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Socioeconomic Patterning of Physical Activity among Middle-Aged to Older Adults

Jane Yuan, *The University of Western Ontario*

Supervisor: Thornton, Jane, *The University of Western Ontario*
: Stranges, Saverio, *The University of Western Ontario*

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Abstract

Regular physical activity is a well-known protective factor against chronic disease and strongly correlated with healthy aging. However, as physical activity levels tend to decline with age, there is a need to identify barriers which prevent older adults from being physically active. This thesis investigated the relationship between socioeconomic status and meeting physical activity guidelines of 150 minutes or more of moderate- to vigorous- intensity physical activity among middle-aged to older adults in Canada. Using cross-sectional data from the baseline assessment of the Canadian Longitudinal Study on Aging, block-wise multivariable logistic regression was performed to assess the association between socioeconomic status, represented by education and wealth, in relation to meeting physical activity guidelines while adjusting for demographic, lifestyle and other health related factors. Sex and age-stratified analyses were conducted. After adjusting for all covariates, having a post-secondary education was a significant correlate of meeting physical activity guidelines among males, while higher wealth was a significant correlate of meeting physical activity guidelines among both males and females. Evidence of effect modification by weight status on education and wealth was found. Our findings highlight the need to increase accessibility of physical activity among disadvantaged population subgroups so that all can reap the benefits of physical activity. Further research using longitudinal data to assess the causality of the association between socioeconomic status and physical activity levels, inclusive of First Nations and people living in the Northern territories, is needed.

Keywords

Physical activity, socioeconomic status, education, wealth, healthy aging

Summary for Lay Audience

The World Health Organization ranks physical inactivity as the fourth leading risk factor for death worldwide and low physical fitness exposes individuals to a greater risk of dying than does smoking, obesity, or hypertension. Physical activity has the potential to improve health outcomes in over 30 noncommunicable diseases. Unfortunately, four out of five Canadians do not meet the national physical activity guidelines and systemic barriers to adoption of physical activity exist, especially for older adults. While socioeconomic status is likely to represent one of the most important factors influencing the uptake of regular physical activity, it remains unknown which socioeconomic indicator affects physical activity in older Canadians. The present study will fill this knowledge gap by summarizing and evaluating variations in physical activity adherence with respect to socioeconomic status, accounting for other correlates of physical activity among middle-aged to older adults.

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Chapter 1

1 Introduction

1.1 Background

1.1.1 Health Burden of Disease

Chronic disease is the number one cause of death worldwide and accounts for 89% of all deaths in Canada [1]. Three in four Canadians over the age of 65 live with at least one chronic condition [2]. It is estimated that $190 billion in annual healthcare spending is attributed to the treatment of chronic disease and its associated losses in productivity [3]. The proportion of Canadians aged 65 years or older is expected to increase to 25% by 2036 with a concomitant rise in the prevalence of chronic conditions and multimorbidity [4]. The most prevalent chronic diseases among Canadians are cardiovascular disease, diabetes and mood and anxiety disorders, and are preventable or treatable through physical activity [1,5]. Cardiovascular disease is the second leading cause of death, representing 27% of deaths in Canada [2]. There is an urgent need to identify and implement effective interventions for the prevention and management of chronic conditions among middle-aged to older adults to minimize the social and economic burden of disease [6,7].

1.1.2 Physical Activity as a Modifiable Risk Factor

Lifestyle behaviours such as physical inactivity are strongly related to the development of chronic disease and highly prevalent in older populations. Physical activity is a modifiable risk factor to prevent and treat chronic disease, improving health outcomes in over 30 conditions such as hypertension, chronic obstructive pulmonary disease, and osteoarthritis [5,8,9]. Research has shown that physical activity has a measurable beneficial impact on health and longevity, and significantly reduces risk for all-cause mortality as well as deaths from cardiovascular disease and cancer [10]. In addition to the benefits of attaining 150 minutes of moderate-vigorous physical activity on a weekly basis, low- to moderate-intensity activities also offer valuable health benefits for older adults [11]. Nonetheless, levels of physical activity tend to attenuate with age. Over 80% of middle-aged to older adults, especially those with one or more chronic conditions,

do not meet Canada's Physical Activity Guidelines, which highlights the need to better understand the underlying factors influencing physical inactivity within this population [12,13].

1.1.3 Social Determinants of Health

Social determinants of health contribute to the risk of chronic disease and perpetuate health inequalities [14]. Low socioeconomic status is one of the most consistent determinants of physical inactivity as well as one of the major drivers of chronic disease. The presence of two or more chronic condition is defined as multimorbidity[15–17]. A study conducted to characterize the association of multimorbidity with age, sex, and social position found that in a sample of Canadians between the ages of 45-85 years old, the typical person had an average of 3.1 chronic illnesses where the prevalence of disease was higher among those with lower income and less education [18]. Those with higher educational qualifications and income have more time and resources to participate in physical activity and are less likely to experience adverse health outcomes [19,20]. In an international review of 28 cross-sectional and five longitudinal studies, adults at the top of the socioeconomic scale, with respect to education and income, reported higher levels of leisure-time or moderate-vigorous intensity physical activity than socioeconomically disadvantaged populations [21].

The current literature often operationalizes income as one of the main measures of socioeconomic status when exploring its association with health outcomes [22–25]. However, wealth is a more consistent measure of socioeconomic status and more appropriately represents the financial resources available to middle-aged to older adults, many of whom are nearing the end of their time in the workforce [26–28]. The distinction between income and wealth is important as opportunities to participate in physical activity are determined by the financial resources available to an individual. Income is characterized by the quantity of money obtained over a period of time, usually from employment, and only provides a snapshot of financial gain for a period in one's life. As such, income typically tends to peak in middle-age and decrease in old age [29]. As many middle-aged to older adults reach the age of retirement, income would cease, and wealth would become the primary financial reserve for which one would use to sustain his/her quality of life and standard of living. When income is lost, wealth represents the accumulated value of economic goods available at a given point in time [30]. Specifically, wealth is characterised by one's net worth, measured by the total value of all financial assets or physical

possessions, such as money in savings, investments and real estate, minus outstanding liabilities and debt [31]. Often, middle-aged to older adults that accumulate more wealth early on can retire from the workforce, before the typical age of retirement, and rely on this financial reserve to allow for more time and opportunities for sports and recreational leisure. In a systematic review to determine if evidence supports including measures of wealth in health research, authors reported that failure to include wealth underestimates the association between socioeconomic status and health-related indicators such as perceived health, functional status, and chronic disease [31].

The relationship between wealth and health is consistent. In a study on the association between wealth and cardiovascular disease risk factors, researchers reported an inverse relationship between wealth and risk of obesity and hypertension after controlling for income and other time-varying confounders [26]. A large national study in the United States examined the degree to which behavioural risk factors contribute to socioeconomic position in the older adult population and found physical inactivity to be higher among those with lower wealth [32]. The underlying mechanism in which socioeconomic status affects health behaviours can be explained by the availability and accessibility of resources for one to participate in healthy lifestyle behaviours, including physical activity [33]. The evidence has established the determining role of socioeconomic status on physical activity engagement and well-being, which contributes to the exacerbation of health inequalities between socially advantaged and disadvantaged groups.

1.2 Importance of Our Study

Although the onset and development of chronic disease can be mitigated through behavioural risk factors and the social determinants of health, epidemiological evidence on the socioeconomic patterning of physical activity uptake in later life of Canadians is sparse. Specifically, the use of wealth as a socioeconomic indicator in relation to health is relatively sporadic. Given the strong relationship between physical activity and positive health outcomes, there is a need to identify how physical activity participation differs across socioeconomic strata to increase its uptake among older adults. As such, using observational data from large population-based studies, is needed to determine if patterns of physical activity among middle-aged to older adults in Canada follow a similar social gradient as previously reported in international studies[21].

It is well known that those with higher socioeconomic status have the resources to live healthier and longer lives. The proposed study offers valuable evidence on the socioeconomic barriers to regular physical activity required for developing and implementing well-founded intervention strategies. By identifying disadvantaged socioeconomic groups that face the most barriers to meeting physical activity guidelines of 150 minutes or more of moderate-vigorous intensity activity, we can allocate resources to promote physical activity accessibility and reduce socioeconomic disparities in health. Therefore, the objective of this thesis is to examine the cross-sectional patterning of physical activity in a nationally representative cohort of the aging Canadian population, and the extent to which socioeconomic status, using indicators of education and wealth, is associated with physical activity participation between sexes and across age groups.

Chapter 2

2 Literature Review

This chapter provides a review of the literature on the association between the social determinants of health and physical activity.

2.1 Physical Activity

Physical activity can be defined as the movement of the skeletal muscles that expends energy above the resting metabolic rate and is characterised by frequency, intensity and duration of movement [34]. Physical activity can be performed in a variety of contexts, including leisure, occupation, transportation, sports, household, and others. Exercise is a sub-category of physical activity performed with the intention of sustaining or improving health and physical fitness [35]. Physical inactivity is characterised by the failure to meet physical activity guidelines [35]. Distinct from physical inactivity, sedentary behaviour represents activity that does not increase energy expenditure above the body's resting rate and is usually performed in a sitting or lying down position [36].

2.1.1 Domains of Activity

Physical activity research has predominantly focused on leisure-time physical activity, occupational physical activity, or active transportation. Leisure-time physical activity can be defined as activity performed in one's disposable time away from work based on personal preferences and needs such as recreational sports or exercise [37]. Leisure-time physical activity has been associated with a wide range of positive physical and psychological health outcomes such as improved general mental health, and reduced risk of chronic disease and overall mortality [38]. An inverse dose-response between long-term leisure-time physical activity and all-cause and cardiovascular disease mortality has been established [39].

Occupational physical activity is defined as activity related to one's employment such as manual labour or sitting office work [40]. Unlike leisure-time physical activity, occupational physical activity does not provide adequate intensity, frequency, or volume to confer positive health benefits [41]. Rather, occupational physical activity has been linked to increased risk for all-cause

mortality, injuries, and carcinomas. A study on the association between occupational physical activity and mortality showed that high occupational physical activity was related to twice-fold risk for all-cause mortality among male workers [42]. In addition, elevated blood pressure from heavy lifting and manual labour, occurring for extended periods of time, is associated to an increased risk for cardiovascular disease and atherosclerosis [43]. Occupational physical activity has been associated to those of low socioeconomic backgrounds, whereas leisure-time physical activity is more so adopted by those of high socioeconomic status [43,44].

Active transportation or commuting physical activity refers to any form of human-powered non-motorized means of transportation, including walking and cycling [45]. Active transportation has been considered a feasible way to increase exercise uptake and has been associated with improvements in obesity and cardiometabolic risk factors among adults [46]. A study on the relationship between active transportation and health found that, although minutes of bicycling and walking for transportation were associated with improvements for some health outcomes such as weight control and cholesterol, active transportation did not have a significant effect on other health measures such as systolic blood pressure and long-term control of diabetes [47]. In contrast, a systematic review investigating the health benefits of active travel found only small improvements in health outcomes from active transport intervention studies, and limited evidence to support the effectiveness of active transport in obesity management. The current scope on the effectiveness of active transportation in improving health outcomes is not well-established [48].

2.1.2 Physical Activity Guidelines

Physical activity occurs at different intensities and can be classified as light, moderate or vigorous/ strenuous. Current physical activity guidelines outlined by the World Health Organization (WHO) recommend at least 150 to 300 minutes of moderate-intensity aerobic physical activity, or at least 75 to 150 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity throughout the week [49]. In addition, the WHO recommends muscle-strengthening activities at a moderate-intensity or higher two or more days of the week to reap additional health benefits. Canada's 24-hour Movement Guidelines for adults and seniors also recommend moderate to vigorous aerobic physical of at least 150 minutes per week as well as muscle strengthening activities using major

muscle groups at least twice a week [50]. Moderate-intensity activities are performed at an absolute intensity of 4 to 6 metabolic equivalents (METs), whereas vigorous-intensity activities are performed at an energy expenditure over 6 METs.

Evidence suggests that activities at a higher intensity confer higher overall health benefits. In a study on the relationship between physical activity intensity and symptoms of depression, researchers found that the incidence of depressive symptoms was lower among individuals who participated in regular intensive activity [51]. Bouts of vigorous-intensity exercise have been associated with increased metabolic rate, resulting in significantly higher postexercise energy expenditure and higher heart rate variability, which are important factors for weight management, cardiovascular health, and reduced risk of coronary heart disease [52–54]. Compared to activities of lower intensity, vigorous-intensity physical activity was associated with reductions in all-cause mortality [55]. In a study comparing the effects of moderate-intensity and vigorous-intensity physical activity on mortality, researchers reported comparable health benefits between moderate- and vigorous-intensity activity when respective physical activity guidelines were met [56]. A systematic review on the relationship between the quantity of moderate-vigorous physical activity and mortality found that risk of all-cause mortality was reduced by 22% for older adults who were active, even if they fell short of meeting guidelines, and risk reduction increased in a linear fashion with increases in physical activity levels.

2.1.3 Physical Activity and Chronic Disease Prevention

Lifestyle interventions such as changes in diet and physical activity participation are key strategies for weight management [57]. As chronic disease develops over the course of years or decades, physical inactivity is a modifiable risk factor for the prevention and treatment of disease. Regular physical activity has favourable effects on cardiovascular health, bone health, metabolic syndrome and insulin sensitivity, and some forms of cancer [5]. Physical activity increases total caloric expenditure, reducing waist circumference and risk of abdominal obesity [58]. Furthermore, muscle-strengthening exercises promote lean muscle mass development which, in turn, increases the resting metabolic rate and allows for sustained weight management [59].

Participation in physical activity has been associated with reduced risk of individual chronic disease as well as multimorbidity. Individuals with multiple chronic diseases or multimorbidity

are some of the most difficult-to-treat patients in healthcare settings and are at an increased risk of adverse health outcomes [15,60]. The risk of multimorbidity is associated with low levels of physical activity [61]. Compared to those without a history of chronic disease, a higher prevalence of inactivity was found among individuals with multimorbidity, independent of sociodemographic characteristics and other lifestyle behaviours. Men with multimorbidity were less active than women [61]. In a longitudinal study from the United Kingdom on the association between physical activity and multimorbidity among older adults, researchers reported an inverse dose-response relationship between level of activity and multimorbidity such that the risk of multimorbidity was reduced by half in the vigorous-intensity physical activity group compared to the inactive group [62,63]. Muscle-strengthening activities reduce the odds of multimorbidity by 26% [63].

Research has shown that hypertension, a major cardiovascular risk factor, can be managed and prevented with moderate levels of exercise. A systematic review on the impact of physical activity on mortality among patients with hypertension reported that physical activity engagement at any intensity-level reduces the risk of cardiovascular mortality between 16% to 27% [64]. In addition, regular engagement in physical activity can independently lower blood pressure, reducing the risk of stroke and coronary artery disease among others [65,66].

Furthermore, research has found waist circumference to be a good predictor of adverse health outcomes, including all-cause, cardiovascular, cancer, and respiratory disease mortality [67]. As such, those that are overweight or obese with increased central adiposity have higher likelihood of serious chronic disease such as cardiovascular disease, diabetes, cancers, reduced quality of life and mortality [68].

Insufficient physical activity and sedentary behaviour results in weight gain and when left unaddressed, may result in obesity [69]. Excessive weight gain occurs when the body's energy intake is greater than its expenditure, and is influenced by genetics, socioeconomic status, lifestyle, and the built environment [70]. Being overweight is characterised by a body mass index (BMI) between 25 and 29.9kg/m^2, where obesity is characterised by a BMI greater or equal to 30kg/m^2 [71]. In 2016, one in four Canadian adults were obese [72]. Within the past four decades, there has been a significant increase in abdominal obesity with the prevalence of obesity

increasing by 455% [72]. Waist circumference naturally increases with age due to age-related declines in muscle mass and accumulation of fat as well as redistribution of adipose tissue from subcutaneous to visceral deposits [73,74]. In a study investigating health outcomes between metabolically healthy and unhealthy weight statuses, researchers found that individuals with metabolically unhealthy normal-weight profiles demonstrated high abdominal-visceral obesity, low leg-fat adiposity and low cardiorespiratory fitness similar to metabolically unhealthy overweight profiles [75]. This finding emphasizes that body fat distribution is an important measure when evaluating an individual's risk of negative health outcomes such as cardiometabolic disease.

2.2 Correlates of Physical Activity

2.2.1 Sociodemographic

Age

An inverse association between age and physical activity levels exists such that physical activity levels often decline with age. From the Healthy Aging report released by Health Canada, data shows that inactivity levels increase from 59%, for adults between 55 to 64 years old, to 74% for seniors aged over 74 [76]. Only 14% of seniors were reaching adequate levels of physical activity [76].

Gender/ Sex

It is well established that physical activity levels are higher among men compared to women. Evidence suggests that lower activity levels among women can be attributed to poor personal and environmental conditions such as family responsibility and access to places to exercise [77,78]. In addition, men were reported to engage in higher levels of overall physical activity and moderate- to vigorous-intensity leisure-time physical activity, whereas women were reported to engage in higher household activity and light-intensity activity [25,79].

Race

In Canada, those identifying as a visible minority are more likely to be inactive compared to Whites [13,22,23,80,81]. A study investigating variation in physical activity preference among ethnic minority and immigrant groups found that they were more likely to report no physical activity and less likely to engage in endurance, recreation, and sport activities compared to Whites [82]. The influence of race on health and physical activity can be attributed to its connection to socioeconomic status which drives inequities in housing, income and education, and consequently, is linked to limited economic opportunities to engage in leisure-time physical activity [83].

Education

Educational attainment has been positively linked to physical activity engagement among adults such that those with higher levels of education are more likely to be physically active. In a large population-based study conducted in the United States, researchers reported the highest prevalence of individuals meeting physical activity guides of 150 minutes among the most educated adults [84]. This study also reported that the highest-educated groups favoured active transportation whereas the lowest-educated groups were the most active in occupation-related activities [84]. The literature has documented significant associations between education and physical activity such that higher educational attainment was linked to higher levels of self-reported moderate- and vigorous-intensity activity as well as regular exercise engagement [85–87].

Income and Wealth

The literature indicates a positive association between economic resources, such as income and wealth, and physical activity. Studies have reported that higher income individuals are more likely to report higher levels of physical activity and, in turn, meet physical activity guidelines [88,89]. Evidence suggests that higher incomes provide more opportunities for physical activity as well as reduced barriers such as infrastructure and cost [90]. In a systematic review examining changes in physical activity into retirement, authors reported that those of high socioeconomic status demonstrated an increase in physical activity after retirement, whereas physical activity levels declined among those of low socioeconomic status [91].

A study investigating changes in physical activity levels in respect to changes in wealth among older adults in the United States found that the decline in physical activity with old age is exacerbated by a lack of wealth, whereas the opposite was true among individuals with high wealth [92]. The effect of wealth on physical activity participation in old age can be explained by the increased available financial resources to support leisure-time activities.

Employment

Physical activity participation has been found to vary by employment status. Being employed has been positively associated with physical activity compared to those that do not have full-time employment [93,94]. Those employed accumulate additional physical activity from their commute as well as from occupation [95]. Furthermore, being employed has been associated with higher minutes of moderate and vigorous activity compared to those that are not employed [96].

Social Capital

Indicators of social capital including social support, social participants and higher network diversity are found to have a positive association with physical activity participation among middle-aged to older adults. High levels of trust in social groups, and the quality and amount of resources from social networks have been linked to higher levels of physical activity and lower levels of inactivity [97,98]. A potential explanation for the relationship between social capital and physical activity can be attributed to the increase in the availability of resources through one's social connections that one may not otherwise have [99].

Place of Residence

Geographical differences have been associated with levels of physical activity. In a study on the urban and rural variations in physical activity across the United States, researchers found a higher proportion of individuals meeting physical activity guidelines among urban residents and higher levels of no leisure-time activity in rural regions [100]. In Canada, researchers have found that rural seniors are more likely to report higher levels of total physical activity and minutes per day of activity compared to urban seniors [22,101]. Despite higher levels of activity, rural residents report facing more barriers to accessing low-cost facilities as well as limited opportunities to be active [100]. Evidence suggests that correlates of physical activity differ between rural and urban

areas, and can be linked to differences in sociodemographic factors such as educational attainment and income levels between the two populations [102,103].

Marital Status

Studies investigating the association between marital status and physical activity participation produced mixed findings. Some studies reported higher levels of activity among those that were single compared to those that were married or living with a partner, whereas other studies reported lower levels of physical activity among those that were single [104–109]. In a study that evaluated the effects of marital transition on changes in physical activity participation, researchers found that the transition from single to married had a positive effect on physical activity, whereas the transition from married to single state did not have any significant effect [110].

Sexual Orientation

Conflicting evidence exists on the role of sexual orientation and physical activity participation [111,112]. In a population-based study on sexual identity and leisure-time physical activity among adults in Sweden, researchers reported lower prevalence of physical activity among bisexual men and women when compared to their heterosexual counterparts [113]. Another study investigating sexual orientation disparities in physical activity reported that sexual minority women engaged in physical activity more frequently and at a higher intensity than heterosexual women, whereas sexual minority men engaged in more frequent physical activity at lower intensity levels compared to heterosexual men [114]. One study reported that homosexual and bisexual women engaged in higher levels of physical activity compared to their heterosexual counterparts [22].

Immigration Status

Immigration status and time since migration are correlated with physical activity. A large nationally representative study on leisure-time physical activity levels among the immigrant population in Canada reported higher likelihoods of inactivity among recent immigrants and even more so among immigrants of visible minorities [23]. A potential explanation for the low levels of activity among immigrants can be linked to barriers such as availability of resources and lack of peer support to facilitate participation in leisure-time activity [115]. Specifically, new

immigrants are often of lower socioeconomic status and face competing time demands, with little opportunities to participate in leisure-time activities [116].

2.2.2 Lifestyle Behaviors

Smoking

Negative health behaviours, such as smoking, have been inversely related to physical activity. In a cross-sectional study on smoking and physical inactivity among healthy middle-aged adults, researchers reported five times higher odds of insufficient physical activity among smokers compared to non-smokers [117]. In a study exploring physical activity in relation to smoking status among middle-aged Norwegian adults, researchers found that current smokers performed lower levels of strenuous leisure-time physical activity compared to non-smokers [118].

Alcohol Use

When examining the clustering of lifestyle risk factors in the English adult population, there was a positive association between alcohol consumption and overall physical activity [116]. A potential explanation for the positive association can be attributed to the definition of overall physical activity, which included occupational activity and those with manual occupations are more likely to engage in excessive alcohol consumption [119].

Fruit and Vegetable Consumption

Health promotion behaviours such as meeting public health guidelines for fruit and vegetable intake and physical activity often occur in combination [120]. High fruit and vegetable consumption was associated with higher levels of regular physical activity participation among the aging population in the Netherlands [121]. Furthermore, older adults with high vegetable intake as well as both fruit and vegetable consumption were more likely to perform moderate to vigorous leisure-time activity [122].

Sleep Quality

A bidirectional relationship between sleep quality and physical activity has been established in the literature [123,124]. Results from a longitudinal examination of sleep quality and physical

activity found that better sleep quality predicted higher levels of physical activity among community dwelling adults[125]. Specifically, researchers have found that an increased 30 minutes to sleep onset was associated with fewer minutes of exercise the next day [126]. In a systematic review on the interrelationship between sleep and exercise, researchers reported improved sleep efficiency and duration among middle-aged to older adults in intervention studies independent of the type and intensity of exercise where those with chronic disease benefited the most [127]. Further research has also reported a positive association between sleep efficiency and minutes of moderate- to vigorous-intensity activity performed the subsequent day, supporting the evidence that sleep quality is a strong predictor of next-day physical activity [128].

2.2.3 Chronic Conditions and Other Health-Related Risk Factors

Waist Circumference and BMI

Waist circumference and BMI are accurate measures of body fat distribution and weight status, respectively, which are correlated to physical activity. In a study investigating the association between leisure-time physical activity and several health outcomes, researchers correlated low leisure-time physical activity to higher BMI, body fat percentage and waist circumference [129]. In a study examining weight-related barriers to physical activity found that participants who felt "too fat to exercise" experienced feelings of embarrassment or shyness that deterred them from participating in physical activity [130]. Further research reported that being overweight was associated with lower odds of leisure-time physical activity among women and being obese was associated with lower levels of leisure-time physical activity for both men and women [131]. In addition, most overweight men and women failed to recognize their weight as harmful to their health, with this perception being more common among men than women such that men were less likely to participate in weight control behaviours [132]. It is hypothesized that as overweight individuals did not perceive their weight as harmful to their health, they were subsequently less likely to recognize the benefits and need to participate in physical activity [131].

Research has shown that obesity plays a role in the relationship between socioeconomic status and physical activity at the individual and environmental level. Individuals of lower income face more barriers to acquiring healthy foods, such as fruit and vegetables, and resort to more affordable diets consisting of high-fat energy-dense diets and processed foods, which contribute

to the development and maintenance of obesity [133]. Overweight individuals of low socioeconomic background are less likely to perceive their weight as problematic compared to overweight individuals of high socioeconomic status [134]. In a study exploring the socioeconomic gradient in obesity, researchers found that individuals of higher socioeconomic status demonstrated more weight concern and were more likely to monitor their weight compared to individuals of low socioeconomic status [135]. Furthermore, there is a strong link between low socioeconomic status and obesogenic environments such that access to fast-food restaurants and processed foods is more readily available, but access to recreational facilities and parks is lacking [136–138]. In a systematic review of neighbourhood socioeconomic status and obesity, researchers reported the odds of obesity to be almost 50% higher in low socioeconomic neighbourhoods compared to high[139].

High Blood Pressure

High blood pressure is related to physical activity participation. Individuals with high blood pressure are recommended to avoid strenuous activities such as sprinting, which can increase the risk for sudden cardiac arrest among individuals with underlying heart conditions or history of hypertension [140–142]. This relationship is likely bidirectional as obesity is associated with hypertension [64].

Depression

The literature supports a bidirectional relationship between depression and physical activity. A systematic review on the longitudinal effects of depression on physical activity found that depression is a significant risk factor for decreased levels of activity and increased sedentary behaviour [143]. Additional studies have reported a decline in physical activity in response to worsening depression over time [144,145]. A potential explanation for the association between depression and subsequent decline in physical activity can be linked to the lack of motivation and energy to complete everyday tasks and lack of enjoyment of exercise among those with poor mental health [145].

Multimorbidity

Multimorbidity, defined by the co-occurrence of more than one chronic condition, has been repeatedly reported in the literature [146]. In a study on the barriers to accessing exercise interventions among adults with chronic disease, over one third of respondents indicated that the physical symptoms of disease were one of the primary factors that led to non-adherence to exercise prescription programs [147]. The functional limitations and physical disability that accompanies chronic disease is a major deterrent to physical activity adoption among older adults [148].

Life Satisfaction

A positive association between life satisfaction and physical activity exists among middle-aged to older adults [149]. The relationship between life satisfaction and physical activity is bidirectional such that higher engagement in physical activity is associated with higher life satisfaction, and in turn, higher life satisfaction is linked to the adoption of healthy lifestyle behaviours such as frequent physical activity [150,151].

Self-Rated Health

Self-perceived health is positively correlated with physical activity engagement. Specifically, a bidirectional association was found between high self-rated health and levels of moderate to vigorous physical activity such that the odds of good self-rated health were highest among the moderate/vigorous physically active participants [152]. In a study on the relationship between self-rated health and health behaviours among older middle-aged to older adults, researchers reported a significant association with poor self-rated health and no participation in moderate- or vigorous-intensity activity [153].

2.3 Social Determinants of Health and Physical Activity

Previous research has established that the social determinants of health have a strong influence on an individual's chance of good health. The social gradient of health can be characterised by the inequalities in population health status related to inequities in social status such that health status is directly related to social status [154].Those who are more socially advantaged (e.g., reside

in more affluent neighbourhoods, have higher income and/or higher level of education) may be more likely to engage in regular physical activity and consequently, less likely to be linked to poor health outcomes associated with inadequate physical activity [20]. An individual's social environment often contributes substantially to creating and perpetuating health inequities, exacerbating health-related disparities in good health.

Given that many of the sociodemographic correlates align the with social determinants of health framework, a search of the literature was conducted to understand the relationship between the social determinants of health and physical activity participation among middle-aged to older adults in Canada and the United States.

2.3.1 Search Strategy

We searched for studies that explored the relationship between the social determinants of health and physical activity among middle-aged to older adults in Canada and the United States. A limited search of MEDLINE and CINAHL was conducted to identify relevant keywords and subject headings. Searches were carried out on four English language electronic databases between June 15th (MEDLINE, EMBASE, Scopus) to June 17th (CINAHL), 2021. The search was restricted to studies published since 2010 with the intention to provide a current picture of the social context in which middle-aged to older adults engage in physical activity. No limits were applied based on language or publication status. Full texts of eligible studies were found, and a manual search of their reference lists were hand-searched for additional studies. All potentially relevant articles were uploaded to Covidence systematic review management system where duplicates were removed. Two reviewers independently extracted all relevant information from the included articles, and a third reviewer resolved any discrepancies.

2.3.2 Study Population and Design

Eighty-four articles (Canada n=15; United States n=69) exploring the association between the social determinants of health and physical activity participation were identified. Of the included studies, seventy-nine articles were cross-sectional studies, and five articles were prospective cohort designs. The sample sizes ranged from 50 [155] to 1,537,798 [156]. Thirty-two articles captured physical activity using physical activity guidelines, eighteen articles investigated physical activity volume (i.e., minutes, MET-hrs, steps), thirteen articles looked at physical inactivity,

nine studies looked at being physically active, twelve studies created their own unique categories of physical activity.

2.3.3 Operationalizing the Social Determinants of Health

Due to the conflicting conceptual models of the social determinants of health, the socioecological model best aligned with the identifying the most relevant correlates of activity for the aging population. This conceptual framework was developed to understand the interplay between personal and environmental factors such as individual, social environment, physical environment, and public policies that shape human behaviour [157]. Although other models such as the Health Belief Model [158] and Stages of Change Model [159] have been applied to increase the adoption of physical activity, these models only address factors at the individual level such as intrinsic motivation and personal beliefs. The socioecological model provides researchers with an understanding of the multi-dimensional contextual factors of behaviour as well as opportunities to promote physical activity at the population level [160,161].

This review aims to investigate the impact of social determinants of health on physical activity in North America, specifically Canada and the United States. The Public Health Agency of Canada lists 12 social determinants of health: income and social status, social support networks, education and literacy, employment/ working conditions, social environments, physical environments, personal health practices and coping skills, healthy child development, biology and genetic endowment, health services, gender and culture[162]. These determinants align with the Healthy People 2020 framework, created by the U.S. The Department of Health and Human Services, which organizes the key components of social determinants of health into five categories: economic stability, education, social and community context, health and healthcare, and neighbourhood and built environment [163]. As a means of harmonizing these indicators to select our variables and guide our systematic review, we employed the PROGRESS framework originally proposed by O'Neil and colleagues[164] and further developed by the Campbell and Cochrane Equity Methods Group [165]. The acronym PROGRESS refers to Place of residence, Race/ethnicity, Occupation, Gender/ sex, Religion, Education, Social capital, Socioeconomic status. This framework conceptualizes the factors contributing to social inequality by considering the intersecting determinants of health when assessing intervention programmes. As no relevant articles on the association between religion and

physical activity engagement among older adults in Canada or the United States were identified in our search, religion was not included as a relevant social determinant of health in this review. It is important to note that the literature review explored both gender and sex based on selected framework, whereas only sex will be investigated in the thesis objectives.

2.3.4 The Association between the Social Determinants of Health and Physical Activity

Gender/ Sex

All Canadian studies explored the association between sex and physical activity guidelines. Nine Canadian studies found evidence suggesting lower levels of physical activity among females[22–25,80,166–169]. Three studies explored the association between gender and physical activity from the Canadian Community Health Survey, a large population-based cross-sectional study [22,23,80]. Abichahine and colleagues reported lower odds of leisure-based physical activity for females than males, with heterosexual visible minority females being the least active [22]. Females were found to have higher odds of physical inactivity and lower activity when compared to males [23,25,80,168]. This held for cardiac rehabilitation settings as well[166,169]. [2077,165165163]. In a population of older adults living on low income in Vancouver, Canada, females were found to engage in more minutes of light physical activity, but fewer minutes of moderate to vigorous physical activity compared to males [167]. Similar findings were found across all studies in the United States [32,79,104–106,108,109,156,170–198].

Race

Four Canadian studies observed significant relationships between race and physical activity participation among middle-aged to older adults [22,23,80,199]. Across all studies, race was dichotomized as “visible minority” and “White”. Three studies reported significant correlations between being a visible minority and higher odds of inactivity even when stratified by gender and immigrant status [22,23,80]. In a study comparing lifetime physical activity in postmenopausal Caucasian and Chinese-Canadian women, Tam and colleagues reported lower total household and recreational physical activity among Chinese women in all age-groups [199]. However, Chinese-Canadian women did accumulate significantly higher total lifetime occupational physical activity than Caucasian women.

Studies investigating race and physical activity in the United States made different racial comparisons than Canadian studies. Twenty-one studies reported significant differences in physical activity between Blacks and non-Hispanic Whites [106,108,109,156,170,171,173,175,180,182,185,188,191,193,200–206]. Lower levels of physical activity were reported for Hispanics [106,109,156,170,173,182,185,188,190,202,204,206–208], Asian Americans [106,109,201,207,209], Asian Pacific Islanders [156,210], and American Indians/ Alaska Natives [185,211] compared to non-Hispanic Whites. However, a handful of studies reported higher levels of physical activity among Blacks, multiracial groups and those that identified as 'other' compared to Whites [106,171,190,212].

Education

Eight of ten Canadian studies reported significant positive associations between educational attainment and physical activity [22–24,80,168,213–215]. Two studies found the odds of physical inactivity to be significantly higher for those with no degree or a college degree compared to those with a university degree [22,168]. In addition, lower odds of physical inactivity were reported with each increase in level of educational attainment [23,80,214]. In addition, higher odds of being physical active through different physical activity measures such as Active living scores, minutes of exercise and overall activity were associated with higher educational attainment [23,24,213,215]. All 24 studies that explored education and physical activity in the United States reported significantly higher levels of physical activity among middle-aged to older adults with higher levels of education [105,106,108,109,170,171,173–176,181,185,186,190,191,193,195,200,202,203,207,216–218].

Socioeconomic Status

Three studies assessed the association between income and physical activity [22–24], and one study assessed both income and social status [25]. Studies in both Canada and the United States investigated income in respect to socioeconomic status, however studies in the United States also focused on wealth and poverty risk. All three Canadian studies investigating the association between income and physical activity found that those with higher incomes were more active, and the odds of inactivity increased as household income decreased [22–24]. In addition, Murray and colleagues also reported significant positive associations between income and exercise behaviour as well as with social status, such that where individuals perceived their place on the social ladder was correlated to minutes of exercise [25].

Studies on socioeconomic status and physical activity in the United States were more prevalent. In total, 27 studies were identified and 20 studies reported significant findings [32,79,105–107,109,170,171,173,185,188,190,191,200,202,203,218–221]. Twelve studies found that lower levels of income were associated with lower levels of physical activity [79,105,106,109,170,171,173,185,190,202,219,220]. Three studies investigated the association between wealth and physical activity and reported higher levels of physical activity among those with higher wealth [32,218,221]. In addition, five studies reported a negative association between poverty status, using measures of poverty risk such as the poverty income ratio, and reported an inverse association between physical activity and household poverty level [107,188,191,200,203].

Social Capital

Four Canadian studies reported significant associations between social capital and physical activity [80,168,214,222]. In a study investigating the social environmental correlates of leisure-time physical activity with meeting cancer prevention guidelines, Aparicio-Ting and colleagues found that social support from friends and family had significant correlations with meeting physical activity guidelines in both men and women [222]. Azagba and colleagues reported a significant association with strong social interaction, respondents with a very strong or somewhat strong sense of belonging to community, and lower odds of physical inactivity [80]. Similarly, Legh-Jones and colleagues found that those with higher social participation, defined as involvement in both a neighbourhood and other voluntary association, had lower odds of physical inactivity compared to those with lower social capital [168]. The same was true for those with higher network diversity; individuals with a higher number of ties to others working in specific types of occupations were more likely to be physically active. Moore and colleagues reported a significant negative association between social isolation and physical activity [214]. Those that had not discussed important matters with anyone within the last 6 months were more likely to be physically inactive. Moore and colleagues also reported a significant positive association between high participation, being members or officials of any community or other voluntary associations over the past year, and reduced likelihood of physical inactivity [214].

Ten American studies investigated community level social factors and likelihood of physical activity and reported significant positive association between social support and physical activity

[108,155,188,191,208,223–227]. Indicators included social network size, social engagement, family social support, social cohesion, social integration, and number of non-spouse workout partners. In addition, six studies also included marital status as an indicator of social capital [104–109]. Of those, four studies reported higher levels of physical activity among those that were single compared to those that were married or living with a partner [104–107], whereas two studies reported lower levels of physical activity among those that were single [108,109].

Place of Residence

Two Canadian studies reported significant associations between place of residence and physical activity [24,101]. In a study on the rural-urban disparities in total physical activity in Atlantic Canada, Forbes and colleagues found that rural residents were more likely to report higher levels of total physical activity, in the top tertile of activity, compared to their urban counterpart [101]. Spinney and colleagues also found that rural residents had significantly higher rates of activity and minutes per day of aerobic activity for rural seniors compared to urban seniors [24].

Four American studies reported significant differences in physical activity participation between urban and rural residents [106,200,220,228] and two studies compared regional differences in physical activity [202,203]. In contrast to the Canadian studies, four studies reported lower odds of being physically active for rural residents compared to urban residents [106,200,220,228]. When compared to suburban seniors, rural residents had higher levels of inactivity [106].

Occupation

No significant findings were found among Canadian studies investigating the relationship between employment and physical activity. Specifically, no significant associations were identified between work status (retired/ other) to either self-reported or objectively measured moderate-vigorous activity [169].

More studies exploring the association between occupation and physical activity were identified from the United States. Six studies reported a significant association between physical activity and work status [170,171,178,188,210,219]. Those employed, unemployed, homemakers [170,171], retired, and unable to work [170] reported significantly lower levels of physical activity compared to students. Three studies reported significantly higher levels of physical activity among the

employed [178,188,219] when compared to those unemployed, whereas one study reported less physical activity [210].

2.3.5 Gaps in the Literature

Although the onset and development of chronic disease can be mitigated through behavioural risk factors and the social determinants of health, epidemiological evidence on the socioeconomic patterning of physical activity in later life of Canadians is sparse. Only ten Canadian studies have investigated the association between education and physical activity, and eight studies on income and physical activity. However, from the eight studies identified in the literature search, only half reported a significant association between income and physical activity. Although income is a common indicator of socioeconomic status, there is a shift among researchers to favour the use of wealth. As income is strongly correlated to employment, wealth better represents the financial resources available to middle-aged to older adults and in a sample where many participants are retired from the workforce. With that, there has been no Canadian study to date to the best of our knowledge that has operationalized wealth as a socioeconomic indicator in the context of meeting physical activity guidelines. It remains unclear to what extent socioeconomic status, specifically education and wealth, is associated with physical activity behavior among middle-aged to older adults in Canada.

2.4 Importance of Socioeconomic Status

Given the strong relationship between physical activity and health, there is a need to identify how physical activity participation differs across socioeconomic strata and examine changes in physical activity over time in respect to the social determinants of health to increase its uptake. As such, cross-sectional analyses using observational data from large population-based studies is needed to determine if patterns of physical activity among middle-aged to older adults in Canada follow a similar social gradient as previously reported in international studies. While this is our primary aim, it is important to account for other predictors in this population, including lifestyle behaviours, physiological risk factors as well as physical and mental health [5,8,229]. The proposed study offers valuable evidence on the socioeconomic barriers of physical activity required for developing and implementing well-founded intervention strategies relevant to the aging Canadian population.

2.5 Thesis Objectives

The aim of this thesis is to examine the relationship between socioeconomic status and physical activity among middle-aged to older adults in Canada. Furthermore, the effect of education and wealth may differ between weight groups and in turn, opportunities to be physically active. Therefore, the objectives of this research are:

1. to examine the association between socioeconomic status, operationalized using educational attainment and wealth, and meeting physical activity guidelines, and to identify whether sex and age differences exist in this association.

2. to explore whether weight status modifies the relationship between socioeconomic status and meeting physical activity guidelines while adjusting for other demographic characteristics, lifestyle behaviours, chronic conditions, and other health-related risk factors.

Chapter 3

3 Methods

This chapter provides a description of the data source (Section 3.1), the inclusion and exclusion criteria of the analytic sample (Section 3.2), the independent and outcome variables included in the analysis and how each variable was operationalized (Section 3.3), handling of missing data (Section 3.4) and the statistical analyses performed (Section 3.5).

3.1 Data Source

Cross-sectional data from the Canadian Longitudinal Study on Aging (CLSA) were used to examine the association between socioeconomic status and physical activity among middle-aged to older adults in Canada. The CLSA is a national longitudinal study of 51,338 randomly stratified Canadians between the ages of 45 to 85 years old at time of recruitment [230]. The objective of the CLSA is to examine the complex inter-play of intrinsic and extrinsic factors to understand their impact in maintaining health in the progression of disease from mid-life to older age in the Canadian population [231]. The CLSA excludes those living on reserves/aboriginal settlements, full time members of the Canadian Armed Forces, the institutionalized population and people living in the Northwest Territories, Yukon, and Nunavut. Participants in the CLSA were recruited from a subset of participants in the Statistics Canada's Canadian Community Health Survey - Healthy Aging, registries of provincial health care systems, or using Random Digit Dialing (RDD) of landline telephones[230]. Efforts were made to oversample individuals of lower socioeconomic status and educational attainment, identified using census data, to avoid under-representation of this group in the CLSA.

The CLSA sample consists of two cohorts: the Comprehensive cohort (N= 30,097) and the Tracking cohort (N= 21,241). Data from the Comprehensive cohort was collected through in-person home interviews and data collection site visits, whereas data from the Tracking cohort was collected through phone interviews. Respondents were required to complete the questionnaire in English or French, and have the cognitive and physical capacity to complete the interview on their own [230]. Participants in the Comprehensive cohort were randomly selected within a 25 to 50km radius of the data collection sites, located in seven provinces, and provided

physical measurements and, optionally, biological specimens such as blood and urine. Follow-up data is collected every three years from baseline until 2033 or death [230]. Only data from the baseline Comprehensive cohort, collected between May 2012 and May 2015, was used for analysis. Data access and ethics approval was obtained from the CLSA (Application Number: 2104057) and the Western University Health Science Research Ethics Board (Project Number: 120016), respectively.

3.2 Inclusion and Exclusion Criteria

For the purpose of the study, only respondents with complete responses for the selected socioeconomic indicators and physical activity were included. Specifically, participants with missing or invalid responses for the Physical Activity Scale for the Elderly (PASE) questionnaire [232], level of education and total value of savings and investments were excluded from the analysis.

3.3 Variables

3.3.1 Outcome Variable

Meeting Physical Activity Guidelines

The PASE questionnaire was used to measure levels of physical activity and is a validated epidemiological instrument to measure physical activity levels in individuals 65 years and older. Respondents were asked to report the number of days per week and the number of hours per day they engaged in the following activities within the previous seven days: walking outside; light, moderate, and strenuous sports or recreational activities; exercises to increase muscle strength or endurance; light and heavy housework or chores; home repairs, lawn, or yard maintenance; outdoor gardening; work or volunteer-related physical activity; and physical activity related to caring for other people. Frequency was reported as “never”, “seldom (1 to 2 days)”, “sometimes (3 to 4 days)”, or “often (5 to 7 days)”. Average hours per day was reported as “less than 30 minutes”, “30 minutes but less than 1 hour”, “1 hour but less than 2 hours”, “2 hours but less than 4 hours”, or “4 hours or more”. The mid-point value for the frequency and average hours per day were selected for coding, and those who indicated “4 hours or more” per day were coded as engaging in 5 hours of the activity.

Only PASE items relevant to meeting physical activity guidelines (moderate sport/ recreational activities, strenuous sport/ recreational activities) were selected to determine adequate physical activity (≥150 minutes per week of moderate-intensity physical activity, ≥75 minutes per week of vigorous-intensity) or low physical activity. As it was not possible to distinguish whether an individual met the muscle-strengthening guidelines of two or more days a week or not, due to how respondents reported frequency of activity, only aerobic activities were selected to deem whether a respondent met guidelines. The proportion of respondents meeting physical activity guidelines was calculated among males and females and by age category.

3.3.2 Exposure Variables

Level of Education

Respondents reported his/ her highest level of education as "less than secondary school graduation", "secondary school graduation, no post-secondary education", "some post-secondary education", or "post-secondary degree/diploma". The education variable was dichotomized into "less than post-secondary" and "post-secondary degree/diploma" similar to the operationalization of other Canadian studies on education and physical activity [22–24,80,168,213–215].

Total Amount of Savings and Investments

Wealth was captured by asking respondents, "Which, if any, of the following savings and investments do you (and your spouse/partner) have"? Respondents were prompted to reflect on the total value of savings and investments in the bank account, Registered Retirement Savings Plan (RRSP), and financial investments outside of RRSPs. Responses were classified into one of four categories: "less than $50,000", "$50,000 to less than $100,000", "$100,000 to less than $1 million", or "$1 million or more".

3.3.3 Covariates

3.3.3.1 Demographic Variables

Age

All analyses were stratified by age group to account for age-differences in physical activity engagement. Age was captured by asking respondents to indicate their current age in years. Age was operationalized as a continuous variable for descriptive analyses and as a categorical variable for stratification in the statistical analyses. The following age-groups were established: "45-54 years", "55-64 years", "65-74 years" and "75-85 years".

Sex

All analyses were stratified by sex, male and female, to account for sex-differences in physical activity participation. Sex was captured by asking respondents, "Are you male or female"?

Racial Background

Race was included in the model as those identifying as White were found to be more active compared to visible minority groups. Respondents were asked, "People living in Canada come from many different cultural and racial backgrounds. Are you…"? Possible selections were White only, Black only, Korean only, Filipino only, Japanese only, Chinese only, South Asian only, Southeast Asian only, Arab only, West Asian only, Latin American only, Other racial or cultural origin (only), or Multiple racial or cultural origins. Race was dichotomized as "White" and "Other", consistent with the operationalization of race in similar Canadian studies on physical activity [22,23,80,199].

Immigrant Status

Immigration status was included in the model because immigrants were found to be less active compared to their non-immigrant counterparts [23]. In the CLSA, the questionnaire included an immigrant flag to categorize respondents as "immigrant" or "not an immigrant".

Marital Status

Marital status was included in the model because being married has been associated with higher levels of physical activity [233]. Specifically, those that are married may have higher social capital as well as increased financial resources to participate in physical activity. Marital status was captured by asking participants "What is your current marital/ partner status?". Response categories include "single, never married or never lived with a partner", "married/living with a partner in a common-law relationship", "widowed", "divorced", or "separated". For the purposes of the analyses, marital status was categorized into the following three classifications: "single, never married or never lived with a partner", "married/ living with a partner in a common-law relationship", and "widowed, divorced, or separated" similar to the operationalization of marital status in other CLSA studies [234].

Place of Residence

Place of residence was described using the provided rural/ urban classification. Urban-rural status was included in the model to account for differences in available resources due to differing population densities that may infringe one's ability to participate in physical activity. The CLSA derived the classification based on Statistics Canada's Postal Code Conversion File to link the six-character postal code to an urban population center or rural area [235,236]. Participants were classified into the following: "rural", "urban core", "urban fringe", "urban population centre outside CMA and CA", "secondary core", or "postal code link to dissemination area". For the analyses, the variable was recoded into "rural" and "urban" (urban core/ urban fringe/ urban population centre outside CMA and CA/ secondary core/ postal code link to dissemination area). Respondents whose postal code was linked to dissemination area were included in the urban classification as per CLSA recommendations [235].

Sexual Orientation

Previous studies have observed differences in physical activity participation based on sexual orientation, although the observed relationships have been conflicting [22,111,112]. One study reported that homosexual and bisexual women report higher levels of physical activity compared

to their heterosexual counterpart whereas other studies have reported low participation rates among lesbian, gay and bisexual individuals.

Sexual orientation was captured by asking participants to classify themselves as one of the following: “heterosexual (sexual relations with people of the opposite sex)”, “homosexual, that is lesbian or gay (sexual relations with people of your own sex)” or “bisexual (sexual relations with people of both sexes)”. For the purpose of the analyses, sexual orientation was dichotomized into “heterosexual” and “homosexual/ bisexual”.

3.3.3.2 Lifestyle Behaviours

Smoking

Smoking has been found to be correlated with physical inactivity [237,238]. Smoking status was captured in the CLSA by asking participants “What is your smoking status?” Respondents selected one of the following: “yes (I currently smoke)”, “no (I don't smoke and I never have)”, or “former (I don't smoke now but I have in the past)”. Responses were recoded as “current smoker”, “never smoker”, and “former smoker”, respectively.

Alcohol Use

Previous studies have observed that negative health behaviours, such as alcohol consumption, have been found to be associated with poor lifestyle behaviours such as physical inactivity, but the results from the available evidence are conflicting [237]. Data from large population-based studies indicates that a positive relationship between alcohol consumption and being physical active [239].

The CLSA created a derived variable for type of drinker based on the respondent’s drinking habits in the past 12 months [240]. For the analyses, respondents were categorized as one of the following: “never drinker”, “occasional drinker”, or “regular drinker”. Alcohol use was captured by asking respondents “Have you ever drunk alcohol?” and “About how often during the past 12 months did you drink alcohol?” Respondents that indicated “no” to the first question were categorized as “never drinker”. For respondents who indicated “yes”, they were prompted to answer the latter question. Respondents that indicated “almost every day (incl. 6 times a week)”,

“4-5 times a week”, “2-3 times a week”, “once a week”, “2-3 times a month”, or “about once a month” were categorized as “regular drinker” whereas those who responded, “less than once a month” were categorized as “occasional drinker”.

Fruit and Vegetable Consumption

Adequate fruit and vegetable intake has been correlated with higher habitual physical activity among older adults [121]. The CLSA captured fruit and vegetable consumption using part of the Seniors in the Community: Risk Evaluation for Eating and Nutrition Version II (SCREEN II) assessment tool developed by Dr. Heather Keller (University of Guelph, Ontario, Canada). Participants were asked “In general, how many servings of fruits and vegetables do you eat in a day?” This variable was dichotomized into meeting the recommended fruit and vegetable serving of four to five servings a day or not.

Sleep Quality

Sleep quality was included in the model as those that are more well rested tend to participate in more physical activity [124]. The CLSA captured sleep quality by asking participants, “How satisfied or dissatisfied are you with your current sleep pattern?” Those that responded “satisfied” or “very satisfied” were considered to have “good sleep quality”, whereas those that responded “neutral”, “dissatisfied” or “very dissatisfied” were considered to have “poor sleep quality”. Operationalization of sleep quality was based on prior studies using CLSA data [241].

3.3.3.3 Chronic Disease and Other Health-Related Factors

We adjusted for waist circumference, BMI and blood pressure as these risk factors have been found to be associated with both socioeconomic status and limit physical activity participation. Both indicators for obesity were included in the model as waist circumference is used to assess obesity-related health risk, whereas BMI is a relevant measure with implications in public health policy.

Waist Circumference

Waist circumference was reported in centimeters for all respondents excluding those with being pregnant more than 12 weeks and those unable to stand unassisted. For the analyses, waist circumference was operationalized as a continuous variable.

BMI

Being overweight has been found to be related to low physical activity [233,242]. The CLSA calculated BMI from weight and height measurements collected at the data collection site interview and classified respondents in one of the following categories, "underweight", "normal weight", "overweight", "obese – class I", "obese – class II", or "obese – class III". For the analyses, BMI was classified as "underweight", "normal weight", "overweight", and "obese" (obese – class I/ obese – class II, or obese – class III).

High Blood Pressure

Having high blood pressure is more prevalent among those with lower levels of physical activity. High blood pressure was captured by asking participants, "Has a doctor ever told you that you have high blood pressure or hypertension?". Respondents indicating "yes" were classified as having high blood pressure. In addition, participants with an average systolic blood pressure over 140mmHg and/ or an average diastolic blood pressure greater of equal to 90mmHg were also classified as having high blood pressure.

Multimorbidity

Multimorbidity has been linked to low socioeconomic status and physical inactivity [237,243,244]. The public health definition of multimorbidity, outlined in the work by Roberts and colleagues, include the following chronic conditions: Alzheimer's disease, anxiety or mood disorder, arthritis, asthma, cancer, chronic obstructive pulmonary disease, diabetes, heart diseases and stroke [245]. The presence of a chronic condition was captured by asking participants "Has a doctor ever told you that you have …?" Respondents who indicated osteoarthritis in one or both hands, osteoarthritis in the hip, osteoarthritis in the knee, rheumatoid arthritis, or other type of arthritis were included in the arthritis classification. Chronic obstructive pulmonary disease was defined

as emphysema, chronic bronchitis, or chronic changes in lungs due to smoking. Diabetes included respondents with reported borderline diabetes and high blood sugar. The definition of cardiovascular disease encompassed heart-related disorders such as myocardial infarction, angina, heart disease (including congestive heart failure), peripheral vascular disease or poor circulation in limbs, and hypertension [246]. A binary variable for multimorbidity was derived where respondents that indicated "yes" to two or more chronic conditions were classified as having "multimorbidity", and those that indicated "yes" to one or less chronic conditions were classified as "no multimorbidity".

Depression

Depression was included in the model as those with poor mental health are less likely to engage in leisure-time physical activity [143]. Depression was captured by asking participants, "Has a doctor ever told you that you have a mood disorder such as depression (including manic depression), bipolar disorder, mania, or dysthymia?" Respondents that indicated "yes" were classified as being depressed.

Life Satisfaction

Life satisfaction was included in the model as those with a positive evaluation of the overall quality of his/ her life are more likely to engage in healthy lifestyle behaviours, such as physical activity, that continue to promote their well-being [247,248]. The CLSA measured life satisfaction using the Satisfaction with Life Scale (SWLS) which assesses the respondent's level of agreement/ disagreement for five items [249]. The derived variable classifies the respondent's global life satisfaction based on the SWLS score in one of the following categories: "extremely dissatisfied", "dissatisfied", "slightly dissatisfied", "neutral", "slightly satisfied", "satisfied", or "extremely satisfied". For the analyses, life satisfaction was dichotomized into "dissatisfied" (extremely dissatisfied/dissatisfied/slightly dissatisfied/neutral) and "satisfied" (slightly satisfied/ satisfied/ extremely satisfied) [250].

Self-Rated Health

Regular physical activity is associated with a lower risk of poor or average perceived health [251]. Self-rated health was captured by asking participants, "In general, would you say your health is

excellent, very good, good, fair, or poor?" For the purposes of the analyses, self-rated health was dichotomized into "good" (excellent/ very good/ good) and "poor" (fair/ poor).

3.4 Missing Data

Patterns among missing values were examined for all focal variables prior to conducting the analyses. When only selecting cases with complete responses, only 80.04% of the Comprehensive cohort had valid responses (n=24,091). Wealth had the largest percentage of missing cases (15.51%).

There are three missing data mechanisms believed to contribute to the pattern of missing values within a dataset: missing completely at random (MCAR), missing at random (MAR) or missing not at random (MNAR). MCAR occurs when neither observed nor unobserved values predict the pattern of missingness. MAR occurs when the observed data predict the pattern of missingness. MNAR occurs when the unobserved value predicts its own pattern of missingness. Listwise deletion and complete case analysis require missing data to be MCAR. However, this mechanism of missingness has strict restrictions and is unlikely to occur in observed data [252]. Performing a complete case analysis when missing data is MAR or MNAR produces biased results but, it is difficult to differentiate between MAR and MNAR in observed data alone [253].

For the analyses, data were assumed to be MAR and multiple imputation was performed. Multiple imputation refers to the process of replacing missing data with multiple plausible values [254]. Unlike listwise deletion and single imputation procedures, multiple imputation utilizes incomplete observations, allows for the inclusion of auxiliary variables in the imputation model, and yields valid estimates of standard error [255]. A more flexible adaptation of the multiple imputation procedure better equipped to handle different types of variables, multiple imputation by chained equations (MICE) was selected to handle the missing data [256,257]. Multiple imputation was performed under the fully conditional specification method for arbitrary missing data patterns as it allows for multivariable data imputation for both categorical and continuous data. As outlined in the guidance for practice for multiple imputation by White and colleagues, five imputed datasets were created to equal the proportion of missing cases [253]. For each logistic regression model, the statistical model was fitted with five imputed data sets and the PROC MIANALYZE procedure was performed to pool the imputed observations into a single

observation, reflecting the standard errors associated with the imputed values. Taking the average of the imputed parameter estimates increases efficiency and reduces sampling variation [258].

3.5 Statistical Analyses

Data was originally provided in .csv format by McMaster University. Baseline data from the Comprehensive cohort was uploaded to SAS v9.4. and converted to. sas7bdat format. Variables were re-coded to meet the study objectives and all statistical analyses were conducted using SAS v9.4.

Due to the binary nature of the outcome variable, diagnostic tests were performed to determine if the assumptions for a multivariable logistic regression were met which include independence of errors, linearity in the logit for continuous variables, absence of multicollinearity, and lack of strongly influential outliers. A correlation matrix of all the independent variables was generated to illustrate the pairwise correlation between all variables. In addition, the variance inflation factor (VIF) was computed for each independent variable. Severe collinearity was set at a correlation greater than 0.8 or a VIF greater than 10. Variables with high collinearity will be assessed using the available evidence, and the most appropriate variable will be included in the model.

3.5.1 Descriptive Analyses

Adjusted CLSA sampling weights for the sample of respondents analyzed were applied to account for the complex sampling design and to allow for the generalizability of the respondents to the Canadian population on various key demographic variables [230,259]. Inflation weights were used for descriptive analyses and analytic weights were used for regression analyses as indicated in the CLSA documentation. Comparisons of the sociodemographic characteristics between the included and excluded participants were conducted using two-tailed t-tests and chi-square tests for continuous and categorical variables, respectively. Descriptive statistics of the analytic sample using the mean (SD) for continuous variables and frequency (%) for categorical variables were generated. Specifically, the weighted proportion of participants meeting physical activity guidelines, education, wealth, racial background, immigrant status, marital status, place of residence, sexual orientation, smoking, alcohol use, fruit and vegetable consumption, BMI

classification, high blood pressure, depression, multimorbidity, life satisfaction, self-rated health and sleep quality, and the mean waist circumference was computed. Descriptive statistics were stratified by sex and age-group.

3.5.2 Objective 1

The main objective is to examine the association between socioeconomic status and meeting physical activity recommendations, and to identify sex and age-group differences. We performed bivariate logistic regressions between education and physical activity, and wealth and physical activity to examine the association between each socioeconomic indicator on meeting physical activity guidelines independent of the other. We performed unadjusted and block-wise multivariable logistic regression, adjusting for demographic variables, followed by the addition of lifestyle behaviours, then physiologic risk factors, and lastly chronic conditions and other health-related factors [241]. Models were stratified by sex and age-group. Statistical significance was reported where the 95% confidence interval of the odds ratio did not include one.

Table 1. Block-wise multivariable logistic regression models

Model 1	Socioeconomic indicators
Model 2	Model 1 + Demographic Factors (racial background, immigrant status, marital status, place of residence, sexual orientation)
Model 3	Model 2 + Lifestyle Behaviours (smoking, alcohol use, and fruit and vegetable consumption, sleep quality)
Model 4	Model 3 + Chronic Conditions and Other Health-Related Factors (waist circumference, BMI, high blood pressure, depression, multimorbidity, life satisfaction, and self-rated health)

3.5.3 Objective 2

We wanted to test if there was effect modification of weight status in the relationship between socioeconomic status and meeting physical activity guidelines. Specifically, does the association between socioeconomic status and physical activity guidelines differ between those that are overweight/obese compared to those that are underweight/ normal weight? Therefore, the final model was stratified by weight status (underweight/ normal weight vs overweight/ obese) to test for effect modification.

3.5.4 Sensitivity Analyses

A sensitivity analysis was conducted to determine if there would be any differences in significance if a complete case analysis was performed to address missing data opposed to multiple imputation. The unadjusted and fully adjusted models were performed using list-wise deletion and compared to the results of the multiple imputation.

Chapter 4

4 Results

4.1 Sample

Of the 30,079 participants that completed the CLSA Comprehensive cohort baseline assessments, 25,113 participants (83.49%) met the inclusion criteria and had complete data on age, sex, level of education, total value of savings and investments, and physical activity.

4.2 Missing Data

Table 2 provides a description of the extent of missing data among participants in the analytic sample. Of the 25,113 participants, only 5.22% of respondents (n=1,310) had missing data for at least one variable of interest. Variables with the most missing data was alcohol use (n=538), life satisfaction (n=258), fruit and vegetable consumption (n=173), and waist circumference (n=173). Data on age, sex, urban/ rural classification, blood pressure and multimorbidity did not have any missing values. As the percentage of missingness approximated the acceptable proportion of missing data (5%), a sensitivity analysis was conducted to compare if performing a complete case analysis would impact the results from the fully adjusted imputed multivariable methods. Results from the sensitivity analyses are detailed in Section 4.8.

Table 2. Description of missing data in the analytic sample (N=25,113)

	n (% missing)
Outcome Variable	
Meeting PAG	0 (0.0)
Exposure Variable	
Education	0 (0.0)
Wealth	0 (0.0)
Covariates	
Race	21 (0.0)
Immigrant Status	3 (0.0)
Marital Status	7 (0.0)
Urban/ Rural Classification	0 (0.0)
Sexual Orientation	33 (0.0)
Type of Smoker	1 (0.0)
Alcohol Use	538 (0.02)
Fruit and Vegetable Consumption	173 (0.01)
Waist Circumference	173 (0.01)
BMI	101 (0.0)
High Blood Pressure	0 (0.0)
Sleep Quality	19 (0.0)
Multimorbidity	0 (0.0)
Depression	84 (0.0)
Life Satisfaction	258 (0.01)
Self-Rated Health	16 (0.0)

4.3 Sample Characteristics

4.3.1 Comparison of Characteristics between Included and Excluded Groups

Comparisons of the sociodemographic characteristics between included and excluded (n=4,934) participants are outlined in Table 3. Those excluded from the analysis were older, female, non-white, immigrant, not married, had less than post-secondary education, and had less acquired wealth. Place of residence, urban or rural, was not significantly different between included and excluded participants.

Table 3. Weighted comparison of participant characteristics between included and excluded groups

Variable	Analytic Sample with Complete Data (n=25,113)	Excluded Group with Missing Data (n=4,934)	*p*
Age, mean ± SE	59.18	62.40	<.0001
Sex, n (%)			<.0001
Female	50.83	59.86	
Male	49.17	40.14	
Race, n (%)			<.0001
White	92.72	90.36	
Non-White	7.28	9.64	
Immigration Status			<.0001
Immigrant	18.12	23.89	
Non-Immigrant	81.88	76.11	
Marital Status, n (%)			<.0001
Single	8.67	8.96	
Married	75.02	69.73	
Widowed, divorced, separated	16.31	21.31	
Education, n (%)			<.0001
Less than postsecondary	35.87	48.09	
Postsecondary degree/ diploma	64.13	51.91	
Total Wealth			<.0001
less than $50,000	27.49	39.74	
$50,000 to less than $100,000	16.99	10.67	
$100,000 to less than $1 million	46.32	41.98	
$1 million or more	9.20	7.61	
Place of Residence			0.74
Urban	94.79	94.67	
Rural	5.21	5.33	

4.3.2 Characteristics of Analytic Sample

The socioeconomic characteristics, demographic characteristics, prevalence of lifestyle behaviours, health-related characteristics, and prevalence of adequate physical activity of the analytic sample are displayed through Table 4 – 7, respectively. All descriptive characteristics were stratified by sex and age-group.

Socioeconomic Characteristics

Education and wealth were used to operationalize socioeconomic status as described in Chapter 3. Most males (65.5%) and females (62.8%) had a postsecondary degree or diploma. Males (72.8%) and females (76.2%) between the ages of 45-54 were the most educated, whereas males (48.9%) and females (38.5%) over the age of 75 were the least educated. Most males (48.9%) and females (43.8%) had a total value of savings and investments between $100,000 to $1 million. Across both sexes and age groups, males between 55 and 74 had the highest proportion of wealth (males 55-64: 13.5%; males 65-74: 13.5%). Females between the ages of 55 and 64 had the highest wealth for females (9.0%).

Demographic Characteristics

About one third of males (33.0%) and females (34.5%) were between the ages of 55 to 64. Both males and females in the sample were predominantly White (males: 92.1%; females: 93.3%), non-immigrants (males: 80.9%; females: 82.8%), married (males: 81.5%; females: 68.7%), lived in an urban area (males: 95.3%; females: 94.3%) and heterosexual (males: 96.8%; females: 98.4%). Males over the age of 75 had the highest portion of White (95.3%), widowed, divorced, or separated (23.2%), and heterosexual (99.0%) respondents. Compared to other age groups, over half of females over the age of 75 were widowed, divorced or separated (55.5%). Only a small proportion of the sample were not White (3.1% to 10.6%), single (4.2% to 10.9%), or homosexual or bisexual (0.8% to 4.0%)

Lifestyle Behaviours

Males were predominantly former smokers (46.8%) and regular drinkers (79.2%). Compared to all other age groups, males over the age of 75 had the lowest proportion of current smokers (4.1%), drinkers (77.1%), and adequate fruit and vegetable consumption (41.3%). Females were more likely to be never smokers (46.2%) and regular drinkers (68.9%). Among females, the highest proportion of current smokers (14.2%) and regular drinkers (72.2%) were between the ages of 45 to 54 years old. Between sexes, females were more likely than males to meet fruit and vegetable guidelines (68.2% vs 45.1%). Most males and females rated their quality of sleep as

good (males: 60.7%; females: 56.4%), and males and females between the ages of 65 to 74 had the highest ratings of sleep quality (males: 68.5%; females: 58.6%).

Chronic Conditions and Other Health-Related Factors

Across all age groups, a higher proportion of males were classified as overweight (45.6%) and did not have high blood pressure (58.7%), depression (86.7%), or multimorbidity (55.2%). The mean waist circumference for males was 100.7cm and increased with age until the age of 75. Males over the age of 75 were the most likely to have high blood pressure (60.2%) and multimorbidity (66.8%). Across all age groups, most females were normal weight (35.0%), did not have high blood pressure (64.0%) or depression (77.6%), but more likely to have multimorbidity (50.8%). The mean waist circumference for females was 88.1cm. Across all age groups, over half of females were overweight or obese (45-54: 56.4%; 55-64: 68.3%; 65-74: 71.9; 75+: 62.8%). Females over the age of 75 had the largest proportion of those with high blood pressure (65.5%) and multimorbidity (70.7%).

Most males and females rated their life satisfaction as satisfied or very satisfied (males: 87.4%; females: 85.3%), and self-rated health as good (males: 90.0%; females: 91.2%). Males and females between the ages of 65 to 74 had the highest ratings of good self-rated health (males: 91.5%; females: 90.3%).

Table 4. Weighted socioeconomic characteristics of included participants stratified by age and sex

	Males				
	All (n=12,778)	**45-54 (n=3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Education, (%)					
Less than postsecondary	34.54	27.22	34.95	42.37	51.10
Postsecondary degree/ diploma	65.46	72.78	65.05	57.63	48.90
Total Wealth, (%)					
Less than $50,000	23.78	27.30	22.40	19.31	21.12
$50,000 to less than $100,000	16.43	17.51	15.73	13.56	19.42
$100,000 to less than $1 million	48.92	47.39	48.38	53.59	48.77
$1 million or more	10.88	7.79	13.49	13.54	10.70
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Education, (%)					
Less than postsecondary	37.16	23.85	37.83	51.13	61.54
Postsecondary degree/ diploma	62.84	76.15	62.17	48.87	38.46
Total Wealth, (%)					
Less than $50,000	31.09	31.74	26.06	32.46	41.77
$50,000 to less than $100,000	17.53	16.69	17.55	17.52	20.73
$100,000 to less than $1 million	43.80	44.18	47.42	43.35	31.95
$1 million or more	7.57	7.39	8.97	6.68	5.55

Table 5. Weighted demographic characteristics of included participants stratified by age and sex

	Males				
	All (n=12,778)	**45-54 (n=3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Racial Background, (%)					
White	92.11	89.45	93.80	93.64	95.31
Not white	7.89	10.55	6.20	6.36	4.69
Immigrant status, (%)					
Yes	19.06	17.95	15.79	24.88	24.18
No	80.94	82.05	84.21	75.12	75.82
Marital Status, (%)					
Single	8.75	10.93	9.15	5.24	4.16
Married	81.54	82.37	81.92	83.59	72.68
Widowed, divorced, separated	9.71	6.70	8.93	11.17	23.16
Place of residence, (%)					
Urban	95.32	95.85	94.4	95.32	96.08
Rural	4.68	4.15	5.60	4.68	3.92
Sexual orientation, (%)					
Heterosexual	96.81	95.96	97.12	97.06	99.04
Homosexual/ Bisexual	3.19	4.04	2.88	2.94	0.96
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Racial Background, (%)					
White	93.32	90.65	93.69	96.44	96.94
Not white	6.68	9.35	6.31	3.56	3.06
Immigrant status, (%)					
Yes	17.21	14.69	16.79	22.47	18.82
No	82.79	85.31	83.21	77.53	81.18
Marital Status, (%)					
Single	8.61	9.86	9.49	6.19	5.31

Married	68.70	77.76	70.95	61.78	39.21
Widowed, divorced, separated	22.69	12.38	19.56	32.03	55.48
Place of residence, (%)					
Urban	94.27	92.57	94.54	95.62	97.60
Rural	5.73	7.43	5.46	4.38	2.40
Sexual orientation, (%)					
Heterosexual	98.39	97.94	98.29	99.21	98.94
Homosexual/ Bisexual	1.61	2.06	1.71	0.79	1.06

Table 6. Weighted lifestyle behaviour characteristics of included participants stratified by age and sex

	Males				
	All (n=12,778)	**45-54 (n=3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Smoking, (%)					
Never smoker	40.58	49.15	36.10	33.16	31.54
Former smoker	46.81	36.22	49.59	57.61	64.36
Current smoker	12.61	14.63	14.31	9.23	4.10
Alcohol use, (%)					
Never drinker	11.83	11.14	11.90	11.82	14.72
Occasional drinker	8.97	10.08	8.14	8.29	8.10
Regular drinker	79.20	78.78	79.96	79.89	77.18
Fruit and vegetable consumption, (%)					
Not meeting recommended serving	54.92	53.29	55.54	55.73	58.70
Meeting recommended serving	45.08	46.71	44.46	44.27	41.30
Sleep quality, (%)					
Poor	39.34	42.78	41.24	31.52	32.14
Good	60.66	57.22	58.76	68.48	67.86
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Smoking, (%)					
Never smoker	46.23	48.61	43.69	44.43	48.09
Former smoker	42.79	37.20	44.55	49.23	47.51
Current smoker	10.98	14.19	11.76	6.34	4.40
Alcohol use, (%)					
Never drinker	15.74	13.68	15.72	18.11	19.68
Occasional drinker	15.33	14.27	14.82	17.54	17.17
Regular drinker	68.93	72.05	69.46	64.35	63.15
Fruit and vegetable consumption, (%)					
Not meeting recommended serving	31.83	30.15	31.88	32.59	36.86

Meeting recommended serving	68.17	69.85	68.12	67.41	63.14
Sleep quality, (%)					
Poor	43.64	46.19	43.58	39.47	41.41
Good	56.36	53.81	56.42	60.53	58.59

Table 7. Weighted physiological and health-related risk factor characteristics of included participants stratified by age and sex

	Males				
	All (n=12,778)	**45-54 (n=3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Waist Circumference (cm), mean (SD)	100.66 (13.06)	98.95 (17.26)	101.68 (13.05)	102.49 (10.12)	101.50 (8.04)
BMI, (%)					
Underweight	0.29	0.30	0.43	0.15	0.04
Normal weight	23.62	26.30	21.31	19.49	27.31
Overweight	45.59	44.26	44.36	48.71	49.78
Obese	30.50	29.14	33.90	31.65	22.87
High blood pressure, (%)					
Yes	41.29	27.90	46.05	54.44	60.19
No	58.71	72.10	53.95	45.56	39.81
Depression, (%)					
No	86.69	86.26	83.28	89.85	94.30
Yes	13.31	13.74	16.72	10.15	5.70
Multimorbidity, (%)					
No	55.17	70.33	50.62	39.13	33.18
Yes	44.83	29.67	49.38	60.87	66.82
Life satisfaction, (%)					
Dissatisfied	12.62	14.19	14.56	8.35	6.96
Satisfied	87.38	85.81	85.44	91.65	93.04
Self-rated health, (%)					
Poor	10.02	9.33	11.76	8.48	10.03
Good	89.98	90.67	88.24	91.52	89.97
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Waist Circumference (cm), mean (SD)	88.10 (14.01)	85.25 (16.83)	90.25 (13.69)	89.96 (11.94)	89.15 (10.37)
BMI, (%)					

Underweight	1.31	1.50	0.69	1.55	2.07
Normal weight	35.01	42.13	30.97	26.53	35.15
Overweight	33.82	31.09	34.07	38.24	35.73
Obese	29.86	25.28	34.27	33.68	27.05
High blood pressure, (%)					
Yes	63.97	80.12	63.35	46.61	34.46
No	36.03	19.88	36.65	53.39	65.54
Depression, (%)					
No	77.61	77.12	74.47	79.09	86.63
Yes	22.39	22.88	25.53	20.91	13.37
Multimorbidity, (%)					
No	49.22	65.22	44.62	33.73	29.30
Yes	50.78	34.78	55.38	66.27	70.70
Life satisfaction, (%)					
Dissatisfied	14.69	15.11	15.59	14.03	11.38
Satisfied	85.31	84.89	84.41	85.97	88.62
Self-rated health, (%)					
Poor	8.80	8.06	9.55	8.57	9.73
Good	91.20	91.94	90.45	91.43	90.27

4.4 Assessing Multicollinearity

Multivariable logistic regression models were performed to assess multicollinearity between variables. Upon assessing the correlation matrix, no severe collinearity was detected among all independent variables using a correlation cut-off of 0.8 or greater. As displayed in Table 8, all VIF values are less than 10, which supports the lack of multicollinearity as previously demonstrated with the correlation matrix. Therefore, no variables were removed from the multivariable logistic regression analyses.

Table 8. Measure of multicollinearity using VIF for each independent variable

Independent Variables	VIF Value	Tolerance
Education	1.07	0.94
Wealth	1.12	0.90
Race	1.10	0.91
Immigration Status	1.09	0.92
Marital Status	1.03	0.97
Place of Residence	1.01	0.99
Sexual Orientation	1.02	0.98
Smoking	1.06	0.94
Alcohol Use	1.06	0.94
Fruit and Vegetable Consumption	1.06	0.94
Sleep Quality	1.04	0.96
Waist Circumference	2.41	0.41
BMI	2.30	0.43
High Blood Pressure	1.35	0.74
Depression	1.18	0.85
Multimorbidity	1.44	0.69
Life Satisfaction	1.13	0.88
Self-Rated Health	1.13	0.88

4.5 Meeting Physical Activity Guidelines

Table 9 and Table 10 present the weighted proportion of individuals meeting physical activity guidelines stratified by age and sex. A higher proportion of males met physical activity guidelines compared to females (22.7% vs 19.7%), however, no significant difference was reported between sexes (p=0.63). Males between the ages of 65 to 74 had the highest proportion of individuals meeting physical activity guidelines across all age and sex groups (26.9%). Among females, those between the ages of 55 to 64 were the most active (20.9%), whereas females in the youngest and oldest age groups were the least active (18.9%).

Table 9. Weighted proportion of participants meeting physical activity guidelines by socioeconomic indicator stratified by age and sex

	Males				
	All (n=12,778)	**45-54 (n= 3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Sample, (%)	22.66	20.95	22.40	26.86	23.28
Education, (%)					
Less than postsecondary	22.89	19.52	22.11	27.75	25.15
Postsecondary degree/ diploma	22.54	21.48	22.56	26.21	21.32
Total Wealth, (%)					
Less than $50,000	18.22	17.37	16.44	26.43	15.31
$50,000 to less than $100,000	20.37	18.03	19.92	24.85	25.15
$100,000 to less than $1 million	25.08	23.41	25.22	27.86	26.03
$1 million or more	24.99	25.05	25.08	25.54	23.05
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Sample, (%)	19.65	18.90	20.90	19.54	18.90
Education, (%)					
Less than postsecondary	16.34	16.92	15.90	14.94	18.36
Postsecondary degree/ diploma	21.61	19.52	23.93	24.36	19.77
Total Wealth, (%)					
Less than $50,000	16.53	16.92	15.65	15.11	19.01
$50,000 to less than $100,000	18.98	18.19	20.35	19.64	16.89
$100,000 to less than $1 million	20.63	19.34	22.09	20.85	20.23
$1 million or more	28.41	26.40	30.86	32.37	18.02

Table 10. Weighted prevalence of meeting physical activity guidelines by covariates stratified by sex

	Male	Female
Racial Background, (%)		
White	23.15	19.97
Not white	17.19	15.22
Immigrant status, (%)		
Yes	20.12	21.07
No	24.78	21.20
Marital Status, (%)		
Single	16.53	18.70
Married	25.06	22.06
Widowed, divorced, separated	21.41	20.19
Place of residence, (%)		
Urban	23.69	21.09
Rural	26.39	22.16
Sexual orientation, (%)		
Heterosexual	24.22	21.09
Homosexual/ Bisexual	13.70	26.09
Smoking, (%)		
Never smoker	23.63	21.06
Former smoker	24.36	22.15
Current smoker	22.97	16.90
Alcohol use, (%)		
Never drinker	20.05	19.08
Regular drinker	18.52	15.97
Occasional drinker	25.12	22.79
Fruit and vegetable consumption, (%)		
Not meeting recommended serving	23.09	17.15
Meeting recommended serving	25.00	22.81
Sleep quality, (%)		
Poor	22.70	19.63
Good	24.67	22.37
BMI, (%)		
Underweight	15.38	19.23
Normal weight	23.27	26.40
Overweight	25.02	20.82
Obese	22.85	15.54
High blood pressure, (%)		
No	24.63	23.10
Yes	23.03	18.27
Depression, (%)		
No	24.46	22.00
Yes	20.25	18.10

Multimorbidity, (%)		
No	24.60	22.46
Yes	23.19	20.08
Life satisfaction, (%)		
Dissatisfied	16.48	15.55
Satisfied	24.95	22.14
Self-rated health, (%)		
Poor	16.05	13.25
Good	24.66	21.89

4.6 Association between Socioeconomic Status and Physical Activity

Table 11 presents the results of bivariate analyses between individual socioeconomic indicators and meeting physical activity guidelines stratified by sex. Table 12 presents the unadjusted and adjusted association between socioeconomic status and meeting physical activity guidelines for the overall sample. Table 13-16 presents the results of the multivariable analyses between socioeconomic status and meeting physical activity guidelines, stratified by age and sex, for Models 1 to 4. Table 17 presents the multivariable logistic regression of meeting physical activity guidelines for each covariate across all models.

4.6.1 Education

From the bivariate analysis, having a postsecondary degree/ diploma was correlated with an increased odds of meeting physical activity guidelines only among females (OR=1.20 [1.07, 1.34]). No significant association was found between educational attainment and physical activity among males. When combined with wealth in the unadjusted multivariable regression, educational attainment was not a significant correlate of physical activity for the entire sample.

Multivariable Analyses

Males:

When stratified by sex in Model 1, education was only a significant correlate of physical activity among males. Specifically, males with a postsecondary degree/ diploma were 14% less likely to meet physical activity guidelines compared to those with less than postsecondary education (OR=0.86 [0.77, 0.96]). After adjusting for demographic characteristics (Model 2: OR=0.87

[0.78, 0.97]), lifestyle behaviours (Model 3: OR=0.85 [0.77, 0.95]), and chronic disease and lifestyle behaviours (Model 4: OR=0.85 [0.76, 0.94]), educational attainment continued to be associated with a reduced likelihood of meeting physical activity guidelines among males.

When investigating age-differences in education attainment and physical activity among males, having a post-secondary degree or diploma was consistently associated with a reduced likelihood of meeting physical activity guidelines among males between the ages of 55 to 64 across all models.

Females:

When stratified by sex, educational attainment was not a significant correlate of physical activity among females (Model 1). This association persisted after adjusting for demographic characteristics, lifestyle behaviours, and chronic disease and other health related risk factors.

When investigating age-differences in educational attainment and physical activity among females, higher education increased the likelihood of meeting physical activity guidelines by about 30% in the unadjusted model (55-64 years old: OR=1.31 [1.06,1.61]; 65-74 years old: OR=1.33 [1.05,1.68]). This association persisted after adjusting for demographic characteristics and lifestyle behaviours. However, after adjusting for chronic disease and other health related factors, having a postsecondary degree or diploma was not significantly associated with meeting physical activity guidelines (Model 4). Although statistically insignificant, the odds of meeting physical activity guidelines increased with age, up to of 75, for females with higher education in all models.

4.6.2 Wealth

From the bivariate analyses, wealth as associated with increased likelihoods of meeting physical activity guidelines for males and females. This association was significant for females with a wealth over $50,000 and males with a wealth over $100,000. There was no significant difference in meeting physical activity guidelines between males with a wealth less than $50,000 and those with a wealth between $50,000 and $100,000. When combined with education in the unadjusted multivariable regression, the association between wealth and meeting physical activity guidelines held true in respect to the entire sample.

Multivariable Analyses

Males:

When stratified by sex, higher wealth was a significant correlate of meeting physical activity guidelines among males (Model 1). All wealth groups had higher odds of meeting physical activity guidelines compared to the lowest wealth group. After adjusting for demographic characteristics, only those with a wealth over $100,000 had significantly higher odds of meeting physical activity guidelines ($100,000 to less than $1 million: OR=1.38 [1.22,1.56]; $1 million or more: OR=1.64 [1.41,1.91]) (Model 2). This finding remained true after adjusting for lifestyle behaviours and chronic conditions and other health related risk factors. After controlling for all covariates, males with a wealth between $100,000 and $1 million were 26% more likely to meet physical activity guidelines compared to the lowest wealth group (OR=1.26 [1.11, 1.42]); and males with a wealth over $1 million were almost 50% more likely to meet physical activity guidelines compared to the lowest wealth group (OR=1.47 [1.26, 1.72]) (Model 4). Across all models, the odds of meeting physical activity guidelines increased with each increase in wealth group

When investigating age-differences in wealth group and physical activity, males between the ages of 55 to 64 have the highest odds of meeting physical activity guidelines within each wealth group across all models. Among males 65 to 74 years old, wealth was only significantly correlate of adequate activity for males in the highest wealth group in the unadjusted analyses (OR=1.47 [1.02, 2.11]). However, after adjusting for demographic characteristics, wealth was not significantly associated with meeting physical activity guidelines for the subsequent models. For males between the ages of 45 to 54 years old as well as those over the age of 75, wealth was only a significant correlate of adequate physical activity for the top two wealth groups in Model 1 and Model 2. However, after adjusting for lifestyle behaviours, wealth was not significantly associated with meeting physical activity guidelines in the following models for both age groups.

Females:

When stratified by sex, wealth was a significant correlate of meeting physical activity guidelines among females (Model 1). However, after adjusting for demographic characteristics, wealth only

remained significant for females in the top two wealth groups for the remainder of the models. After controlling for all covariates, females with a wealth between $100,000 and $1 million were almost 20% more likely to meet physical activity guidelines compared to those with a wealth of less than $50,000 (OR=1.18 [1.04, 2.33]); and females with a wealth over $1 million were 52% more likely to meet guidelines (OR=1.52 [1.28, 1.80]).

When investigating age-differences in wealth group and physical activity, females between the ages of 45 to 74, in the top two wealth groups, were significantly more likely to meet physical activity guidelines in Model 1, 2 and 3. However, after adjusting for chronic disease and other health-related risk factors, only females in the top wealth group between the ages of 45 to 54 had a significantly higher likelihood of meeting physical activity guidelines (OR=1.68 [1.28, 2.20]). Wealth was not associated increased odds of meeting physical activity among females over the age of 75 in any model.

4.6.3 Other Correlates

Racial Background

In the final model, being non-White was not associated with a significant different likelihood of meeting physical activity guidelines in all models for both males and females.

Immigrant Status

In the final model, immigrant males were 21% less likely to meet physical activity guidelines compared to non-immigrant males (OR=0.79 [0.70,0.89]). There was no significant difference in meeting physical activity guidelines between immigrant non-immigrant women in all models.

Marital Status

In the final model, married males were more likely to meet physical activity guidelines compared to single males in all models (OR=1.29 [1.07, 1.55]). Widowed, divorced, or separated males were more likely to meet physical activity guidelines compared to single males in Model 1 and Model 2, but after the inclusion of chronic disease and other health related risk factors, no significant difference existed between groups. There was no significant difference in meeting

physical activity guidelines between married or widowed, divorced, and separated females and single females across all models.

Place of Residence

There were no significant differences in the likelihood of meeting physical activity guidelines between rural and urban residents for both males and females across all models.

Sexual Orientation

In the final model, homosexual or bisexual males were more likely to meet physical activity guidelines than heterosexual males (OR=1.69 [1.23, 2.31]). Homosexual or bisexual females were less likely to meet physical activity guidelines than heterosexual females in Model 1 and Model 2, but after the inclusion of chronic disease and other health related risk factors, no significant difference existed between groups.

Smoking

There were no significant differences in the likelihood of meeting physical activity guidelines among male former or current smokers compared to male never smokers across all models. In the final model, female former smokers were more likely to meet physical activity guidelines compared to female never smokers (OR=1.18 [1.07, 1.30]). There were no significant differences in meeting physical activity guidelines between female current smokers and female never smokers.

Alcohol Use

Male occasional drinkers were 25% more likely to meet physical activity guidelines compared to male never drinkers in the final model (OR=1.25 [1.07, 1.46)]. Female regular drinkers were significantly less likely to meet physical activity guidelines compared to female never drinkers (OR=0.74 [0.61, 0.89]).

Fruit and Vegetable Consumption

Males and females consuming adequate servings of fruit and vegetables were more likely to meet physical activity guidelines than those that did not meeting the recommended serving (males: OR=1.11 (1.02, 1.21); females: OR=1.25 [1.13, 1.40)].

Sleep Quality

Females that reported good sleep quality were 14% more likely to meet physical activity guidelines compared to that reported poor sleep quality (OR=1.14 [1.04, 1.24]. No significant differences were observed among males.

BMI

Males that were overweight or obese had a significantly higher likelihood of meeting physical activity guidelines compared to those that are normal weight (overweight: OR=1.17 [1.04, 1.31]; obese: OR=1.25 [1.04, 1.49]). In contrast, females that were overweight or obese had significantly lower likelihood of meeting physical activity guidelines compared to those that were normal weight (overweight: OR=0.79 [0.70, 0.89]; obese: OR=0.67 [0.55, 0.82]).

High Blood Pressure

There were no significant differences in the likelihood of meeting physical activity guidelines between those with and without high blood pressure for both males and females.

Depression

Females with depression were 14% less likely to meet physical activity guidelines compared to females without depression (OR=0.86 [0.76,0.97]. No significant differences were observed among males with and without depression.

Multimorbidity

Females with multimorbidity were 18% more likely to meet physical activity guidelines compared to those without (OR=1.18 [1.06, 1.32]). No significant differences were observed among males.

Life Satisfaction

Males and females that reported high life satisfaction were 43% and 25% more likely to meet physical activity guidelines, respectively, compared to those that rated poor life satisfaction (males: OR=1.43 [1.23, 1.68]); females: OR=1.25 [1.08, 1.46]).

Self-Rated Health

Both males and females that reported good self-rated health were more likely to meet physical activity guidelines compared to those that reported poor self-rated health (males: OR=1.40 [1.17, 1.68]); females: OR=1.31 [1.07, 1.62]).

Table 11. Bivariate logistic regression of meeting physical activity guidelines for each socioeconomic indicator stratified by sex

	Males		Females	
	OR	**95% CI**	**OR**	**95% CI**
Education				
Less than postsecondary	Ref.		Ref.	
Postsecondary degree/ diploma	0.92	0.83, 1.03	**1.20**	**1.07, 1.34**
Total Wealth				
Less than $50,000	Ref.		Ref.	
$50,000 to less than $100,000	1.15	0.99, 1.34	**1.17**	**1.01, 1.35**
$100,000 to less than $1 million	**1.41**	**1.26, 1.59**	**1.43**	**1.28, 1.60**
$1 million or more	**1.68**	**1.45, 1.94**	**2.01**	**1.70, 2.36**

Table 12. Unadjusted and adjusted association between socioeconomic status and meeting physical activity guidelines for the whole analytic sample (N=25,113)

	Unadjusted Model		Adjusted Model*	
	OR	**95% CI**	**OR**	**95% CI**
Education				
Less than postsecondary	Ref.		Ref.	
Postsecondary degree/ diploma	0.98	0.91, 1.06	0.95	0.88, 1.03
Total Wealth				
Less than $50,000	Ref.		Ref.	
$50,000 to less than $100,000	**1.17**	**1.05, 1.30**	1.07	0.95, 1.17
$100,000 to less than $1 million	**1.45**	**1.33, 1.57**	**1.25**	**1.15, 1.36**
$1 million or more	**1.85**	**1.66, 2.07**	**1.54**	**1.38, 1.73**

*Adjusted model was adjusted for demographic factors, lifestyle behaviours, and chronic disease and other health-related factors

Table 13. Multivariable logistic regression for socioeconomic indicators and meeting physical activity guidelines stratified by age and sex (Model 1)

	Males				
	All (n=12,778)	**45-54 (n= 3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Education					
Less than postsecondary	Ref	Ref	Ref	Ref	Ref
Postsecondary degree/ diploma	**0.86 (0.77, 0.96)**	0.93 (0.78, 1.13)	**0.77 (0.64, 0.92)**	0.92 (0.72, 1.18)	0.97 (0.71, 1.33)
Total Wealth					
Less than $50,000	Ref	Ref	Ref	Ref	Ref
$50,000 to less than $100,000	**1.17 (1.01, 1.36)**	0.91 (0.73, 1.14)	**1.54 (1.16, 2.05)**	1.29 (0.88, 1.89)	1.51 (0.93, 2.46)
$100,000 to less than $1 million	**1.44 (1.28, 1.63)**	**1.28 (1.07, 1.52)**	**1.73 (1.39, 2.16)**	1.31 (0.97, 1.77)	**1.56 (1.04, 2.33)**
$1 million or more	**1.73 (1.49, 2.01)**	**1.46 (1.14, 1.87)**	**2.16 (1.66, 2.81)**	**1.47 (1.02, 2.11)**	**1.73 (1.05, 2.88)**
	Female				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Education					
Less than postsecondary	Ref	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	1.12 (1.00, 1.25)	1.14 (0.93, 1.41)	**1.31 (1.06, 1.61)**	**1.33 (1.05, 1.68)**	0.81 (0.60, 1.08)
Total Wealth					
Less than $50,000	Ref	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	**1.16 (1.01, 1.34)**	1.08 (0.86, 1.36)	1.32 (1.00, 1.73)	1.20 (0.86, 1.68)	0.97 (0.65, 1.45)
$100,000 to less than $1 million	**1.41 (1.26, 1.58)**	**1.32 (1.11, 1.58)**	**1.48 (1.19, 1.83)**	**1.62 (1.24, 2.12)**	1.16 (0.83, 1.62)
$1 million or more	**1.97**	**2.21**	**1.90**	**1.88**	1.25

	(1.67, 2.32)	**(1.71, 2.85)**	**(1.41, 2.54)**	**(1.28, 2.77)**	(0.68, 2.29)

Table 14. Multivariable logistic regression for socioeconomic indicators and meeting physical activity guidelines adjusting for demographic characteristics stratified by age and sex (Model 2)

	Males				
	All (n=12,778)	**45-54 (n= 3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	**0.87 (0.78, 0.97)**	0.95 (0.78, 1.14)	**0.77 (0.64, 0.93)**	0.96 (0.75, 1.23)	1.00 (0.73, 1.38)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.14 (0.98, 1.32)	0.88 (0.7, 1.1)	**1.50 (1.12, 2.00)**	1.21 (0.82, 1.78)	1.53 (0.94, 2.50)
$100,000 to less than $1 million	**1.38 (1.22, 1.56)**	**1.20 (1.01, 1.44)**	**1.65 (1.32, 2.07)**	1.25 (0.92, 1.7)	**1.59 (1.06, 2.38)**
$1 million or more	**1.64 (1.41, 1.91)**	**1.36 (1.06, 1.75)**	**2.05 (1.57, 2.68)**	1.40 (0.96, 2.03)	**1.75 (1.05, 2.91)**
	Female				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	1.12 (1.00, 1.26)	1.14 (0.92, 1.40)	**1.30 (1.06, 1.61)**	**1.34 (1.05, 1.69)**	0.83 (0.62, 1.11)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.15 (0.99, 1.33)	1.05 (0.84, 1.33)	1.29 (0.98, 1.70)	1.22 (0.87, 1.72)	0.95 (0.63, 1.42)
$100,000 to less than $1 million	**1.39 (1.24, 1.56)**	**1.27 (1.06, 1.52)**	**1.43 (1.15, 1.79)**	**1.65 (1.26, 2.17)**	1.13 (0.81, 1.60)
$1 million or more	**1.93**	**2.11**	**1.80**	**1.93**	1.15

	(1.63, 2.28)	**(1.62, 2.74)**	**(1.33, 2.43)**	**(1.30, 2.87)**	(0.62, 2.14)

Table 15. Multivariable logistic regression for socioeconomic indicators and meeting physical activity guidelines adjusting for demographic characteristics and lifestyle behaviours stratified by age and sex (Model 3)

	Males				
	All (n=12,778)	**45-54 (n= 3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	**0.85 (0.77, 0.95)**	0.91 (0.75, 1.10)	**0.76 (0.63, 0.91)**	0.95 (0.74, 1.22)	0.96 (0.70, 1.33)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.11 (0.95, 1.29)	0.83 (0.66, 1.04)	**1.49 (1.12, 1.99)**	1.20 (0.82, 1.77)	1.49 (0.91, 2.44)
$100,000 to less than $1 million	**1.34 (1.18, 1.51)**	1.14 (0.95, 1.36)	**1.62 (1.29, 2.03)**	1.24 (0.91, 1.68)	1.51 (1.00, 2.28)
$1 million or more	**1.57 (1.35, 1.83)**	1.28 (0.99, 1.65)	**1.99 (1.52, 2.62)**	1.37 (0.94, 2.00)	1.62 (0.97, 2.72)
	Females				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	1.09 (0.97, 1.22)	1.12 (0.90, 1.38)	**1.25 (1.01, 1.55)**	**1.28 (1.00, 1.63)**	0.81 (0.60, 1.09)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.10 (0.95, 1.28)	1.03 (0.82, 1.31)	1.21 (0.92, 1.60)	1.17 (0.83, 1.65)	0.90 (0.60, 1.36)
$100,000 to less than $1 million	**1.30 (1.15, 1.46)**	**1.23 (1.02, 1.48)**	**1.29 (1.03, 1.61)**	**1.53 (1.16, 2.03)**	1.07 (0.76, 1.52)
$1 million or more	**1.76**	**2.04**	**1.57**	**1.76**	1.06

	(1.49, 2.09)	**(1.56, 2.66)**	**(1.15, 2.13)**	**(1.18, 2.64)**	(0.56, 1.99)

Table 16. Multivariable logistic regression for socioeconomic indicators and meeting physical activity guidelines adjusting for demographic characteristics, lifestyle behaviours, chronic disease and other health-related risk factors stratified by age and sex (Model 4)

	Males				
	All (n=12,778)	**45-54 (n= 3,252)**	**55-64 (n=4,220)**	**65-74 (n=3,167)**	**75+ (n=2,139)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	**0.85 (0.76, 0.94)**	0.91 (0.75, 1.10)	**0.74 (0.61, 0.89)**	0.93 (0.72, 1.21)	0.96 (0.69, 1.32)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.06 (0.91, 1.23)	0.80 (0.64, 1.00)	**1.38 (1.03, 1.85)**	1.15 (0.78, 1.70)	1.42 (0.87, 2.33)
$100,000 to less than $1 million	**1.26 (1.11, 1.42)**	1.09 (0.91, 1.30)	**1.47 (1.17, 1.85)**	1.17 (0.85, 1.60)	1.46 (0.97, 2.21)
$1 million or more	**1.47 (1.26, 1.72)**	1.21 (0.94, 1.57)	**1.79 (1.36, 2.36)**	1.26 (0.86, 1.84)	1.52 (0.90, 2.57)
	Female				
	All (n=12,335)	**45-54 (n=3,350)**	**55-64 (n=4,259)**	**65-74 (n=2,899)**	**75+ (n=1,827)**
Education					
Less than postsecondary	Ref.	Ref.	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	1.03 (0.92, 1.16)	1.05 (0.84, 1.30)	1.19 (0.96, 1.47)	1.21 (0.95, 1.55)	0.78 (0.58, 1.05)
Total Wealth					
Less than $50,000	Ref.	Ref.	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.02 (0.88, 1.19)	0.92 (0.73, 1.17)	1.16 (0.87, 1.53)	1.09 (0.77, 1.55)	0.87 (0.58, 1.32)
$100,000 to less than $1 million	**1.18 (1.04, 1.33)**	1.09 (0.90, 1.31)	1.17 (0.93, 1.48)	1.33 (1.00, 1.77)	1.01 (0.71, 1.44)

$1 million or more	**1.52 (1.28, 1.80)**	**1.68 (1.28, 2.20)**	1.37 (1.00, 1.88)	1.41 (0.93, 2.13)	0.94 (0.50, 1.79)

Table 17. Multivariable logistic regression of meeting physical activity guidelines for covariates

	Model 2		Model 3		Model 4	
	Male	Female	Male	Female	Male	Female
Racial Background						
White	Ref.		Ref.		Ref.	
Not white	1.09 (0.90,1.32)	1.12 (0.91, 1.39)	1.03 (0.85, 1.24)	0.99 (0.87, 1.13)	1.04 (0.86, 1.26)	1.03 (0.83, 1.27)
Immigrant status, (%)						
No	Ref.		Ref.		Ref.	
Yes	**0.79 (0.71, 0.89)**	0.98 (0.86, 1.11)	**0.79 (0.70, 0.89**)	0.99 (0.87,1.13)	**0.79 (0.70, 0.89)**	0.97 (0.86, 1.11)
Marital Status, (%)						
Single	Ref.		Ref.		Ref.	
Married	**1.42 (1.18, 1.71)**	1.13 (0.96, 1.35)	**1.40 (1.16, 1.68)**	1.09 (0.92, 1.29)	**1.29 (1.07, 1.55)**	1.02 (0.85, 1.21)
Widowed, divorced, separated	**1.29 (1.03, 1.62)**	1.11 (0.92, 1.34)	**1.28 (1.02, 1.60)**	1.09 (0.90, 1.31)	1.26 (1.00, 1.58)	1.05 (0.87, 1.27)
Place of residence, (%)						
Urban	Ref.		Ref.		Ref.	
Rural	1.13 (0.97, 1.30)	1.00 (0.86, 1.16)	1.11 (0.96, 1.29)	1.01 (0.86, 1.17)	1.10 (0.95, 1.28)	0.99 (0.85, 1.16)
Sexual orientation, (%)						
Heterosexual	Ref.		Ref.		Ref.	
Homosexual/ Bisexual	**1.65 (1.20, 2.25)**	**0.73 (0.54, 0.97)**	**1.67 (1.22, 2.28)**	**0.73 (0.55, 0.98)**	**1.69 (1.23, 2.31)**	0.75 (0.56, 1.00)
Smoking, (%)						
Never smoker			Ref.		Ref.	
Former smoker			1.03 (0.94, 1.12)	**1.13 (1.03, 1.23)**	1.04 (0.95, 1.14)	**1.18 (1.07, 1.30)**
Current smoker			1.08 (0.93, 1.25)	0.99 (0.82, 1.18)	1.13 (0.97, 1.31)	1.01 (0.84, 1.21)
Alcohol use, (%)						

Never drinker		Ref.		Ref.	
Regular drinker		0.98 (0.79, 1.21)	**0.74 (0.61, 0.89)**	0.98 (0.79, 1.21)	**0.74 (0.61, 0.89)**
Occasional drinker		**1.32 (1.13, 1.54)**	1.03 (0.90, 1.19)	**1.25 (1.07, 1.46)**	0.95 (0.82, 1.10)
Fruit and vegetable consumption, (%)					
Not meeting recommended serving		Ref.		Ref.	
Meeting recommended serving		**1.13 (1.04, 1.23)**	**1.34 (1.21, 1.49)**	**1.11 (1.02, 1.21)**	**1.25 (1.13, 1.40)**
Sleep quality					
Poor		Ref.	Ref.	Ref.	Ref.
Good		**1.05 (1.02, 1.20)**	**1.15 (1.12, 1.30)**	1.04 (0.95, 1.13)	**1.14 (1.04, 1.24)**
BMI					
Normal weight				Ref.	
Underweight				0.62 (0.23, 1.68)	0.74 (0.47, 1.17)
Overweight				**1.17 (1.04, 1.31)**	**0.79 (0.70, 0.89)**
Obese				**1.25 (1.04, 1.49)**	**0.67 (0.55, 0.82)**
High blood pressure					
No				Ref.	
Yes				0.96 (0.87, 1.06)	0.90 (0.80, 1.01)
Depression					
No				Ref.	
Yes				0.92 (0.80, 1.06)	**0.86 (0.76, 0.97)**

Multimorbidity				
No			Ref.	
Yes			1.06 (0.96, 1.17)	**1.18 (1.06, 1.32)**
Life satisfaction				
Dissatisfied			Ref.	
Satisfied			**1.43 (1.23, 1.68)**	**1.25 (1.08, 1.46)**
Self-rated health				
Poor			Ref.	
Good			**1.40 (1.17, 1.68)**	**1.31 (1.07, 1.62)**

4.7 BMI as an Effect Modifier

We assessed the potential effect modification by BMI on the association between socioeconomic status and physical activity. These models controlled for demographic factors, lifestyle and behavioural factors, and chronic conditions and other health-related factors and were stratified by sex (Table 18). Among males, level of education is seen to reduce the likelihood of meeting physical activity guidelines only among males that are overweight, but not for males that are normal weight (OR=0.84 [0.74, 0.95]). In addition, the likelihood of meeting physical activity guidelines is significantly higher for normal weight males for all groups of wealth, opposed to only the top two groups of wealth among males that are overweight.

Among females, weight status did not moderate the relationship between education and physical activity. However, the positive effect of educational attainment did trend toward significance for females classified as normal weight. The likelihood of meeting physical activity guidelines becomes significant for only the top wealth group among females that are normal weight, whereas it remains significant for the top two groups of wealth among females that are overweight. Upon exploring the effect modification of BMI, results indicate that the effect of wealth on physical activity is amplified among males that are normal weight, whereas the effect of wealth on physical activity is weakened for females of normal weight.

Table 18. Odds ratios of meeting physical activity guidelines by socioeconomic status, stratified by sex and BMI

Males			
	Overall	Normal Weight [a]	Overweight [b]
Education			
Less than postsecondary	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	**0.85 (0.76, 0.94)**	0.86 * (0.67, 1.11)	**0.84 (0.74, 0.95)**
Total Wealth			
Less than $50,000	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.06 (0.91, 1.23)	**1.50* (1.07, 2.09)**	0.97 (0.81, 1.15)
$100,000 to less than $1 million	**1.26 (1.11, 1.42)**	**1.55 (1.18, 2.05)**	**1.19 (1.03, 1.36)**
$1 million or more	**1.47 (1.26, 1.72)**	**1.53 (1.09, 2.13)**	**1.47 (1.23, 1.76)**
Females			
	Overall	Normal Weight [a]	Overweight [b]
Education			
Less than postsecondary	Ref.	Ref.	Ref.
Postsecondary degree/ diploma	1.03 (0.92, 1.16)	1.21 (1.00, 1.47)	0.93† (0.80, 1.07)
Total Wealth			
Less than $50,000	Ref.	Ref.	Ref.
$50,000 to less than $100,000	1.02 (0.88, 1.19)	1.09 (0.86, 1.38)	0.98 (0.81, 1.19)
$100,000 to less than $1 million	**1.18 (1.04, 1.33)**	1.17 * (0.96, 1.42)	**1.19 (1.02, 1.38)**
$1 million or more	**1.52 (1.28, 1.80)**	**1.59 (1.24, 2.05)**	**1.44 (1.12, 1.84)**

* Indicates significant effect modification of BMI on socioeconomic status and physical activity

[a] Normal weight includes those with a BMI classification of "underweight" or "normal weight"

[b] Overweight includes those with a BMI classification of "overweight" or "obese"

4.8 Sensitivity Analyses for Complete Case Analysis

Sensitivity analyses were conducted to assess if differences would arise from multiple imputation and complete case analysis, only including participants with complete data, and are presented in Table 19. The sensitivity analyses indicate that no significant differences exist between performing multiple imputation or list-wise deletion of missing data.

Table 19. Comparison of unadjusted and adjusted odds ratio between socioeconomic indicators and meeting PAG stratified by sex

	Males				Females			
	Unadjusted OR (95%)		Adjusted OR		Unadjusted OR		Adjusted OR	
	MI	CCA	MI	CCA	MI	CCA	MI	CCA
Education								
Less than postsecondary	Ref	Ref	Ref.	Ref	Ref	Ref	Ref.	Ref
Postsecondary	**0.86 (0.77,0.96)**	**0.86 (0.77, 0.96)**	**0.85 (0.76, 0.94)**	**0.85 (0.76, 0.95)**	1.12 (1.00, 1.25)	1.12 (1.00, 1.25)	1.03 (0.92, 1.16)	1.03 (0.91, 1.16)
Total value of savings and investments								
Less than $50,000	Ref	Ref	Ref.	Ref	Ref	Ref	Ref.	Ref
$50,000 to less than $100,000	**1.17 (1.01,1.36)**	**1.17 (1.01, 1.36)**	1.06 (0.91, 1.23)	1.07 (0.91, 1.25)	**1.16 (1.01, 1.34)**	**1.16 (1.01, 1.34)**	1.02 (0.88, 1.19)	1.00 (0.86, 1.16)
$100,000 to less than $1 million	**1.44 (1.28,1.63)**	**1.45 (1.28, 1.63)**	**1.26 (1.11, 1.42)**	**1.25 (1.11, 1.42)**	**1.41 (1.26, 1.58)**	**1.41 (1.26, 1.58)**	**1.18 (1.04, 1.33)**	**1.15 (1.01, 1.3)**
$1 million or more	**1.73 (1.49,2.01)**	**1.73 (1.49, 2.01)**	**1.47 (1.26, 1.72)**	**1.48 (1.26, 1.73)**	**1.97 (1.67, 2.32)**	**1.97 (1.67, 2.32)**	**1.52 (1.28, 1.80)**	**1.47 (1.24, 1.76)**

Chapter 5

5 Discussion

5.1 Summary of Key Findings

5.1.1 Main Objective

This is the first study to date that has investigated the association between socioeconomic status and physical activity among middle-aged to older adults in Canada focusing on wealth as one of the main socioeconomic indicators. In our sample, only 20% of males and females met physical activity guidelines, which is consistent with findings from the 2018-2019 Canadian Health Measures Survey [260]. However, contrary to prior research that has reported an age-related decline in physical activity, our results show that the proportion of individuals meeting physical activity guidelines increases with age up to 75. This may be attributed to the characteristics of the sample, such that participants that self-enrol in studies tend to be healthier compared to those who refuse to participate in cohort studies independent of random sampling selection [261]. In addition, participants were required to be physically and cognitively capable of completing the baseline interview on their own, preventing those of poor health from participating in the study.

Our results suggest that wealth plays a stronger role than education in meeting physical activity guidelines among middle-aged to older adults in Canada. After adjusting for all covariates, education was only a significant correlate of physical activity among males and reduced the likelihood of meeting physical activity guidelines for those with more education. Our results did not align with previous studies which have shown education to be positively correlated to physical activity participation among older adults [22–24,80,213–215,262]. Given that education and income are strongly correlated, a potential explanation of this insignificant association between education and physical activity can be linked to the shift in financial reserve from income to wealth with age, weakening the role of education in physical activity participation as income becomes less influential in terms of accessibility [263,264]. In a population-based study using data from eight longitudinal cohort studies, researchers reported that the cumulative disadvantage of education on health is apparent in the early stages of life but did not contribute to further disparities in later life [263]. This suggests that education-related disparities in health as well as

opportunities to participate in health-related behaviours, such as physical activity, may be greater during early to middle adulthood but eventually dissipates as individuals reach the later stages of life. This result is important because it prompts researchers to revaluate the strength in which education plays as a socioeconomic indicator in later life in respect to health outcomes. Further research is needed to replicate the above finding in a similar sample to understand the underlying mechanism of education and physical activity in older age.

Wealth was one of the most consistent determinants of adequate physical activity, increasing the likelihood of meeting physical activity guidelines compared to education, and remained statistically significant after the adjustment of demographic characteristics, lifestyle behaviours, and chronic diseases and other health-related factors. After adjusting for all covariates, wealth increased the likelihood of meeting physical activity guidelines for males and females in the top two groups of wealth. In addition, the odds of adequate activity increased with wealth. Our results align with previous research conducted in the United States on wealth and physical activity, which have shown an improvement in physical activity uptake with increasing wealth [32,218,221]. A large population-based study in the United States, examining the degree in which behavioural risk factors contribute to socioeconomic position, found physical inactivity to be higher among those with lower wealth in the elderly population [32]. A plausible explanation is that similar to the effect of income on physical activity in the earlier stages of life, wealth provides the time and the financial freedom to participate in leisure-time physical activity [265–267]. This finding pertaining to the wealth and physical activity is novel as this association has yet to be studied in Canada.

5.1.2 Covariates

Consistent with prior literature, married males were more likely to engage in physical activity than single males [108,109]. In addition, both males and females that met fruit and vegetable consumption guidelines, had high life satisfaction and good self-rated health also met physical activity guidelines. In comparison to past studies [23,115], our results also indicated that non-immigrant males were less likely to meet physical activity guidelines compared to immigrant males, but no significant differences were found in the likelihood of meeting physical activity guidelines among Whites and non-Whites. However, this may be attributed to the underrepresentation of non-Whites and immigrants in the sample, biasing the results of our

study. Interestingly, males that were overweight were more likely to engage in physical activity whereas females that were overweight were significantly less likely compared to those that were normal weight. However, the use of BMI alone may not be an accurate representation of obesity as males tend to carry higher amounts of lean muscle mass compared to females [268].

5.1.3 Effect Modification by Weight Status

For this thesis, we explored whether weight status modified the relationship between socioeconomic status and meeting physical activity guidelines. In the prior literature, education has been reported to have a positive association with physical activity [22,24,80,168,213–215]. In our sample, education was found to be negatively associated with meeting physical activity guidelines among males. However, after stratifying by weight status, the significance of this association disappears among normal weight males but persists among those that are overweight. This finding implies that the association between education and physical activity is not significant among normal weight males, but being overweight significantly reduces the likelihood of meeting physical activity guidelines regardless of higher education. When investigating the moderating effects of weight status on wealth, we found significant effect modification of weight status between wealth and physical activity for males and females. When stratified by weight status, the association between wealth and physical activity was stronger among normal weight males compared to overweight males for all wealth groups, whereas higher wealth was only a significant determinant of physical activity among overweight males belonging to the top two wealth groups. This weakened association of socioeconomic status and physical activity participation for overweight males may be linked to weight-related barriers to physical activity such as feelings of embarrassment or shyness that prevent overweight individuals from engaging in leisure-time physical activity [269,270].

When stratified by weight status, the association between wealth and physical activity weakened for normal weight females, such that only females in the highest wealth group was significantly more likely to meet physical activity guidelines. This may be explained by the social stigma surrounding female obesity and ideologies of female beauty in society, creating societal pressure to lose excessive weight [271,272].

5.2 Implications for Physical Activity Promotion

The benefits of physical activity on the treatment and prevention of chronic disease, especially among middle-aged to older adults, is well established. Although physical activity is a feasible and effective way to reduce the potential upcoming burden of chronic disease in Canada, access to physical activity is not as simple. Social determinants of health, specifically socioeconomic status, dictate the opportunities, resources, and time one has to participate in physical activity. As our results have shown, among both males and females, greater wealth is associated with a greater likelihood of meeting physical activity guidelines. This indicates that future policies and interventions must focus on increasing access to means of participating in physical activity among low-wealth older adults to reduce the gap between socially advantaged and disadvantaged groups. For example, this may be creating more infrastructure accessible to older adults that promote walkability or fitness facilities that provide discounted rates for seniors in neighbourhoods where the level of wealth is low. In addition, by targeting areas where there is a lack of infrastructure to support low wealth individuals would also consequently address other social determinants of health that are associated with physical inactivity due to an absence of resources such as immigrant populations or visible minority groups [83,115,116].

It is important to note the differing effects of socioeconomic status on physical activity participation based on weight status. Specifically, normal weight males benefit more from being wealthy compared to overweight males. Contrarily, normal weight females are less likely to benefit from wealth compared to overweight females. It is important to take into consideration that the effect of weight status differs between sexes and affects how or if individuals take advantage of the resources associated with wealth in participating in physical activity. This can be implemented at the primary care level where physical activity is prescribed. For example, a significant association between wealth and meeting physical activity guidelines is revealed for normal weight males in the $50,000 to $100,000 wealth group, whereas this association remained insignificant for the overweight counterparts after stratifying by weight status. This indicates that removing barriers to physical activity in terms of cost would be effective in increasing leisure-time activity among normal weight males but may not be as effective among overweight males in this wealth group. By taking into consideration the moderating effect of weight status on physical activity, this eliminates weight-related barriers and allows for

personalized physical activity programs to ensure all groups can take advantage of the resources available to facilitate physical activity participation.

5.3 Strengths

There are several strengths to the current study. To begin, our study employs wealth as one of the main socioeconomic indicators. Due to the older age of our sample, wealth more accurately represents the financial resources available to participate in physical activity. To our knowledge, no Canadian study has explored wealth in relation to physical activity among older adults. Furthermore, the CLSA is a large population-based study that provides a comprehensive research platform on health and aging of Canadians, and provides high statistical power given the large sample size of the study. Our study operationalizes physical activity using the physical activity guidelines over other self-reported measures such as questionnaire scores, energy expenditure and steps per day. This allows our results to be valuable from a public health perspective, as the benefits of the physical activity guidelines are well supported by the literature and associated with improving a magnitude of chronic conditions and other positive health outcomes. By controlling for relevant covariates such as demographic characteristics, lifestyle behaviours and other health-related risk factors allows our study to control for other correlates of activity and, in turn, achieve greater precision while investigating the effects of socioeconomic characteristics on physical activity. An additional strength is our sex- and age-stratified analysis to account for biological and clinical differences between population groups. We performed multiple imputation of missing data and used analytic sampling weights to prevent the potential effects of bias as well as allow our results to be generalizable to the aging Canadian population, respectively.

5.4 Limitations

5.4.1 Self-Reported Measures

A limitation of the study includes the self-reported measures of physical activity and wealth which tend to be overestimated due to social desirability bias [273,274]. Wealth is often self-reported in studies in health and is difficult to measure effectively and validate. It requires researchers to ask a variety of sensitive questions on all financial reserves and debts relevant to the individuals, which results in wealth being over-estimated. Over-estimation of the determinant and the

outcome pulls the estimate away from the null, presenting a stronger association than the true relationship. As opposed to using a continuous indicator of wealth, response categories were presented in intervals of $50,000 which allowed for higher accuracy in capturing the respondent's wealth group and reduced the effect of response bias. Compared to objective measures of physical activity such as accelerometers, self-reported measures of activity are more feasible and allows for the collection of data for a larger sample relevant to generalizability to the population.

5.4.2 Measures of Physical Activity

To align with the new physical activity recommendations highlighted in the Canadian 24-Hour Movement Guidelines, any duration of moderate to vigorous activity should be counted towards meeting the guidelines [275,276]. However, as physical activity was only derived from components of the PASE questionnaire that provided duration and frequency, additional moderate to vigorous activities such as rowing and heavy housework were not accounted for in the study. Furthermore, the updated guidelines included an additional criterion, participating in two or more sessions of muscle-strengthening activities a week, in the new physical activity guidelines. However, due to the nature of the questionnaire, it was not possible to differentiate between participating in one or two sessions of muscle strengthening activities, which would have resulted in an over-or under-estimation of meeting physical activity guidelines. In addition, the questionnaire only captures physical activity patterns within the last seven days which may not reflect the individual's long-term physical activity habits prior to the administration of the interview. However, capturing a respondent's physical activity level throughout their lifetime or for the past 12 months would be subjected to greater recall bias than for the past seven days.

5.4.3 Representativeness of the Sample

It is important to note that individuals included in the CLSA comprehensive cohort were more likely to be educated, had higher incomes, were non-immigrants and perceived their general health to be very good [277]. Furthermore, as interviews for the Comprehensive cohort were performed at the Data Collection Sites and required individuals to answer questions in French or English, this would exclude potential respondents that were not proficient in French or English, such as recent immigrants and visible minorities, as well as those with debilitating health

conditions such as cognitive or mobility impairments. In addition, our results indicate that respondents excluded from the analytic sample were older, female, non-white, immigrant, not married, had less than post-secondary education, and had less acquired wealth. As the baseline sample initially comprised of individuals that were more socially advantaged, further exclusion of vulnerable populations resulted in a more socially homogenous sample that does not necessarily represent the general Canadian population. These results may not apply to those over the age of 85, or First Nations from reserves and aboriginal settlements, and people living in the Northwest Territories, Yukon, and Nunavut due to the exclusion of these groups from the CLSA. Differences in physical activity participation across socioeconomic strata may be underestimated by the homogenous sample used for analysis. However, our study adjusted for as many relevant covariates from the literature to increase the accuracy and precision of the parameters.

5.4.4 Establishing Causality

As we performed a cross-sectional analysis of the baselines CLSA Comprehensive cohort, temporality and causality of the association cannot be established between socioeconomic status and physical activity. Although prior literature has suggested causality between the social determinants of health and physical activity, we cannot establish the temporal direction of the association such that meeting physical activity guidelines result from higher wealth.

5.5 Future Research

Results of our study have highlighted areas of further research. Despite the strong correlation between wealth and meeting physical activity guidelines, 80% of our sample were not meeting physical activity guidelines. This prompts further research into investigating other correlates of physical activity among older adults other than socioeconomic status. It would be of interest to understand the association between neighbourhood socioeconomic status, using linkage of postal codes to census data, through spatial analysis to consider accessibility of community resources that influence physical activity engagement. Furthermore, qualitative research on the perceived barriers of physical activity among low-wealth older adults would be beneficial in understanding how to promote the adoption of physical activity among disadvantaged groups. In our age-stratified results, wealth was only a significant correlate of physical activity up to the average age of retirement and earlier among females. Therefore, further investigation of other determinants of

physical activity is warranted to understand additional barriers to activity for adults past the age of retirement. Further research should aim to include a representative sample of the population where vulnerable populations such as visible minorities, females and those with poor health are not excluded from the study sample. In addition, researchers need to assess the association between education and physical activity between sexes to determine how the relationship between socioeconomic status and health behaviours evolve. Specifically, further longitudinal research is warranted to investigate how changes in wealth affect physical activity participation to establish causality as well as determine if and how the effect of socioeconomic status changes over time. As respondents in the CLSA sample were born between the 1920s to the 1970s, the evolution of social norms surrounding leisure-time physical activity engagement limits the simple age effects analysis. It would be important to consider difference in age-cohort effects on physical activity to represent changes in social attitudes towards routine exercise unrelated to aging. Our results have also highlighted a need to adopt a life course approach when evaluating the effect of socioeconomic indicators in respect to physical activity engagement.

5.6 Conclusion

Physical inactivity is an important modifiable risk factor for the treatment and prevention of chronic disease and healthy aging, but access to participating in physical activity follows a social gradient. For the adoption of physical activity to be successful, it is important to evaluate the barriers to hinder many from being physically active. As the incidence of chronic disease rises with the aging population, our study found evidence on the association between wealth and physical activity among middle-aged to older adults in Canada regardless of differences in demographic characteristics, lifestyle behaviours and other health-related risk factors. The present study informed the knowledge gap by summarising and evaluating the evidence on the association between socioeconomic status and physical activity among middle-aged to older adults in Canada. Our results showed that higher wealth was positively associated with the likelihood of meeting physical activity guidelines. Weight status was also found to modify the association between education and wealth on physical activity. Therefore, there is a need to improve access to physical activity among to those that are less wealthy or with lower educational level. Although the association between wealth and physical activity was stronger among overweight females and normal weight males, the association remained significant for all

weight groups. Further research is warranted to explore the association between education and wealth in a sample that is representative of the aging Canadian population to allow for a more accurate understanding of the role socioeconomic status on physical activity engagement in the later stages of life. A one-size fits all approach to promoting physical activity excludes the most disadvantaged socioeconomic groups and further amplifies existing social inequalities. Tailoring physical activity prescription and creating opportunities for physical activity guidelines to be attainable in any context reduces the potential burden of chronic disease on the Canadian healthcare system and provides everyone a chance at healthy aging.

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Curriculum Vitae

Name:	Jane Yuan
Post-secondary Education and Degrees:	Queen's University Kingston, Ontario, Canada 2016-2020 BSc. with a Specialization in Kinesiology Western University London, Ontario, Canada 2020-present MSc. Epidemiology and Biostatistics
Honours and Awards:	Western Graduate Research Scholarship 2020-2021
Related Work Experience	Epidemiological Research Assistant SeroTracker 2022-present Graduate Research Assistant Return to Health and Performance Lab 2020-2022 Data Analyst Center for Population Health and Disease - Statistics Canada 2021
Publications:	Thornton J, Rosen C, Davenport M, Dorian P, Gouttebarge V, Breau B, Pila E, Reilly K, **Yuan J**, Mok K, Di Ciacca S, Speechley M, Crossley K. Beyond the Medals: A cross-sectional study investigating retired high performance female athletes' health. BMJ Open Sport & Exercise Medicine 2023;9:e001479. doi: 10.1136/bmjsem-2022-001479
Conference Presentations:	**Yuan, J**. (2022, September). "Social patterning of physical activity among middle-aged to older adults". Poster presented at the ACTIVE for Health Symposium, Ontario. Aversa, I., Carter, B., Loeschnik, E., **Yuan, J**. (2020, May). "Association between self-perceived weight and weight control behaviors among adolescents with anxiety and mood disorders." Poster presented at the annual London Health Research Day, Ontario.