chronic disease and improved their mental health (ParticipACTION Advisory Groups, 2012). Enhanced musculoskeletal fitness attained through PA was positively associated with functional status, glucose homeostasis, bone health, mobility, psychological well-being, and overall quality of life, and negatively associated with fall risk, morbidity, and premature mortality (Warburton, Glendhill, & Quinney, 2001a, 2001b). This finding was important for older adults as it demonstrated improved mobility, independence, and cognitive wellness because PA improved balance, core strength, and stability which in turn prevented falls (ParticipACTION, 2019). However, the potential benefits derived from PA are uneven across socioecological levels (e.g., individual, social, environmental). Participation in PA is disproportionately lower among rural compared to urban residents, females compared to males, older people, and racial and ethnic minorities compared to non-Hispanic whites (AuYoung et al., 2016). Thus, initiatives are needed to support these demographics to access PA-attributable benefits.

**Financial and health impacts of physical inactivity.** The Canadian economic costs attributable to physical inactivity are substantial. Janssen et al. conducted an economic analysis of seven physical inactivity-related diseases and found the direct ($2.4 billion), indirect ($4.3 billion), and total costs ($6.8 billion) represented 3.6% to 3.8% of the overall annual health care costs in 2009 (Janssen, 2012). As demonstrated by the scientific evidence supporting PA, being physically active was one of the best investments individuals and communities could make in health and welfare (Piercy et al., 2018). Yet, 18% of Canadians 18 to 79 years completed less than 5,000 steps per day, thereby falling within the ‘sedentary lifestyle’ category (ParticipACTION, 2019). Evidence suggested that sedentary behaviour (e.g., sitting or laying down when awake), as distinct from a lack of MVPA, had independent effects on human metabolism, physical function, and health outcomes and thus should be treated as a separate and unique construct (Tremblay, Colley, Saunders, Healy, & Owen, 2010). Since those who had high levels of sedentary behaviour were at the highest risk for chronic diseases, researchers called for the avoidance of sitting for prolonged periods of time and emphasized the need to engage in routine PA (Warburton & Bredin, 2016). In Canada, physical inactivity was more prevalent than other risk factors for heart disease (Warburton & Bredin, 2018). It is estimated that 19% of the coronary artery disease cases in Canadian men was attributable to physical inactivity (Katzmarzyk and Janssen 2004).

**Correlates and determinants of physical activity**

The benefits of engaging in PA extend to healthy consequences within populations across all socioeconomic classes, ethnicities, and phenotypes (Weiler et al., 2012). One key influence for PA levels is cultural values. In some countries, girls, women, older adults, underprivileged groups, and people with disabilities and chronic diseases had fewer opportunities to access safe, affordable, and appropriate programs and places in which to be physically active (Tremblay et al., 2010; World Health Organization, 2018). There is a need to better understand the physical inactivity impacts experienced by these groups and to identify potential solutions.

Barriers to PA were exacerbated by environmental factors. Microenvironmental factors (e.g., homes, programs, workplaces), more often than broader macroenvironmental influences (e.g., public, private sectors), affected PA attainment (Spence & Lee, 2003). At the micro-environment level, participants often described the physical environment as shaping their ability to be physically active (Nieuwendyk et al., 2016). Different aspects of surroundings related to health conditions, such as obesity, were proximal determinants in residential contexts: cities with high residential density, street connectivity, and walkability were associated with decreased population obesity and neighbourhoods with fewer recreation opportunities were associated with higher BMI among adults (Raine, Muhajarine, Spence, Neary, & Nykiforuk, 2012). Assessing the influence of multiple levels had beneficial research implications when contextual factors were considered in the design of research studies. Heath et al (2012) examined systematic reviews of evidence-based PA interventions and found that more effective interventions addressed multiple levels of change: the individual, social, and environmental (Heath et al., 2012). Examinations of PA at the micro-environment level were needed in order to better understand the disparities attributable to one's environment.

In summary, the health benefits of regular PA were determined to be substantial and conclusive including decreased the risk of mortality and chronic diseases while improving quality of life. Guideline concordant levels of PA were favourable for producing health benefits, while PA below guidelines contributed to considerable benefit compared to no PA. Financial costs of inactivity represented a substantial proportion of Canada's health spending. While PA benefitted adults regardless of demographic characteristic, PA attainment differed across demographic categories and environments. Because of the described benefits from PA, Canada committed to the WHO Global Action Plan for Physical Activity (2018-2030), namely, a 15% relative reduction in the global prevalence of physical inactivity in adults and in adolescents by 2030 (ParticipACTION, 2019; World Health Organization, 2018). Achieving this goal would require effort in individual, interpersonal, organizational, community, and public policy domains (ParticipACTION Advisory Groups, 2012).

**Role of Health Care Providers**

The primary health care system is an appropriate avenue for the promotion of PA (ParticipACTION, 2019). The Canadian Institute for Health Information reported that 85.1% of Canadians received care from their primary care doctor or FP (Canadian Institute for Health Information, 2016), who were tasked with providing care across a wide spectrum of care across settings and patients, contributing to and overseeing health promotion and illness prevention, coordinating care with allied health care providers, and acting as advocates for their patients (Canadian Medical Association, 2018). The following section describes the role of FPs in Canada, the education FPs required to practise, and their professional role as PA-advocates.

**Family Physicians**

Collaborating with a range of allied health care providers, FPs provide accessible and comprehensive front-line (College of Family Physicians of Canada, 2018) and preventative care (College of Family Physicians of Canada, 2017) for a large proportion of the Canadians (Gates, 2016). They are responsible for overarching and proactive treatment of patients, ensuring follow-up, facilitating transitions of care, and making referrals as required (College of Family Physicians of Canada, 2018). They develop long-term, trusting relationship with patients and their families, which in turn informs the goals of care and the specific approach taken (College of Family Physicians of Canada, 2018). It is through these relationships that illnesses can be recognized that in turn trigger integrative strategies to develop patient-centred treatment plans for patients with and without multiple morbidities and chronic illness (College of Family Physicians of Canada, 2018).

The medical care for patients with early-stage chronic diseases are primarily managed by FPs (Birtwhistle et al., 2009) through the provision of a wide range of treatment and preventative services (Belanger et al., 2017). The potential for public health contributions by FPs are therefore substantial because through evidence-based medical approaches, they can modify the ongoing care they provided to a large sector of the population (Grandes et al., 2009). This provides great potential for upstream, preventative approaches to care. Further, most (56.5%) FPs in Canada provided primary health care in independently-run group practices (Canadian Institute for Health Information, 2010) and therefore had autonomy over how their practice was operated (e.g., control of the management and finances of the practice, and choosing the medical record system to document their patients' care). This enables FPs to modify their procedures to meet the needs of their patients.

**Education.** In order to become a FP, a medical degree from an accredited university is required followed by a residency in family medicine or specialty post-graduate training. Successfully completing the qualifying examinations of the Medical Council of Canada and licensing by the provincial or territorial licensing authority are required prior to practising (College of Physicians and Surgeons of Alberta, 2020).

**Medical program and family medicine residency accreditation in Canada.** In Canada, the Committee on Accreditation of Canadian Medical Programs (CACMS) determines the criteria for accrediting Canadian medical education programs (Committee on the Accreditation of Canadian Medical Schools, 2018). However, each medical program defines the competencies to be achieved by its medical students through medical education program objectives (Committee on the Accreditation of Canadian Medical Schools, 2018). These objectives are statements of the knowledge, skills, behaviours, and attitudes that medical students are to exhibit as evidence of their achievement in the program (Committee on the Accreditation of Canadian Medical Schools, 2018). For example, the medical program must ensure that the medical curriculum include content and clinical experiences related to:

> each organ system; each phase of the human life cycle; continuity of care; and preventive, acute, chronic, rehabilitative, end-of-life, and primary care in order to prepare students to: a) recognize wellness, determinants of health, and opportunities for health promotion and illness prevention; b) recognize and interpret symptoms and signs of disease; and c) develop differential diagnoses and treatment plans (Committee on the Accreditation of Canadian Medical Schools, 2018).

Family medicine program residency accreditation standards in Canada are established by the College of Family Physicians of Canada and are designed to adequately prepare residents to enter the workforce as competent physicians who are able to adapt to the independent practise of comprehensive family medicine in Canada (College of Family Physicians of Canada, 2018a). The Family Medicine Profile from the College of Family Physicians of Canada states that FPs must be able to provide, comprehensive medical care for all people, at various life stages from preventive to palliative care using holistic, integrative reasoning to reach a patient-centred diagnosis and treatment plan (College of Family Physicians of Canada, 2018b).

Medical programs have autonomy to develop curriculum objectives as long as they meet the required overarching regulatory standards. There may be variability between medical programs' course materials, the required depth of knowledge, and observable skills regarding preventive, acute, chronic, rehabilitative, end-of-life disease management, and subsequently counselling, and recording of exercise within patient care and care plans. The extent of the variation for PA curriculum in Canadian programs is not known.

**Family Physician Physical Activity Curriculum**

There are limitations to health care professional education (Lion et al., 2019) including lack of knowledge and confidence when discussing PA with patients. PA advocacy organizations have recommended that PA content be required in medical and allied health professional medical curriculum (ParticipACTION, 2019); training on evaluating and tracking PA prescriptions (ParticipACTION, 2019) (e.g. through medical records and billing) is also recommended. The following section describes the measurement of PA in health care settings, the potential for FPs to be PA advocates, and audits of PA-related curriculum in medical program and family medicine residency programs.

**Measurement of physical activity in health care settings**

Measurement of PA in health care settings is usually accomplished through questionnaires that vary in the number of questions and the length of time required necessary to complete them (Lobelo et al., 2014). The most commonly used tools to assess MVPA for both the general population and for patients with existing or at risk of chronic disease were Exercise Vital Sign (EVS), Physical Activity Vital Sign (PAVS), Speedy Nutrition and Physical Activity Assessment (SNAP), General Practice Physical Activity Questionnaire (GPPAQ), and Stanford Brief Activity Survey (SBAS) (Golightly et al., 2017; Lobelo et al., 2018).

Due to its short completion time and the capacity to specify PA across differing domains (e.g., domestic transportation), the GPPAQ was most commonly used to determine PA-level in health care settings (Smith et al., 2017). Another widely used instrument was the EVS because it could be embedded in clinic workflow when assessing vital signs as a patient entered an examination room (Wald & Garber, 2018). Implantation of the EVS in clinical settings demonstrated favourable changes in clinical practice with patients, likely leading to additional exercise discussions between patients and primary care physicians; within 18-months of implementation 86% of patients (n = 1,537,798) had at least one EVS measure (Coleman et al., 2012). These findings emphasized the efficiency of embedding PA-related tools within the regular activity of clinical practice. In healthcare, the degree to which clinical interventions improved patient overall health and well-being was considered in terms of clinically relevancy. However, there was no clear consensus on the best method of determining a clinically relevant change in PA level (Smith et al., 2017). As a result, clinicians and researchers used differing questionnaires, or none at all, that capture divergent information, thereby limiting direct comparability.

**Expectation and potential for family physicians to provide physical activity-related advice.** Prescribing PA can lead to improvement in physical fitness and quality of life and this act as a strong external cue for health-promotion actions (Belanger et al., 2017; ParticipACTION, 2019). There are several ways of providing PA advice to patients including written prescriptions but only 14% of FPs did so (Owens, 2014). This is surprising since CanMEDS, a competency framework designed for all FPs in Canada, indicated that providing health promotion, disease prevention, and primary, secondary, tertiary care to patient-centred clinical assessments, establishment of management plans and appropriate written or electronic records of clinical encounters to enhance shared decision making with patients are required (College of Family Physicians of Canada, 2017). Some researchers have recommended that FPs assess levels of PA during each office visit and create mechanisms for more frequent evaluation (Lobelo et al., 2018) while others suggested that not providing PA advice constitutes 'medical neglect' (Weiler et al., 2012).

The WHO advised the preservice curriculum of all medical and allied health professionals to include information of the health benefits of PA into the requirements for training on prevention and management of noncommunicable diseases, mental health, healthy ageing, and the wider promotion of community health and well-being (World Health Organization, 2018). Active Canada 20/20 called for the establishment of high-quality accessible programs and services to address physical inactivity in Canada. Specifically, it recommended that primary health care professionals be taught PA prescription, sedentary behaviour reduction, and fitness referrals as part of both preservice education and professional development (ParticipACTION Advisory Groups, 2012). Canadian professional organizations and regulatory bodies agreed that it was the role of FPs to provide "….patient participation and self-help in public health education, e.g., healthful eating and physical activity" (College of Family Physicians of Canada, 2005). The Canadian Medical Association indicated that "Family physicians … play an important role in health promotion and illness prevention, coordinating care with other specialties and health professionals, and advocating on behalf of their patients with respect to the care and services they need in all parts of the healthcare system" (Canadian Medical Association, 2012). This statement was echoed by the Alberta College of Family Physicians (Alberta College of Family Physicians, 2019).

There are many resources to support clinicians as they incorporate PA into health care advice. In 2007, the American College of Sports Medicine, in partnership with the American Medical Association, launched the Exercise is Medicine (EIM) initiative that called for PA to be included as standard medical care in order to improve the health of the population (Lobelo et al., 2014). The EIM was an initiative that was adopted in over 40 countries across five continents (Exercise is Medicine, 2019), including a Canadian chapter Exercise is Medicine Canada (EIMC) (Exercise is Medicine Canada, 2019). EIMC hosted conferences and events, presented resources for health care providers to screen for PA readiness and safety, and provided guidance on how to refer patients to allied healthcare PA specialists (Exercise is Medicine Canada, 2019).

In light of all these recommendations and supports, it is important to understand the nature of PA-related curriculum offered by Canadian medical programs and family medicine residency programs. A 1972 an audit of Canadian medical programs' curriculum using a brief questionnaire resulted in responses from all 15 (at the time) medical programs. It found that no medical program offered a graduate course in general sports medicine while three offered courses in exercise physiology (Cumming, 1972). Half of Canadian universities offered one or two hours of PA-related lectures, one offered six to eight hours of lectures or seminars, one program did not offer any structured lectures or seminars, and 'exercise testing' was taught in 10 programs (Cumming, 1972). Cummings recommended exercise-related courses (e.g., physiology, respirology, and cardiology) be universally offered adding, "... the present situation may well ask why consult your doctor before you exercise?" (Cumming, 1972). An audit of Canadian Family Medicine residency programs was conducted in 1993 to determine the prevalence of sports medicine courses. Program directors from all 16 (at the time) family medicine departments responded to the survey. None reported having mandatory sports medicine content in their programs (Wiley, Strother, & Lockyer, 1993); most (87.5%) had a sports medicine elective, many (62.5%) offered a four-week program, a few (6.3%) offered a one-week program, and more than half (62.5%) held related seminars during family medicine block time (Wiley et al., 1993). This showed that there was merit in offering some sports medicine courses in family medicine programs. To date, there are no known audits of Canadian medical programs in addition to those completed by Cumming and Wiley.

**International medical program and family medicine residency physical activity curriculum audits.** There have been studies related to the PA-related competencies and training taught in medical school programs in the United States, the United Kingdom, Ireland, and Australia.

Two audits of medical program programs in the United States have been conducted. One consisted of a medical program questionnaire that assessed the amount of PA training in medical program curriculum was returned by 74 programs. Fifty-eight programs reported that most (78.4%) included PA in their curriculum (Stoutenberg et al., 2015), 35 (61.4%) included instruction on aerobics, 25 (43.9%) taught strength training guidelines, and 31 (56.4%) reported offering a sufficient level of PA-related instruction to enable students to successfully counsel their patients (Stoutenberg et al., 2015). The programs reported an average of 18 hours of PA training; 8.1 hours of these were compulsory and the remainder of the time was assigned to elective classes or parallel opportunities (Stoutenberg et al., 2015). The authors suggested that offering PA training as a parallel option could lead to the perception that PA knowledge was unimportant, particularly if students were not held accountable for the material (Stoutenberg et al., 2015). In an audit, of 118 (69.41%) Doctor of Medicine and Doctor of Osteopathic Medicine programs in the United States, found that most offered no PA-related courses (51.7%), had a single course (21.2%), while some included up to seven courses (3.4%) (Cardinal, Park, Kim, & Cardinal, 2015). When coursework was offered, the largest percentage were biophysical-focused, appearing as either sports medicine (45.0%) or exercise physiology (40.9%), while the areas of preventive medicine (8.1%), lifestyle medicine (4.7%), and behavioural counseling (1.4%) were offered significantly less often (Cardinal et al., 2015). The researchers concluded that over half of the physicians trained in the United States in 2013 received no formal education about any aspect of PA (Cardinal et al., 2015).

In the United Kingdom, 31 medical programs responded to a questionnaire regarding PA-related curriculum. Five (16.1%) did not include any specific PA teaching and four (15.4%) taught PA in all five years of the program (Weiler, Chew, et al., 2012). The average number of hours devoted to teaching PA throughout the entire curriculum was 4.2 hours; however, this question was only answered by 12 programs (38.7%) (Weiler, Chew, et al., 2012). More than half (55.6%) taught about the current guidelines for PA. The authors found two themes: curriculum was 'integrated' (12 mentions by eight programs), and it was 'difficult to quantify/assess' (five mentions by four programs) the amount of instruction related to PA

(Weiler, Chew, et al., 2012). Delivery of PA teaching was varied across UK medical programs but overall, it was sparse.

A study gauging the interest in teaching sport and exercise medicine within undergraduate medical program education in the United Kingdom and Ireland found that seven (25.0%) medical programs taught these topics in a formal context within the core curriculum while six (21.4%) offered PA as an optional module (Cullen, McNally, Neill, & Macauley, 2000). The proportion of students who were taught sport and exercise medicine ranged from 10% to 100% (Cullen et al., 2000). Programs that did not teach this content were asked if they intended to introduce undergraduate teaching in sport and exercise medicine in the next five years; nine (32.1%) programs replied that they did not intend to introduce it (Cullen et al., 2000). The barriers to the introduction of undergraduate teaching in sport and exercise medicine cited were no time available (n = 4), sufficient informal PA curriculum (n = 4), or no experts to teach PA-related content (n = 1) (Cullen et al., 2000). According to these findings, PA was taught either formally or informally in 13 (46.4%) medical programs that replied to the questionnaire (Cullen et al., 2000).

A survey of 17 Australian medical program websites and curriculum leaders found that PA training was included in the curriculum of 15 (88.2%) programs. Thirteen (86.7%) taught PA in association with the reduction of chronic diseases and national recommendations for strength training were offered in seven (46.7%) (Strong et al., 2017). Five respondents (33.3%) stated their students did not want PA training and six (42.9%) felt that their PA training was insufficient to prepare their students to provide PA counseling to future patients (Strong et al., 2017). The four, five, and six-year programs offered an average of 6.6, 5.0, and 12.3 hours of required PA training across their curriculum, respectively within musculoskeletal units (n = 6), clinical rotations (n = 5), the cardiovascular units (n = 4), problem-based learning (n = 4), and in public health lectures (n = 4) (Strong et al., 2017). The most commonly mentioned barriers in providing PA training included time (n = 7) and a lack of a champion advocating for more PA training (n = 2). Conversely, seven programs (41.2%) reported experiencing no barriers to integrating PA training into their curriculum (Strong et al., 2017).

Health organizations, regulators, and medical schools in Canada and abroad agree that it is within the purview of FPs to provide PA-related advice. However, the PA-related curriculum provided to preservice FPs varied in how courses were delivered, and the time allotted for the material. The frequency of offering related curriculum in offshore medical programs and family medicine residency programs ranged from 88.2% in Australia to 46.4% in United Kingdom and Ireland; the average number of hours were 12.3 in Australia to 4.2 in the United Kingdom.

**Family Physician Physical Activity Advice**

The Canadian Academy of Sports and Exercise Medicine posited that all primary care physicians should include PA assessment and prescription as part of routine healthcare for patients at every level of medicine (Thornton et al., 2016). There are opportunities to routinely screen for PA through the use of PA assessment tools (Smith et al., 2017). However, there is variability in the number of providers offering PA-related advice. The following subsection outlines the extent of FPs providing PA-related advice, the content of that advice, and the cost effectiveness of PA interventions.

**Family physician physical activity-related advice.** The impact of FP PA-related advice has been studied. The rates of provider-initiated PA counseling and recommendations were low (<40%) (Forjuoh et al., 2017), but increased for patients with diagnosed chronic conditions

(Joyce & O'Tuathaigh, 2014) including cardiovascular disease (41.2%), hypertension, (44.2%), obesity (46.9%), and diabetes mellitus (56.3%) (Lobelo et al., 2018). Those more likely to have received advice on exercise were men (aOR 1.7, 95% CI 1.3-2.2), people older than 35 years (aOR 1.7, 95% CI 1.2-2.4), patients with one or more chronic illnesses (aOR 1.3, 95% CI 1.1-1.5), and individuals reporting higher scores on communication (aOR 3.2, 95% CI 2.3-4.4) and enablement (aOR 1.8, 95% CI 1.3-2.4) (Sinclair, Lawson, & Burge, 2008). Patient demographic characteristics and disease status predicted the likelihood of receiving PA-related advice.

Studies have found that efforts to encourage providers to undertake PA-related discussions had mixed results. Increasing the time spent with patients had little impact on the proportion of exercise conversations. Extending FP appointment length from 7.5 minutes or less to ten minutes per patient in general practise, resulted in the discussion of exercise increased from 0.7% and 0.4% to 1.1% (Brosius et al., 2006; Wilson, McDonald, Hayes, & Cooney, 1992).

Less than half (48%) of Mexican primary care physicians, reported that they always asked patients about their PA, 33% provided verbal prescriptions, 6% provided written prescriptions, 8% referred patients to PA resources, and 4% assessed fitness (Leijon et al., 2010). While Canadian FPs self-reported that they implemented a high degree of preventive services, such as taking histories of tobacco use (97.9%), but less so for counseling about regular PA (87.2%) (Petrella, Lattanzio, & Overend, 2007). Most primary care physicians (85.2%) reported asking patients about their PA levels and one-quarter (26.2%) reported assessing patient fitness as part of a physical examination or through a fitness test while few (10.9%) reported referring patients to others for fitness assessment (Petrella et al., 2007). Most (69.8%) provided patients with verbal counseling about PA, but few 15.8% provided patients with written prescriptions to PA programs (Petrella et al., 2007), but there was no mention as to the frequency of that FPs document PA in their EMRs. Patients who were likely to receive a written prescription of PA levels were female, older than 35 years, issued by FPs who practised less than 6 years, and by those who provided care in privately-owned clinics in urban communities (Petrella et al., 2007). The low proportion of FPs providing PA-related advice was has been postulated to be due to attitudes about its perceived effectiveness. In a cross-sectional survey of 330 Canadian FPs, 58.2% believed 0–25% of their patients would respond to their PA counselling and 42.4% felt “moderately knowledgeable” about exercise counselling (Kennedy & Meeuwisse, 2003). Only 11.8% counselled 76–100% of their patients about exercise while nearly half (43.3%) thought they should be counselling 76–100% of their patients (Kennedy & Meeuwisse, 2003). Barriers to exercise counselling included lack of time in clinic (65.7%) and lack of education while in medical program (64.8%) (Kennedy & Meeuwisse, 2003). Not providing PA-related advice to patients is a missed opportunity considering patients who receive advice and materials from their physician were more likely to remember the materials, show them to others, and believe that they applied to them, three months following the session/advice compared to patients who receive education material but not physicians' advice (64% vs 48%; OR = 1.51, 95% CI = 0.95-2.40) (Kreuter, Chheda, & Bull, 2000).

**The content and effectiveness of family physician-provided physical activity advice.** A review of five meta-analyses, three systematic reviews, and two literature reviews published over the last decade confirm that PA counseling by primary care providers had a small to moderate positive effect on increasing PA levels (standardized mean effect range, 0.17–0.28; risk ratio/odds ratio range, 1.22–1.42) (Lobelo et al., 2018). Further, a small effect was found for exercise referral for physically inactive patients to reach PA guidelines (RR range: 1.12–1.20, 95% CI range: 1.03–1.35) (Lion et al., 2019). Exercise referrals were associated with statistically significant changes in most health and well-being outcomes (e.g., BMI, blood pressure), though the amount of change is not clinically meaningful (Wade, Mann, Copeland, & Steele, 2020).

The PA-related support that FPs provided to patients is commonly described in the literature as 'brief advice', however there is no agreement about the definition of brief interventions in the context of PA intervention in health care settings and the factors that influenced effectiveness of brief interventions have not been well determined (Lamming et al., 2017). There is some evidence to suggest that brief FP-delivered motivational advice was not effective with more intensive or theory-based behavioural interventions designed to increase PA levels (Kinmonth et al., 2008). For example, a community-based walking scheme compared with FP PA advice in middle aged adults found the proportion who increased their activity above 120 minutes of moderate intensity activity per week was 22.6% for FP advice and 35.7% in the health walks group at 12 months (Lamb, Bartlett, Ashley, & Bird, 2002). Another study foudn that compared tailored PA interventions with physicians supplemented by a 'booster' call to provide patients with encouragement and the opportunity to answer questions, compared to standard PA advice. The results showed that the two approaches were comparable at six months post intervention (van Sluijs et al., 2005). In a third example, a study assigned participants to either a group with feedback from their physicians about their PA level (advice-only) or advice that matched their patients' stage-of-change, leaflets, and a 45-min counselling session (advice plus). Seven weeks post intervention, 35% of patients in the advice-only group and 38% of patients in the advice plus group were classified as active; at 14 months, 47% of the subjects in both groups were active (Jimmy & Martin, 2005). This indicated that there was some evidence that more intensive interventions may not be as effective as general FP advice.

Conversely, there is evidence of effective long-term multi-component PA counselling. An intervention involving initial in-person and subsequent telephone counseling by a lifestyle counselor, one-time clinical endorsement of PA, monthly automated telephone messaging by a primary care provider, and quarterly tailored mailings of progress in PA resulted in an increase in minutes of MVPA per week from 57.1 (SD = 99.3) to 126.6 (SD = 142.9) compared to usual care, which averaged 60.2 (SD = 116.1) to 69.6 (SD = 116.1) for patients who did not engage in regular PA at baseline (Morey et al., 2009). A randomized control trial of 915 US adults showed that those who received educational materials on PA and reported that their physicians persuaded them to increase PA participation, were 1.51 times more likely to have increased levels of PA compared to those who did not have physicians' encouragement (OR = 1.51, 95% CI = 0.95-2.40) (Kreuter et al., 2000). In a study comparing brief advice supplemented with educational materials and an additional 15-minute appointment to prescribe an individualized PA plan that included goal setting, addressing potential barriers, prescription of a self-monitoring log for patients to complete, and a folder to retain this information compared to usual care found that at six months the PA of patients was more than those who received usual care (adjusted difference, 18 minutes per week [95% CI, 6-31 minutes per week]) (Grandes et al., 2009). Further, the number of those in the intervention group who achieved minimal recommended PA guideline was 3.9% higher than in the intervention group (1.2%-6.9%; NNT = 26) resulting in a small but positive effect (Grandes et al., 2009). Lastly, in a comprehensive primary care intervention for patients not meeting PA guidelines, information from a primary care providers about increasing PA or walking, written prescriptions, referrals to exercise specialists who made at least three telephone calls lasting 10-20 minutes to motivate patients, newsletters from sports foundations about PA initiatives in the community compared to usual care, resulted in an increase of meeting

PA guidelines by 9.72% (NNT = 10.3) (Elley, Kerse, Arroll, & Robinson, 2003). This cumulative evidence demonstrates that the effectiveness of primary care PA interventions had mixed results. Studies showed that FPs were a trusted source of health information and could improve PA levels in patients, but the most effective strategies to improve PA levels were not clearly defined in the literature.

**Cost effectiveness of physical activity interventions.** In order to be considered cost-effective, health economists use a threshold of treatment cost compared to the quality-adjusted life-year (QALY) gained. The threshold to determine whether an intervention was cost effective in the UK was £20,000 to £30,000 per QALY (Anokye, Lord, & Fox-Rushby, 2014). A British systematic review of the cost-effectiveness of brief interventions by primary care providers estimated the incremental cost of moving an inactive person to an active state ranged from £96 to £986 (Vijay et al., 2016), well below the threshold. Another study that evaluated the cost-effectiveness of brief advice by health providers using Markov modelling, estimated a cost-effectiveness ratio of £1730/QALY gained from brief advice compared with usual care (Anokye et al., 2014). The authors concluded that there was a 99.9% chance that brief PA advice is cost-effective (Anokye et al., 2014). Further, an economic analysis found that PA promotion interventions in primary care showed similar or better cost-effectiveness than drug-based interventions that were well established in primary care such as cholesterol lowering medications (€58,882 per QALY) or intensive glucose control (€32610 per QALY); the cost to move one person from physically inactive to active at 12 months was estimated to range from €348 to €86877 (Lobelo et al., 2018).

Studies that used simulated cohorts of patients (aged 40 to 74) without common pre-existing diseases (i.e., diabetes, hypertension, cardiovascular disease, renal disease) found that interventions that provided patients pedometers were the best option in 56% of the 10,000 model simulations (Singh et al., 2018). Advice or counseling interventions was optimal in 22% of the iterations, while action planning interventions had less than 13% probability of being the most cost-effective (Singh et al., 2018). Pedometer interventions, advice counselling, and action planning were less costly and had better outcomes (QALY) than commonly used practices (Singh et al., 2018). In summary, the available evidence suggests that primary care interventions to increase PA are cost effective.

## Perspectives of Practicing Family Physicians and Trainees to Provide Physical Activity-Related Advice

The need to support adequate training and education about prescribing PA in medical programs was endorsed during the CMA’s 149th annual meeting in 2016 (Canadian Medical Association, 2016). Although the College of Family Physicians of Canada stated that FPs should provide PA advice for the care of a wide range of conditions and circumstances, it is important to be aware of the experiences and opinions of FPs and trainees in their role as health care providers tasked to provide PA-related advice including the identification of their perceived barriers therein. The following subsection describes the results from interviews, focus groups, and questionnaires completed by practising and trainee FPs related to their knowledge and experience about providing PA-related advice for their patients.

**Perspectives of practicing family physicians about their competency to provide physical activity-related advice.** Several studies have looked at physicians' rationale for not discussing PA-related matters with their patients. FPs indicated that they do not incorporate PA-related advice because their pre-service training did not teach it (Persson, Brorsson, Ekvall Hansson, Troein, & Strandberg, 2013). Also, they cited difficulty in accurately communicating with patients about optimal PA levels and how to increase PA levels (Winzenberg, Reid, & Shaw, 2009). This reiterates the importance of ensuring that FP tasks and initiatives are considered within the parameters of clinical time and workflow. As well, the role of FPs in providing PA-related advice was unclear to them (Persson et al., 2013). Instead they stated that their role was to describe the importance of PA to patients as there is 'no tradition of prescribing physical activity' in their profession (Persson et al., 2013). FPs have stressed the importance of working with patients to understand their preferred mode of PA or routine (Winzenberg et al., 2009).

There was a perception that PA-related advice was considered more relevant to a presenting complaint or to the management of a specific chronic disease or due to a particular health incident (Winzenberg et al., 2009). FPs were aware of the spectrum of chronic diseases that were preventable and/or better managed by increasing PA (e.g., obesity, diabetes mellitus, hypertension, cardiovascular disease, and depression) and assessing PA was recognized as important, although no more so than other lifestyle factors such as smoking and diet (Winzenberg et al., 2009). Others placed a higher priority on assessing common risk factors (e.g. smoking) instead of PA level (Winzenberg et al., 2009). Another FP-perceived limitation was the lack of guidelines to document PA as well as well-defined referral pathways. One respondent explained “I don’t know who to refer to or how to act.” (Persson et al., 2013). Attitudes, lack of training, and organizational issues seemed to prevent FPs in these studies from prescribing PA.

**Family physician trainee perspective of physical activity training in Canada.** It is important to understand the nature of the training FPs receive in medical program and family medicine residence programs to discern their preparedness to provide PA to their patients. Solmundson and colleagues surveyed 294 Canadian family medicine residents and found that

95.6% believed exercise prescription would be important in their future practice and they had higher confidence in their ability to counsel patients about general PA advice more so than in prescribing exercise (Solmundson, Koehle, & McKenzie, 2016). Through a 7-point Likert scale questionnaire, few residents (11.6%) felt highly confident (7/7) in exercise prescription (Solmundson et al., 2016), especially for providing PA to patients with pre-existing chronic conditions as compared to healthier patients (Solmundson et al., 2016). Regarding resident PA-related beliefs, 98.3% felt a responsibility to promote PA to their patients, 96.6% felt that PA is integral to their patients' health, 96.3% believed sedentary behaviour was harmful, and 86.5% disagreed with the statement "prevention is not as interesting to me as treatment." (Solmundson et al., 2016). Residents indicated they would be able to provide more credible and effective counselling if they exercised regularly and were 'fit' (94.9%) (Solmundson et al., 2016). Overall, residents' knowledge of PA was limited. The proportion who were familiar with Canadian PA guidelines (33.7%) was greater than the proportion who could correctly identify them (31.0%). Most (70%) correctly identified physical inactivity as one of the top four causes of mortality in accordance with the WHO (Solmundson et al., 2016); however, only 14.9% of residents said that they have received adequate training in exercise prescription, while 91% of reported a desire for additional training in exercise prescription (Solmundson et al., 2016). The authors speculated it was possible universities were not providing PA-related lessons because they did not feel competent doing so.

**Practicing family physician perspectives regarding physical activity-related training.** Although PA training opportunities and resources were available to FPs including certifications of Competence in Sport and Exercise Medicine from the College of Family Physicians of Canada (Jattan & Kvern, 2018) and EIMC (Exercise is Medicine Canada, 2019), there was a gap in FPs' PA-related competencies while many stated they wanted more teaching and training in PA-related topics (Lion et al., 2019). Despite the fact that FPs provided more counselling on aerobic exercise than other primary care providers, including pediatricians and geriatricians (Abramson, 2000), their lack of knowledge about ways to improve patient PA levels was compounded by perceived PA risks including potential litigation, and a lack of specialists who would provide for PA referral (Weiler et al., 2012). This was mirrored in a survey of general practitioners in the United Kingdom, 76% of whom welcomed more training and 36% felt that the training they had received was of no value to primary care (Buckler, 1999). In the United States, personal experience was found to predict PA-related advice: physicians who themselves performed aerobic exercise or strength training regularly were more likely to counsel their patients about the benefits of these exercises (Abramson, 2000).

Writing PA prescriptions showed promise in promoting PA. To assist FPs, the College of Family Medicine of Canada distributed PA prescription pads for members at no cost to encourage them to write PA prescriptions. However, following receipt of prescription pads, some perceived their ability to complete them decreased over time while others saw the benefit in using the PA prescription pads (Belanger et al., 2017). Some FPs intended to write PA prescriptions and felt confident in their ability to do so, but the provision of PA prescription pads was not sufficient to make a real change in practice.

Short training sessions were effective in increasing the confidence and the number of FPs who provide PA-related advice. A three-hour workshop to educate FPs on PA prescription and provide tools to facilitate prescriptions resulted in an increase in PA-related referrals from 36% prior to training to 64% one-month post training, PA assessment increased from 52% to 76%, and PA prescriptions went from 40% to 68% (Windt, Windt, Davis, Petrella, & Khan, 2015).

The provision of supports (PAVS and EIMC Exercise Prescription and Referral Tool), in conjunction with the educational intervention, played an important role in FPs providing written prescriptions to patients (Windt et al., 2015).

**Electronic Medical Records**

An EMR is a computer-based patient record specific to a single clinical practice, such as a family health team (Canada Health Infoway, 2020). Often they include information such as billing, patient history, patient demographics, physical measurements (e.g., height, weight, blood pressures), prescribed medications, symptoms, problem list (e.g., indication of patient conditions, risk factors, and diseases), and laboratory results (Canadian Primary Care Sentinel Surveillance Network, 2020). Electronic records have clear advantages over paper records in that they provide an easily accessible record of assessment and a resource for reference in future consultations (Heron, Tully, McKinley, & Cupples, 2014). In the United States, approximately three quarters of primary care providers (72.9%) have access to electronic reminders for prevention or follow up care (Ogburn, Ward, & Ward, 2020).

The 2002 the Romanow Commission recommended sweeping changes to ensure the long-term sustainability of Canada's health care system in the report *Building on Values: The Future of Health Care in Canada.* A recommendation to implement electronic health records for each Canadian was an impetus for implementation EMRs across Canada (Commission on the Future of Health Care in Canada & Romanow, 2002). Since then, EMRs have flourished. In 1999 it was estimated that just over one in 10 physicians (12.5%) was using an EMR (Martin, 1999), and by 2017 more than eight in 10 (82.4%) were doing so (Canadian Medical Association, 2017).

Data can be extracted from EMRs for secondary use to enable the assessment of routine care and clinical behaviour to study patient history of health risk behaviors such as excessive alcohol consumption or smoking (Pham, Cummings, Lindeman, Drummond, & Williamson, 2019). Pertinent information is often found in the unstructured, free-text of physician notes that were difficult to classify due to a lack of standardized formats (Lix, Munakala, & Singer, 2017). Studies found that data for exercise counseling, for example, was not entered in a structured format into the EMR but was most often documented as free text within the assessment and plan sections of the chart (Mattar et al., 2017).

Studies on the use of EMR systems found that augmenting the EMR template by implementing automated functionalities improved risk factor determination and documentation. For instance, an automatic calculation of BMI improved clinician documentation and treatment of overweight and obesity improved documentation from 31% to 71% (PR 2.30, 95% CI 1.44–3.68) after the implementation of an EMR-embedded BMI which lead to an increase in obesity treatment from 35% to 59% (Bordowitz, Morland, & Reich, 2007). Additionally, EMR systems offered a method to better screen patient eligibility for research studies and was recommended to be prioritized over labor-intensive, low-yielding methods such as community screenings and mass mailings (Effoe et al., 2016).

Administrative data, which differs from EMR data in that it is largely information specific to hospital admissions, billing, and pharmaceutical prescriptions (Lucyk, Lu, Sajobi, & Quan, 2015), has limitations. Often, there is no inclusion of information held in primary care EMRs such as problem lists, prescribed medications, risk factors, referrals, and medical history (Birtwhistle et al., 2009; Canadian Primary Care Sentinel Surveillance Network, 2020). Studies found limitations in the use of administrative data to understand disease case-ness (disease specific algorithms used to identify incidence and prevalence) since important data elements were not within administrative data sources. In Alberta, Tonelli and colleagues attempted to discern case definitions for 40 chronic conditions using administrated data and found the administrative data sources did “not have information on potential confounders related to lifestyle (e.g., diet, smoking, exercise) or on measured blood pressure, which may be confounders when examining the association between multimorbidity and outcomes or costs” (Tonelli et al., 2015). There is a unique utility to use primary care EMR data for analyses because of the detailed and specific information it offered that administrative data does not capture.

The rapid expansion of EMRs and the growth of digital health technology have raised concerns about their impact on physician burnout. One key issue was the variability in the frequency and functionality of drop-down menus, open-text inputs, and embedded templates in different EMR systems. There were more than 15 different primary care EMR systems in Canada (Canadian Primary Care Sentinel Surveillance Network, 2019), which had differing interfaces into which data is entered. Another source of EMR-related burnout may be due to the amount of time required to enter patient data. It was determined that physicians used electronic documentation systems an average of 3.3 hours per work day and the mean active time per patient was 952 seconds (SD = 2,538) (Overhage & McCallie, 2020). These concerns may be mitigated by a considered approach to standardize health information technology, including virtual health and communication systems, design, and deployment to support a more user-friendly workflow. This might require enforcing system requirements to deliver care that do not place additional burdens on the medical profession (Virtual Care Task Force, 2020). In a commentary on the utility of medical records, Griever (2015) stated that studies that had positive results often used custom-built systems rather than commercial software. But without funding and regulations to support these changes, it was likely that EMRs would remain, "a very expensive version of paper records". Another example of the system user interface as a barrier was a 2007 study that evaluated an electronic health record (EHR) system designed to improve mammography testing rates. The authors described the complexity of acquiring structured data, difficulty in measuring baseline rates, and the absence of support resources both within and outside the practice (Baron, 2007). For example, mammograms data took one mouse click to sign in patients and 13 clicks to enter structured data (Baron, 2007).

The unintended EMR implementation consequences were described in a University of Toronto review of the first two years of EMR implementation in the practices of 18 community-based FPs (Greiver, Barnsley, Glazier, Moineddin, & Harvey, 2011). Physicians viewed the EMR system as complex, inflexible, and not compatible with their needs. Some of this was attributed to software interface issues and perceived software immaturity. Even though training was offered prior to EMR implementation, there were no formal sessions scheduled to provide continuing support. Participants recognized their need for ongoing training in EMR use. One participant noted a need to improve their documentation, "I don’t even know what I could learn. I know there are buttons there that I am not using efficiently, so it would be nice if you could follow me around for two or three patients to see how I am doing it and tell me probably how I can use it better" (Greiver et al., 2011).

**Canadian Primary Care Sentinel Surveillance Network**

The CPCSSN is the first pan-Canadian primary care repository of interprovincial, de-identified primary care EMR data for research and surveillance (Birtwhistle & Williamson, 2015). Developed in 2008 through a partnership between the College of Family Physicians of

Canada and the Public Health Agency of Canada, it addressed the lack of data infrastructure in Canada in order to study issues in primary care (Glazier, 2008). It spans eight Canadian provinces and territories and extracts EMR data from over 1,400 primary care providers referred to as ‘sentinels’ (Canadian Primary Care Sentinel Surveillance Network, 2019). It is estimated that 96.8% of participating providers are FPs while the remainder are nurse practitioners and pediatricians (Martin K., personal communication, April 25, 2019). Sentinel surveillance, historically used in chronic disease surveillance (Public Health Agency of Canada, 2019), was based on the concept that one or more sites could collect clinically verified information (e.g., risk factors, diagnosis) about relatively few individuals, representative of a larger population to identify public health events of interest (Birtwhistle et al., 2009).

Pan-Canadian (or 'national') CPCSSN data is extracted from all voluntarily participating sentinel EMRs biannually. Thirteen regional networks have autonomy over network data and conducting linkage projects within their jurisdictions but often provide national data cuts for research purposes (Canadian Primary Care Sentinel Surveillance Network, 2019). Extracted data includes longitudinal information from 12 different EMR systems representing nearly two million Canadians. The database includes patient and provider demographics, physical measurements (e.g., height, weight, blood pressures), prescribed medications, symptoms and diagnoses recorded during patient visits, billing claims, and laboratory results (Canadian Primary Care Sentinel Surveillance Network, 2020; Garies, Birtwhistle, Drummond, Queenan, & Williamson, 2017). The CPCSSN reports to be representative of the general Canadian population, but there is an overrepresentation of CPCSSPN patients who were older and female; CPCSSN sentinels tended to be younger, female, and more often practised in an academic centres (Queenan et al., 2016). It was recommended that this be taken into consideration when conducting analysis with CPCSSN data (Queenan et al., 2016).

As EMRs document patient care and are not designed for surveillance and research purposes; cleaning, coding, and processing algorithms are used to standardize various aspects of the EMR record (Garies et al., 2017). The CPCSSN developed EMR-base case definitions and case-finding algorithms to identify common chronic conditions managed in primary care including chronic obstructive pulmonary disease, dementia, depression, diabetes, hypertension, osteoarthritis, parkinsonism, and epilepsy (Williamson et al., 2014). Case definitions were determined through machine learning approaches, literature reviews, and aggregation of commonly used definitions. Algorithms with a minimum 70% sensitivity, specificity, positive and negative predictive values (in comparison to manual review of case-ness) are considered to have sufficient validity and are implemented as CPCSSN definitions (Williamson et al., 2014).

A comparison of data directly from ‘live’ EMRs, that is, remote access to the EMRs in its entirety was compared to CPCSSN-extracted data to determine whether CPCSSN-extracted validated case definitions incorporate condition-relevant information comparable primary care providers in EMR. Manual review of the CPCSSN records for case ascertainment yielded sensitivity ranging from 77.5% (95% confidence interval [CI] 73.3%–81.6%) for depression to 97.2% (95% CI 95.4%–99.0%) was completed for diabetes. Specificity was high for all definitions (range 93.1% [95% CI 91.4%–94.7%] to 99.4% [95% CI 99.0%–99.8%]) (Williamson et al., 2017). Positive predictive values and negative predictive values showed high accuracy of the manual CPCSSN record review relative to review of the raw chart data, thus concluding that CPCSSN was an appropriate reference standard to develop and compute EMR case definitions (Williamson et al., 2017). Therefore, it is possible to determine incident and prevalence case-ness for chronic diseases using the CPCSSN data to compare with lifestyle, demographic, and risk factor inputs. In addition, the CPCSSN has provided bi-annual data cuts to study a wide range of conditions including: young-adult onset metabolic syndrome (Boisvenue, 2019), cancer (Foster, 2019), and speech and language disorders (Miyagishima et al., 2020). These definitions ranged from largely using laboratory measurements to those that included commonly used terminology in the problem list.

Because EMR systems vary in functionally, understanding the data within EMRs is not an easy task. As a result, not all elements of CPCSSN have been examined. To date, there has been no systematic examination of PA or exercise data in national CPCSSN data and little is known of PA documentation across differing EMR systems (Lindeman et al., 2020), nor has there been an attempt to characterize the content of PA-related information. The only study that presented exercise data is from Kalia et al. (2017), who used CPCSSN data from UTOPIAN (one of 13 participating CPCSSN networks) to compare the documentation of common screens (i.e., waist circumference; body mass index; blood pressure; laboratory measurement in the last three year: low-density lipoprotein and fasting blood glucose or haemoglobin A1c, and any presence of lifestyle information including, exercise, smoking, alcohol, and diet) in primary care across three EMR systems: Oscar, Accuro, and Practice Solutions Systems (Kalia et al., 2017). They reported that 15% of patients had exercise in the risk factor table. However, this study did not determine the purpose of exercise inputs (i.e., current PA levels, PA history, contraindications for PA, referral to allied health care providers for PA treatment and prescription, referral to PA programs, domains of PA, or PA prescription) and did not include data across multiple CPCSSN networks, provinces, and pulled data from a small proportion of EMR systems (three of the EMR systems from which CPCSSN extracts data).

In 2018, an informal query of the Southern Alberta Primary Care Research Network (SAPCReN)-CPCSSN network found 46,128 entries in the RiskFactor table to consisted of unstandardized ‘exercise’ inputs; 31,135 (64.5%) of which were unique entries ranging from a few characters to multiple sentences indicating a variety of detail in the ‘exercise’ RiskFactor field (Soos B., personal communication, April 25, 2018). The most common of the unique entries were: ‘yes’ (2.5%), ‘no’ (1.7%), and ‘none’ (1.7%) as of the 2017 Q4 extraction (Soos B., personal communication, April 25, 2018).

**Adult Physical Activity Documentation in Family Physician Electronic Medical Records**

With the recent developments in wearable technology and functional advances in primary care computerized EMRs, it could be expected that embedding PA guidelines and inputting PA-related information within standard note keeping to help guide practitioners would be inexpensive, straightforward, and create opportunity for the health care provider to discuss patients’ PA habits (Weiler et al., 2012). However, there has not been widespread integration of patient-generated data from wearable devices into the EHR or EMR systems (Lobelo et al., 2018). It may be assumed that once a PA assessment is done and recorded in an electronic system, the FP or another provider would review each patient’s self-reported minutes per week of PA and use this to congratulate the patient for meeting guidelines or to provide the patient with brief PA counseling and, when possible, use motivational interviewing, shared decision making, and other proven behaviour-change strategies (Lobelo et al., 2018). In order to understand what is documented in routine care and to respond to calls to monitor PA (ParticipACTION, 2019), it is necessary to examine FP and primary care clinic-entered PA information. The following subsection describes what is known about PA documentation in FP EMRs by study design.

**Physical activity electronic medical record documentation for patients with existing or at high risk of chronic diseases.** An eight-country study sampled primary care EMRs about coronary heart diseases management. Of 2,960 patients, 54.6% (SD = 32.3) had low PA documented as a risk factor and 47.4% (SD = 33.0) of patients had PA advice inputs (van Lieshout et al., 2012). The authors found a positive association of documentation by practice size (van Lieshout et al., 2012). Larger practice sizes resulted in more PA-related documentation for patients with chronic disease, although only half of the patients had any PA inputs. A review of the quality of cardiovascular risk-factor recording and lifestyle counselling in high-risk patients in European primary care found that of 4,479 eligible patients in 268 general practices, PA status was recorded for 45.1%, whereas smoking cessation was recorded in 65.6% (Ludt et al., 2012). Male patients had greater recording rates of PA and related advice compared to females (Ludt et al., 2012). This provided additional evidence of PA being recorded less frequently than other modifiable lifestyle risk factors.

American researchers identified 3,862 obese patients (BMI ≥30) by EMR inputs and examined related inputs such as lifestyle counseling for those patients (Mattar et al., 2017). Both exercise and diet counseling were not entered in the EMR in a structured format. Instead, they were most often documented as free-text in the assessment and planning tables (Mattar et al., 2017). A multivariate analysis found that in addition to age and gender, morbid obesity, and cumulative number of comorbidities were significantly associated with obesity documentation, OR=1.6 and OR=1.3, respectively, with 95% CI [1.4, 1.9] and [1.0, 1.7], respectively. For those with obesity documentation, exercise counseling was provided more often than diet counselling (Mattar et al., 2017). The study found that it is those with many chronic diseases including obesity have PA or exercise counseling noted in their EMR.

**Documentation of physical activity in electronic medical record as usual care.** A Dutch study identified that approximately half (105 of 209) did not have PA recorded in their EMR, as compared to other lifestyle behaviours. Of those that did, 28% of patients had PA registration on initial visit, 49% on last year's notes, and 50% on initial visit plus last year's notes while the majority had smoking 90% and alcohol use 82% consistently documented (Fouwels, Bredie, Wollersheim, & Schippers, 2009). A cross-sectional study in Quebec using questionnaires and a medical chart audit of 40 FPs, 24 nurses, and 439 patients found that 51.9% of patients had PA levels assessed during the past 18 months, but only 21.6% had received PA counselling (Baillot et al., 2018). The authors noted that few studies provided information on Canadian populations, and none used medical charts to analyze assessment of PA level and provision of PA counseling (Baillot et al., 2018). The quality-of-care indicators for hip and knee osteoarthritis in 8,591 Mexican patients, who were considered eligible for the general aerobic and/or muscle strengthening exercise, were explored to identify PA information from unstructured EMR data (Doubova & Perez-Cuevas, 2015). The authors found that 26.1% patients had documented recommendations for general aerobic and/or muscle strengthening exercise (Doubova & Perez-Cuevas, 2015).

**Embedding a tool or checklist in the electronic medical record to document physical activity.** The British National Health Service Health Check is a free checkup of the overall health of patients. It focused on examining risk factors for conditions such as heart disease, diabetes, kidney disease, stroke, and dementia. In 20 to 30 minutes visits, a health provider obtains information pertaining to lifestyle and family history, and takes anthropometric measures: height, weight, blood pressure, and blood tests (National Health Service, 2019). Of 2,892 patients in 13 clinics, 1,912 (66.1%) had missing exercise data; of those had exercise documented, 87% were recorded by health care assistants while only 8% were recorded by general practitioners (Krska, du Plessis, & Chellaswamy, 2016). In another study of the National Health Service Health Check, patients with exercise grading documented (n = 20,973) were characterized as active or inactive (less than 30 minutes five days per week). Of those who underwent a health check, most of the overall cohort (87.8%) was categorized as inactive (Baker, Loughren, Crone, & Kallfa, 2015). Embedding the health check in the EMR led to the identification of patients who were mostly inactive.

In a British randomized control trial to determine the effect of training national recommendations for osteoarthritis compared to usual care, found that 38% to 59% of patients had exercise advice recorded at baseline (Jordan et al., 2017). Written exercise inputs increased from 4% to 22% when there was incorporation of a national recommendations e-template compared to usual care (1% at baseline and 0.9% post trial) (OR = 21.49; 95% CI: 6.62-69.72), which consisted of enhanced FP consultation and guidebooks (Jordan et al., 2017). The authors concluded that there was an important and statistically significant improvement in written advice about PA that is attributable to the introduction of an e-template along with the provision of additional resources provided (Jordan et al., 2017). Providing training and embedding toolkits in EMRs, led to increased documentation.

When an electronic version of the GPPAQ was embedded in EMRs, researchers noted that of 2,154 consultations, 192 (8.9%) of patients had a GPPAQ completed, and 83 (43%) were categorized as inactive (Heron et al., 2014). The authors administered a questionnaire following the study and found that 72.7% (8 of 11) of GPs indicated that the GPPAQ was easy to use but not relevant for every consultation as it could extend consultation time, particularly for patients with complex problems (Heron et al., 2014). In a study following 1.5 years of EVS implementation in primary care EMRs, 86% (1,537,798) of all eligible patients had an EVS completed in southern California (Coleman et al., 2012). It was found that females were 1.12 (95% CI 1.11-1.12) times more likely to be inactive then men, patients with a Charlson Comorbidity Index of three or more were 1.54 (95% CI; 1.53-1.55) times more likely to be inactive compared with patients with a Charlson Comorbidity Index of 0, and patients with a BMI greater than 40 were 1.61 (95% CI; 1.60-1.62) times more likely to be inactive compared to a healthy weight BMI (Coleman et al., 2012). Overall, 36.3% of patients were completely inactive (0 minutes of exercise per week), 33.3% were insufficiently active (more than 0 but less than 150 minutes per week), and 30.4% were sufficiently active (150 minutes or more per week) (Coleman et al., 2012). The study showed that the implementation of the EVS in primary care EMRs enabled the identification of inactive patients and that females, patents who are obese, and patients with multimorbidity tended to be inactive.

Another study evaluated if the EVS could systematically ascertain patient-reported exercise levels at the beginning of each outpatient visit in four medical centres (Grant, Schmittdiel, Neugebauer, Uratsu, & Sternfeld, 2014). Exercise information was recorded in the medical record by medical assistants during 73.9% of eligible patient visits; 83.4% of eligible patients had exercise data collected during at least one visit. In a multivariate model adjusting for demographic differences and repeated measures, the adjusted odds of exercise documentation in primary care provider progress notes increased by 12% (aOR 1.12, 95 % CI: 1.11-1.13) among practices that had implemented EVS compared to practices without EVS (Grant et al., 2014). This added to evidence that implementation of PA-embedded templates resulted in an increase in patient PA documentation.

**Concordance between electronic medical record audit and self-reported care.** The concordance between EMR reporting and patients' self-report in four Aboriginal health services centres in Australia was examined to determine the prevalence of PA screening as a risk factor in EMRs. Out of 109 participants, 87 (80%) self-reported being screened for PA while 65 (60%) had PA recorded in EMRs resulting in 49% concordance (Noble et al., 2019). As well, 83 (76%) reported PA screening in the previous 12 months, compared to 59 (54%) found in EMRs, resulting in 45% concordance (Noble et al., 2019). The authors concluded that the discrepancy may be due to patient recall errors, failure to document PA in the medical records, lower perceived priority of these health risks by healthcare providers, and/or because of difficulties associated with the ability of clinical information systems to record such information (Noble et al., 2019). This study raised the consideration that if PA was not documented, there was no way to accurately determine whether PA was discussed but not documented. The authors stressed the importance of proper documentation practices.

**Review.** According to a recent scoping review, the contents of FP documenting of PA as EMR inputs were often unclear of unspecified in 22 studies (Lindeman et al., 2020). Studies that presented exercise information from FP EMRs tended to focus on patients with specific chronic conditions (63.6% of included documents) and provided little detail about the field from which information was extracted; the number of patients with PA or exercise information was often less than 50% of study samples. The frequency of exercise inputs in primary care records varied from 0.4% of patients with documentation of PA inputs to as high as 87.8% (Lindeman et al., 2020). Documentation of PA in FP and primary care EMRs varied from general advice to status and were found in roughly half of patients, less than other common risk factors for chronic diseases.

It appeared that embedding a tool within an EMR led to better documentation rates, but little is known about the effectiveness of doing so.

**Gaps in the Literature and Links to the Dissertation**

Current methods of measuring PA were deemed to be inadequate according to related expert organizations in Canada. For instance, the 2019 *ParticipACTION Report Card on Physical Activity in Adults* stated that there was a gap in knowledge in understanding PA levels for distinct population groups (e.g., individuals living with disabilities, individuals with low socioeconomic status, Indigenous People, newcomers to Canada, and pregnant women) and called for further research to better understand the common characteristics of low-activity demographic groups to be able to encourage individuals to be more active (ParticipACTION, 2019). Considering that the management of care for patients who had chronic diseases was largely conducted in primary care settings by FPs (Hebert, Caughy, & Shuval, 2012), the information inputted and stored in EMRs may serve as an infrastructure to study PA levels at scale, but this was not put forward in the literature and is not well-studied. No Canadian study has determined if PA guidelines were regularly referenced and subsequently recorded, or if information about patients' exercise level was captured systematically across multiple EMRs in primary care. A better understanding of FPs' recording behaviour and documentation content of EMRs would have had clinical utility and methodological benefits for quality improvement, research, and population-level health surveillance. Further, the advent of EMRs presented the potential to improve health research and patient care as it had functionalities that other systems and health data repositories do not have. To reduce the potential for physician EMR-related burnout, the structure and presentation of information must be in a format that operates within clinical workflow and did not add to demands on time, this requires further investigation.

The contents of PA-related curriculum in Canadian medical programs and family medicine residency programs are not known nor is how Canadian preservice and in-service training compares to those countries that have had PA audits of medical programs and family medicine residency programs. The literature suggests that FPs feel unprepared to incorporate PA discussions in their interactions with patients. They are unsure how to provide PA advice, especially for the patients with existing chronic diseases although time demands were named a significant barrier. Family medicine residents believe that providing PA-related advice to their patients would be beneficial was a part of their role but did not feel adequately prepared. Both active and preservice FPs understand that PA reduces the risk of chronic conditions and would welcome further training. It is important to understand the learned competences about PA that FPs have to better understand the content that they are recording in EMRs. Because if FPs do not receive training to engage in PA-related conversations, incorporate PA in chronic disease prevention and treatment plans, or document PA it will be reflected in the EMR content they input. Without understanding what is learned in Canadian medical training, this remains unknown.

As noted by the WHO, not only should primary health care professionals be trained in PA prescription, sedentary behaviour reduction, and referral as part of their education and professional development, they should be important community leaders and champions for PA (ParticipACTION Advisory Groups, 2012). The *WHO Global Action Plan on Physical Activity 2018-2030* action 3.2 detailed the need to:

> Implement and strengthen systems of patient assessment and counselling on increasing physical activity and reducing sedentary behaviour, by appropriately trained health, community and social care providers, as appropriate, in primary and secondary health

care and social services, as part of universal health care, ensuring community and patient involvement and coordinated links with community resources, where appropriate (World Health Organization, 2018).

Failure to recognize and support PA as a priority within prevention and treatment plans is a missed opportunity (Lion et al., 2019). Ongoing inaction could see the negative financial, social, and medical impacts of physical inactivity continue, or perhaps rise, thereby contributing to further negative impact on health systems, economic development, community well-being, and quality of life (World Health Organization, 2018). The Toronto Charter for Physical Activity recommends that PA and noncommunicable chronic disease prevention be integrated into primary healthcare systems (Blanchard, Shilton, & Bull, 2013). Thus, there is a need to better understand how health care providers are incorporating PA into the care they provide, especially for patients at risk of and/or living with chronic diseases.

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