Were adults with intellectual disability (ID) meeting the 2020 Canadian 24-hour movement guidelines during COVID-19? A pilot study

by

John Cooper Coats
BSc (Honours), Acadia University, 2018

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF SCIENCE

in the School of Exercise Science, Physical & Health Education

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

Supervisory Committee

Were adults with intellectual disability (ID) meeting the 2020 Canadian 24-hour movement guidelines during COVID-19? A pilot study

by

John Cooper Coats
BSc (Honours), Acadia University, 2018

Supervisory Committee

Dr. Lynneth A. Stuart-Hill, School of Exercise Science, Physical & Health Education, University of Victoria, BC, Canada.
Co-Supervisor

Dr. Viviene Temple, School of Exercise Science, Physical & Health Education, University of Victoria, BC, Canada.
Co-Supervisor

Abstract

Maintaining a healthy lifestyle is crucial to reducing the risk of chronic disease and improving overall health and well-being. However, individuals with intellectual disability (ID) experience high levels of physical inactivity, sedentary behaviour, and poor sleep, leading to detrimental health outcomes. This pilot study investigated the extent to which adults with ID met the 2020 Canadian 24-hour Movement Guidelines during COVID-19. This pilot study followed a 9-day observational cross-sectional design and included 15 adults (6F, 9M) between the ages of 20-64 years. Using commercially available wearable technology, moderate-to-vigorous physical activity (MVPA) and sedentary time were extrapolated using heart rate, and total sleep time was measured to compare to guidelines. A novel diary subjectively tracked the number of bouts and types of physical activity performed. Of the 15 participants, 11 met the MVPA guideline (73%), 4 met the sedentary behaviour guideline (27%), 7 met the sleep guideline (47%), and only 1 participant met all 3 of the guidelines (7%). There were no significant differences for MVPA, light-physical activity (LPA), and sleep between weekdays and weekend days, or between females and males. Walking, cleaning dishes, and swimming were the most common types of physical activity performed by participants. Spearman's rank-order correlations showed very low positive correlations between the number of physical activity bouts reported and the number of movement guidelines met, weekly MVPA, weekly sedentary time, sleep, and body mass index. Findings from this pilot study indicate a real need to improve sleep and reduce sedentary time by adults with ID. This pilot study recommends building on the objective and subjective measures used in this study in further research on physical activity and sleep in adults with ID.

Table of Contents

List of Tables

List of Figures

Acknowledgments

There are several people that I need to thank for their involvement in the completion of this thesis. Firstly, to my co-supervisors, Dr. Lynneth Stuart-Hill and Dr. Viviene Temple, I would like to sincerely thank you for taking me on as a graduate student and always challenging me to better myself as a researcher. Your dedication to my academic growth and your unwavering mentorship and guidance have been instrumental in making my experience at UVic so special.

To my classmate, research partner, and friend, Matthew Coxon, thank you for taking on this project with me and for keeping me motivated all the way to the finish line. To the undergraduate honours students who assisted us with data collection, Cara Butler and Stefanie Sajko, thank you for your invaluable additions to the project. To the professors I’ve worked with throughout my degree, Dr. Sam Liu, Dr. John Walsh, Greg Mulligan, and Dr. Kathy Gaul, thank you for making my graduate school experience intellectually stimulating and engaging. To my Canadian rugby coaches, thank you for encouraging me to continue my academic journey. Lastly, to my friends and teammates, thank you for supporting me and always being dependable.

Dedication

To my loving family, who have supported me through everything in life, I dedicate this thesis to you. Your unwavering love, encouragement, and belief in me have allowed me to become the person I am today. Lots of love.

Chapter 1 - Introduction

1.1 Overview & Rationale

Hallmarks of a healthy lifestyle include maintaining regular physical activity, limiting sedentary time, and maintaining proper sleep hygiene. Maintaining a physically active lifestyle has both immediate and long-lasting benefits. A single bout of physical activity has been shown to reduce blood pressure and feelings of anxiety, as well as improve sleep quality, insulin sensitivity, and cognitive function in the prefrontal cortex (U.S. Department of Health and Human Services, 2018). Maintaining regular physical activity also has long-term benefits, including reducing the risk of dementia, cardiovascular disease, stroke, several cancers, and weight gain, as well as improving overall bone health, balance, and coordination (U.S. Department of Health and Human Services, 2018). Meanwhile, inactivity and sedentary behaviour have been linked to an increased risk of cardiovascular disease, type II diabetes, and several various cancers (U.S. Department of Health and Human Services, 2018). Maintaining healthy sleep hygiene has also been shown to reduce the risk of heart disease, and type II diabetes as well as improve immune function, mood, and cognitive function (Centers for Disease Control and Prevention, 2022)

The Canadian Society for Exercise Physiology (CSEP) published the 2020 Canadian 24-Hour Movement Guidelines, which describe suggested amounts of physical activity, sedentary activity, and sleep to maintain a healthy lifestyle and lower the risk of chronic disease (Ross et al., 2020). These guidelines suggest achieving a minimum of 150 minutes of MVPA each week while including two muscle-strengthening activities using major muscle groups (Ross et al., 2020). Limiting sedentary time to eight hours or less while limiting recreational screen time to three hours or less is also recommended (Ross et al., 2020). The guidelines also recommend achieving seven to nine hours of good-quality sleep regularly, with consistent rest- and wake-up times.

While the benefits of maintaining a healthy lifestyle are clear, there is growing evidence suggesting that adults with ID are not achieving healthy levels of physical activity, leading to poor sleep quality and detrimental health outcomes (Dairo et al., 2016; Hsieh et al., 2017). Furthermore, the COVID-19 pandemic has provided an additional barrier to maintaining a healthy and physically active lifestyle, which has disproportionately affected individuals with ID (Theis et al., 2021).

Due to the restrictions of the global pandemic, in-person data acquisition for research on physical activity, sedentary behaviour, and sleep among vulnerable populations became increasingly difficult. However, improvement in wearable technologies provides a unique opportunity for tracking physical activity, sedentary behaviour, and sleep in vulnerable populations (Phillips et al., 2018). Along with the physiological consequences of physical inactivity, there is a significant economic cost to the management and treatment of related diseases (Public Health Agency of Canada, 2014). Therefore, it is with utmost importance that policymakers make informed decisions on efforts to mitigate the risk of chronic disease associated with physical inactivity among Canadians with ID backed with a strong evidence base.

1.2 Objective

The objective of this pilot study was to determine the extent to which adults with ID in Victoria, BC were meeting the physical activity, sedentary activity, and sleep recommendations of CSEP's 2020 Canadian 24-Hour Movement Guidelines during the COVID-19 global pandemic (CSEP, 2020b).

1.3 Research Questions

i) To what extent are adults with ID in Victoria, BC meeting the 24-hour movement guidelines during COVID-19?

ii) What are the most common modalities for achieving physical activity for adults with ID?

iii) What is the relationship between the objective and subjective measures of physical activity in adults with ID?

1.4 Study Significance

Achieving healthy levels of physical activity and sleep, while limiting time spent sedentary are all associated with a reduction in morbidity and all-cause mortality (Morgan & Hartescu, 2019; Warburton & Bredin, 2017). Understanding the current level of physical activity and sleep for adults with ID, will provide policymakers and community outreach programs within Victoria, BC with salient information for public health provisions. Furthermore, the novel design of this pilot study using remote monitoring, which limited contact time thus increasing subject safety, will provide a valuable framework for future studies with vulnerable populations.

1.5 Assumptions

It was assumed that participants did not change their weekly physical activity routine or sleep schedule as a result of the project.

1.6 Limitations

Only adults with ID who were associated with community programs in Victoria, BC and able to perform and track physical activity and sleep independently or with the help of a caregiver participated in this pilot study. Therefore, the findings from this study may not be fully representative of all adults with ID.

1.7 Operational Definitions

2020 Canadian 24-hour movement guidelines:

Set of recommendations by the Canadian Society for Exercise Physiology (CSEP) for the minimum amount and types of physical activity, sedentary behaviour, and sleep that individuals should aim to achieve to promote health and well-being (CSEP, 2020d). The recommendations for adults aged 18-64 years are as follows (CSEP, 2020b):

- Perform an accumulated 150 minutes of moderate to vigorous aerobic physical activity per week.
- Get 7 to 9 hours of good-quality sleep on a regular basis.
- Limit time spent sedentary to 8 hours or less each day.

Intellectual disability (ID):

A disability characterized by deficits in both intellectual and adaptive functioning in conceptual, social, and practical domains, which originates before 18 years of age (Schalock et al., 2010, p. 1). It is also referred to as intellectual developmental disorder (American Psychiatric Association, 2022). Appendix A provides specific information regarding diagnostic criteria for intellectual disability as well as eligibility requirements for the community programs used in this study.

Light aerobic physical activity (LPA):

Light aerobic activities such as slow walking, standing light work (e.g., cooking), and playing most instruments. LPA refers to physical activity that is equivalent to an energy expenditure of 1.5-3.0 METs for adults and older adults (CSEP, 2020d). In this study, LPA was defined as any activity during which an individual's heart rate is within 50 to 64% of their HR_{max} (Warburton et al., 2007).

Moderate-intensity physical activity (MPA):

Aerobic activities such as brisk walking, ballroom dancing, water aerobics, general gardening, and cycling at 10 mph or less. The activities increase heart rate and improve cardiorespiratory fitness. MPA refers to physical activity that is equivalent to an energy expenditure of 3.0-5.9 METs for adults and older adults (CSEP, 2020d). MPA is defined as any activity during which an individual's heart rate is within 64 to 76% of HR_{max} (Warburton et al., 2007). In this study, MPA was not directly measured but included in the measure of MVPA.

Moderate-to-vigorous-intensity physical activity (MVPA):

Refers to any aerobic physical activity performed at an intensity matching MPA or VPA. MVPA is defined as any activity during which an individual's heart rate is within 64 to 93% of their HR_{max} (Warburton et al., 2007). In this study, any activity that had a heart rate of above 64% was recorded as MVPA.

Sedentary behaviour:

Refers to "any waking behaviour characterized by an energy expenditure ≤1.5 METs, while in a sitting, reclining, or lying posture" (CSEP, 2020d). In this study, any activity that had a heart rate of below 50% of HR_{max} was recorded as sedentary behaviour (Warburton et al., 2007). Sedentary behaviour and sedentary activity are used synonymously throughout the present study.

Sleep:

Refers to the natural and reversible periodic state of reduced activity and lowered sensory awareness to support several physiological needs (Kirszenblat & Van Swinderen, 2015). Sleep is made up of cycles of rapid eye movement (REM) and non-rapid eye movement (NREM), where, in the former, the individual typically experiences dreaming (Merriam-Webster, 2023). In this study, quantitative and qualitative measures of sleep were used. The Polar Ignite smartwatch (Polar Canada, 2021) tracked total sleep time each night, while the Physical Activity and Sleep diary included a self-report of sleep time.

Vigorous-intensity physical activity (VPA)

Aerobic activities such as race walking, running, swimming laps, aerobic dancing, uphill hiking, jumping rope, and cycling at 10 mph or faster. These activities typically result in a substantial increase in heart rate and body temperature, as well as induce sweat. VPA refers to physical activity that is equivalent to an energy expenditure of ≥6.0 METs (CSEP, 2020d). VPA is defined as any activity during which an individual's heart rate is within 76 to 93% of their HR_{max} (Warburton et al., 2007). In this study, VPA was not directly measured but included in the measure of MVPA.

Chapter 2 Literature Review

This literature review chapter will elaborate on the 2020 Canadian 24-hour movement guidelines and why achieving regular physical activity, limiting sedentary behaviour, and maintaining proper sleep hygiene, is crucial to living a healthy life. Furthermore, this chapter will shed a light on the challenges faced by adults with ID in achieving these facets of a healthy lifestyle, as well as how the COVID-19 global pandemic has affected physical activity levels. Lastly, this chapter will introduce the use of wearable technology to objectively measure activity levels and sleep with vulnerable populations.

2.1 Health Benefits of Staying Physically Active

A physically active lifestyle is an important component of a healthy lifestyle. There is a plethora of evidence supporting the numerous immediate and long-term health benefits of physical activity, which is why it has been and remains a customary point of any health promotion messaging (Warbuton & Bredin, 2017). More specifically, there is strong evidence that suggests regular physical activity plays a crucial role in all-cause mortality, overall heart and brain health, physical fitness (aerobic, muscle strength, endurance), functional capacity, and risk of falling (U.S. Department of Health and Human Services, 2018).

Even a single 30-minute bout of MVPA has been shown to have immediate positive effects on a person, including reducing blood pressure, reducing the feeling of anxiety, as well as improving one’s quality of sleep (U.S. Department of Health and Human Services, 2018). Although there are immediate positive effects of physical activity, the long-term benefits are only seen when a person achieves consistent regular physical activity. The U.S. Department of Health and Human Services (2018) lists several positive health changes from regular physical activity, including lowering the risk of cardiovascular disease, type II diabetes, certain cancers, dementia, weight gain, and falling risk. Furthermore, there are multiple benefits to psychosocial health as well, including improving cognitive function and quality of life while reducing anxiety and the risk of depression (U.S. Department of Health and Human Services, 2018). It has also been shown that persons who are regularly physically active benefit from improved bone strength, balance, coordination, and immune function (Nieman & Wentz, 2019).

2.2 Consequences of a Sedentary Lifestyle

Maintaining a physically active lifestyle is ideal, however, it is estimated that, worldwide, just over one in four adults are not achieving enough physical activity and that more developed countries show even higher levels of inactivity (World Health Organization, 2020). As economically developed countries further their technological advancement and social media footprint, the trend indicates that individuals are choosing a more sedentary lifestyle and limiting daily physical activity, which is why high-income western countries showed 36.8% of persons not achieving sufficient physical activity in 2016 (Guthold et al., 2018). Knowing the countless benefits of regular physical activity, choosing a sedentary lifestyle has some potentially serious consequences for health.

Sedentary activity or behaviour is defined as “any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying posture”, while physical inactivity is defined as achieving too little exercise or movement (Thivel et al., 2018, p. 2). Sedentary behaviours typically consist of activities such as playing video games, watching television, or using any phone application (Tremblay, 2018). Therefore, it is understandable that developed countries, which have more access to such technologies, show greater amounts of sedentary behaviour among the general population (Prince et al., 2020). Given this trend, there is a growing number of studies and health promotions aimed to warn the public of the consequences of said behaviours (World Health Organization, 2020).

High levels of sedentary behaviour have been linked to several adverse health outcomes, relating to metabolic diseases, bone health, psychosocial health, and other diseases (Park et al., 2020). There is evidence indicating an association between sedentary time and the risk of developing type II diabetes (Biswas et al., 2015). Furthermore, high sedentary behaviour has been reported to have a strong association with the risk of hypertension (Guo et al., 2020). While physical activity improves bone health, prolonged and regular sedentary behaviour has been shown to reduce bone mineral density and increase the risk of osteoporosis (Park et al., 2020). According to Zhai et al.'s (2015) systematic review and meta-analysis, individuals with high levels of sedentary behaviour had a greater risk of depression. However, more recent evidence also shows that cognitively stimulating sedentary activities such as reading books, driving, or kitting were associated with a lower risk of depression (Huang et al., 2020). Lastly, perhaps most known, sedentary behaviour is strongly correlated with waist circumference and the prevalence of obesity (Park et al., 2020).

Overall, there are several deleterious health outcomes associated with sedentary behaviour. Therefore, avoiding sedentary time while replacing it with physical activity is crucial for maintaining overall health and reducing the risk of developing chronic disease.

2.3 Effects of Adequate and Inadequate Sleep

Maintaining a physically active lifestyle while limiting high levels of sedentary behaviour has been shown to have both immediate and long-term health benefits. However, there is another aspect of a healthy lifestyle that is not always mentioned, which is sleep. Sleep is one of our most primitive behaviours yet one of the most complex phenomena, which is why sleep, and its underlying mechanisms and long-term effects are not fully understood (Cappuccio et al., 2010). When discussed, the blanket statement that is often used is that one needs to achieve at least seven to nine hours of sleep, however, there is some evidence indicating that excessive sleep durations (9+ hours) are correlated with a poorer quality of life and a higher risk of all-cause mortality (Gallicchio & Kalesan, 2009; Ohayon et al., 2012).

Healthy sleep is characterized by proper duration (7 to 9 hours), good quality (little to no interruptions), appropriate timing (consistent bed and wake times), and a lack of sleep disorders (Chaput et al., 2020). Achieving a healthy level of sleep has been associated with improvement in a wide range of cognitive functions, such as learning, (Diekelmann et al., 2009), memory (Fogel et al., 2007), attention (Orzech et al., 2011), and academic performance (Okano et al., 2019). Although the previous studies listed above outline several benefits for achieving proper sleep, most research on sleep focuses on the adverse health outcomes of inadequate and excessive sleep.

A systematic review investigating sleep duration and the risk of coronary heart disease (CHD) found a U-shaped relationship between sleep duration and risk of CHD, where the lowest risk was seen in adults achieving seven to eight hours of sleep (Wang et al., 2016). Interestingly, one meta-analysis found a similar U-shaped trend regarding the relationship between sleep duration and risk of type II diabetes with the lowest risk at around seven hours (Shan et al., 2015). Other studies have also shown that sleep duration outside of the normal range of seven to eight hours can increase the risk of cognitive disorders (Wu et al., 2018), cognitive decline (Lo et al., 2016), and risk of falls in workers (Wu & Sun, 2017).

Along with physical activity and sedentary behaviour, achieving adequate sleep is a crucial component of maintaining a healthy lifestyle, which acts to limit the risk of developing deleterious health outcomes. Most studies have found that a sleep duration of between seven to eight hours corresponded with the lowest risk of developing negative health outcomes (Lo et al., 2016; Shan et al., 2015; Wu et al., 2018; Wu & Sun, 2017). Although historically many guidelines around healthy lifestyles have focused on physical activity alone, it is for the reasons mentioned above that the recent guidelines now include a portion on achieving adequate sleep (Ross et al., 2020; U.S. Department of Health and Human Services, 2018).

2.4 2020 Canadian 24-Hour Movement Guidelines

Given the multifaceted benefits of maintaining a healthy lifestyle, many Canadians would find it very useful to understand how much physical activity, sedentary activity, and sleep are necessary. CSEP published the 2020 Canadian 24-Hour Movement Guidelines, which are a series of recommendations for multiple age ranges (0-4 years, 5-17 years, 18-64 years, and 65+ years) encouraging individuals to achieve healthy amounts of physical activity, limit the amount of sedentary behaviour, and get enough quality sleep (Ross et al., 2020). Each age range has slightly different goals, owing to the physiological and sociological differences at each stage of life (Ross et al., 2020). The children and youth category (aged 5-17 years) focuses on high amounts of MVPA, LPA, and sleep, with an added focus to limit recreational screen time to two hours or less (CSEP, 2020c). Meanwhile, the movement guidelines for adults aged 65 years or older tend to focus more on achieving regular amounts of LPA and MVPA while focusing on activities that improve muscle strength as well as balance (CSEP, 2020a).

Pertinent to this study, the largest age range category is for adults aged 18-64 years, which has specific recommendations for both limiting excessive sedentary behaviour as a result of office jobs, as well as achieving regular physical activity at multiple intensity levels (Ross et al., 2020). More specifically, the guidelines recommend achieving a weekly minimum of 150 minutes of MVPA (e.g., running, cycling, aerobic swimming), at least two activities specific to muscle strengthening (e.g., resistance training, yoga, Pilates), and several hours of LPA (e.g., slow walking, preparing food, standing) for optimal health benefits (CSEP, 2020b). For sedentary behaviour, it is recommended to limit sedentary time to eight hours or less per day and break up long periods of sitting with standing/walking breaks, as well as limiting recreational screen time to three hours or less (CSEP, 2020b). Lastly, to benefit from the positive health effects of sleep, the guidelines recommend getting seven to nine hours of good-quality sleep regularly with consistent bed and wake-up times (CSEP, 2020b).

As discussed previously, adults who can follow these healthy lifestyle guidelines can benefit from a myriad of positive health effects, including a lowered risk of cardiovascular disease, hypertension, type II diabetes, multiple cancers, anxiety, dementia, and weight gain (Ross et al., 2020). Furthermore, improved bone health, cognitive function, overall quality of life, and physical function are all associated with following these guidelines (Ross et al., 2020). In summary, there are countless benefits to maintaining a healthy lifestyle and the 2020 24-Hour Canadian Movement Guidelines acts as a salient resource for anyone hoping to understand the necessary levels of activity and sleep to profit from these benefits (Ross et al., 2020).

2.5 Understanding Intellectual Disability

Intellectual disability is defined as “A disability characterized by significant limitations in both intellectual functioning and in adaptive behaviour, which covers many everyday social and practical skills. This disability originates before the age of 18” (Schalock et al., 2010, p. 1). The Centers for Disease Control and Prevention (2020) state that most causes of ID, like “Down syndrome, fetal alcohol syndrome, Fragile X syndrome, genetic conditions, birth defects, and infections”, originate before birth. However, injuries to the head, stroke, or certain infections that occur later in life can also cause ID (Centers for Disease Control and Prevention, 2020). According to the American Association on Intellectual and Developmental Disabilities (AAIDD, 2021), ID impacts both an individual’s intellectual functioning and adaptive behaviour. Intellectual functioning, or intelligence, relates to one’s overall mental capacity, which includes aspects such as “learning, reasoning, problem-solving, and so on” and is typically measured using an IQ test (AAIDD, 2021, Intellectual Functioning section). Adaptive behaviour relates to the conceptual (e.g., language, mathematics, currency), social (e.g., self-esteem, interpersonal skills, social responsibility), and practical skills (e.g., personal hygiene, use of money, daily routine) that are learned from other people in their lives (AAIDD, 2021).

Due to the difficulties associated with completing a comprehensive survey on the global prevalence of ID, global estimates tend to vary between studies (Harris, 2006; Heikura et al., 2003). However, Maulik et al. (2011) completed a meta-analysis of 52 population-based studies and found a global prevalence of ID of 1.037%. Important to note, it was found that low- and medium-income countries showed the highest prevalence rates, while studies based on children and adolescents also tended to show higher rates than studies primarily looking at adults (Maulik et al., 2011).

Although the population of individuals with ID is not large, morbidity and mortality rates in this group are considerably higher than among those without ID (Coppus, 2013). More specifically, one cohort study determined a crude mortality rate of 1.324% per year among adults with ID, while the rate for the English population sample was 0.397% (Hosking et al., 2016). Furthermore, one systematic review determined that individuals without ID, on average, lived 20 years longer than individuals with ID (O'Leary et al., 2018). It was also noted that as the level of ID became more profound, the mortality rate increased (O'Leary et al., 2018). There was also inequality among the sexes as women with ID tended to experience a greater discrepancy in life expectancy compared with individuals without ID (O'Leary et al., 2018). The leading causes of death for adults with ID were respiratory and cardiovascular disease, while cancers were found to be less common within the population (O'Leary et al., 2018). However, a reoccurring issue in these studies investigating mortality rates among adults with ID is that the sample populations tend to only come from medium- to high-income countries, and therefore, it is not known whether these findings are indicative globally (O'Leary et al., 2018).

There is also a concerning lack of representation of adults with ID in contemporary research. Specific to public health research, a systematic review by Brooker et al. (2015) found that cohort studies included in the review excluded people with ID and the randomized control trials (RCT) actively excluded this population. Exposing these discrepancies in research participation is important, as including adults with ID has a multitude of benefits, for both those individuals included in the study (e.g., the feeling of value, improved self-esteem, learning experience) and society at large (e.g., greater insight on ID, research validity, reflective of their views and experiences) (McDonald et al., 2016).

In summary, persons with ID do not make up a large portion of the global population, however, there is a high economic cost associated with the higher prevalence of non-communicable diseases associated with this population (O'Leary et al., 2018). Furthermore, there is also a significant discrepancy in the quality of life reported between adults with and without ID that needs to be addressed (Simões & Santos, 2016). Therefore, governments should be attempting to mitigate these issues by promoting physical activity and supporting individuals with ID to participate in community programs.

2.6 Disproportionate Incidence of Physical Inactivity and Sedentary Behaviour in Adults with Intellectual Disability

As discussed previously, there is a global concern that adults are not achieving enough physical activity and spending too much time sedentary with office jobs and screen time. Yet even more alarming are the levels of physical inactivity and sedentary behaviour in adults with ID (Dairo et al., 2016). When looking at 150 minutes of MPA or

75 minutes of VPA for a weekly guideline, Dairo et al.'s (2016) systematic review found that only 9% of adults with ID in the studies included met these guidelines. One study using remote monitoring with accelerometers on adults with ID found that only 10.7% of participants achieved the recommended 150 minutes of MVPA weekly (Oviedo et al., 2017). Furthermore, in a study that used both self-reporting and accelerometry to measure activity levels in adults with ID, only 23.7% achieved 150 minutes of MVPA per week (Barnes et al., 2013). There are also several studies indicating that adults with ID are at a heightened risk for sedentary behaviour (Melville et al., 2017; Lynch et al., 2021), and knowing the detrimental health outcomes of a sedentary lifestyle (Park et al., 2020), this is a serious concern for the general health of people with ID. Although there may be some methodological differences between these studies, one finding remains consistent, which is that most adults with ID are not achieving enough physical activity to gain from the associated health benefits.

2.7 Issues with Studying Sedentary Behaviour Among Adults with Intellectual Disability

There are many studies of physical activity levels in adults with ID, however, when looking at research done on sedentary behaviour in adults with ID, several potential problems arise. Melville et al.'s (2017) systematic review identified some of these issues. One issue is that many studies did not distinguish between sedentary behaviour (i.e., sitting, stationary activity) and physical inactivity (i.e., too little exercise or movement), which is problematic as it would be unknown whether the study was measuring sedentary behaviour (i.e., sitting, reading) or purely lack of physical activity (Melville et al., 2017). There was also a range of definitions used for sedentary behaviour, some of the definitions included time spent sitting and/or lying (Finlayson et al., 2011; Matthews et al., 2011; Temple et al., 2003), watching television (Frey 2004; Hsieh et al., 2014), or total screen time (Mikulovic et al., 2014). As noted by Lynch et al. (2021), there was also some concern regarding external validity, or more specifically the generalizability of the results, as some of the studies included in Melville et al.'s (2017) systematic review stated that there is a need for larger sample sizes and more sampling randomization.

In summary, there is a need for more studies on sedentary behaviour in adults with ID. Future studies investigating the sedentary behaviours of adults with ID should provide a specific definition of sedentary behaviour, distinguish between whether they are investigating physical inactivity or time spent sedentary, and discuss the threats to the generalizability of their findings given their sample size.

2.8 Sleep Research on Adults with Intellectual Disability

Sleep problems and lack of quality sleep are common issues faced by adults with ID (Surtees et al., 2018; Richdale & Baker, 2014; Wouw et al., 2012). However, due to the heterogeneity of methodologies and definitions used, there is a wide range of prevalence rates for sleep problems in adults with ID (Richdale & Baker, 2014), from 24% to 86%. It is understood that adults with ID experience poorer sleep quality and length, however, there are gaps and methodological issues in research on the matter. In particular, most studies on sleep focus on children with ID and not adults (Surtees et al., 2018). Additionally, most studies use qualitative questionnaires or surveys to determine sleep length and quality (Wouw et al., 2012), rather than using direct measurements such as actigraphy, as used by Dodd et al. (2008) in a case series. One issue with the use of questionnaires or self-reports, as discussed by Wouw et al. (2012), is that often adults with ID have difficulties communicating their sleeping experiences, and so caregivers end up having to report on their behalf (e.g., proxy reports), which can result in a reporting bias. Therefore, future research should attempt to incorporate self-reports of sleep that are user-friendly to both reduce the methodological burden of these studies and improve the response rate by participants.

In summary, there is a clear need for more research on the current levels of sleep and sleep quality in adults with ID. Future studies should aim to establish a uniform definition of a sleep problem and when attempting to measure sleep length and quality, objective measures like that of actigraphy should be prioritized as qualitative reporting can lead to strong bias.

2.9 COVID-19 is an Additional Barrier to a Healthy Lifestyle

The onset of the COVID-19 global pandemic brought with it a sweep of unprecedented restrictions, which have especially affected vulnerable populations like adults with ID (Courtenay & Perera, 2020). To combat the spread of the virus, governments, like the Government of Canada, introduced and enforced many restrictions that limited normal daily activities (Hossain et al., 2020), including many mediums through which people achieve regular physical activity. Some of these mediums are public gyms, swimming pools, group fitness classes, play areas, and even some outdoor activity spaces (Maugeri et al., 2020). Likely because of these closures and restrictions, there have been multiple studies indicating an overall fall in physical activity levels in adults during COVID-19 lockdown measures (Ammar et al., 2020; Constandt et al., 2020). However, it should be noted there have been other studies indicating that although most physical activity levels had decreased, still a significant portion of the population studied was able to either maintain or increase their activity levels despite the global pandemic's restrictions (Gallè et al., 2020; Rhodes et al., 2020).

Specific to individuals with ID, Theis et al. (2021) found in their cross-sectional study that 61% of participants reported a decrease in physical activity as a result of the COVID-19 restrictions. Although, due to the contemporary nature of these issues, there is a lack of research studying activity levels in adults with ID during the COVID-19 global pandemic. Therefore, there is an understandable necessity for more research on how individuals with ID are achieving physical activity during COVID-19.

2.10 Use of Wearable Technology to Remotely Measure Physical Activity, Sedentary Behaviour, and Sleep

The 2020 Canadian 24-Hour Movement Guidelines have several recommendations within each of the three categories (physical activity, sedentary behaviour, sleep) (Ross et al., 2020). Most studies published prior to the development of the 24-hour guidelines focus on, operationalize, and measure, one or two behaviours. For example, a common measure for tracking physical activity in adults with ID is the amount of MVPA (Dairo et al., 2016; Oviedo et al., 2017). For sedentary behaviour, although there is some inconsistency in the extant literature, the most frequent measure is total sedentary time (Melville et al., 2017). Lastly, for measuring sleep in adults with ID, a common metric used to compare with published guidelines was total sleep length (Surtees et al., 2018; van de Wouw et al., 2012). This section of my thesis will explore how wrist-based technology can remotely measure these three metrics.

As mentioned previously, many studies on physical activity and sedentary behaviour use a combination of objective (e.g., pedometer, accelerometer) and subjective (e.g., questionnaire survey) measures (Melville et al., 2017; Dairo et al., 2016). Indeed, a common suggestion from these studies is to include both objective and subjective measures whenever possible as subjective measurement alone can lead to reporting and recall biases (van de Wouw et al., 2012; Dairo et al., 2016). In Dairo et al.'s (2016) review, MVPA was commonly measured using wrist- or hip-based accelerometers using previously published MET cut-offs (Freedson et al., 1998; Temple et al., 2000; Temple & Walkley, 2003). Technological advancement in the area of wrist-based devices (i.e., smartwatches) has provided researchers with a novel method for tracking physical activity (Gao & Lee, 2019). New smartwatches, like the Polar Ignite, have accelerometer functions, and can also measure and track heart rate every second (Polar Canada, 2021). With this development in wrist-based technology, more and more studies are turning to the use of heart rate to measure physical activity levels (Hollis et al., 2017; Warburton et al., 2007). Warburton et al. were able to define various activity levels (very light, light, moderate, and vigorous) as a percentage range of an individual participant's maximal heart rate (HR_{max}). These activity levels were also presented as ranges of one's rating of perceived exhaustion (RPE), relative breathing rate, and body temperature (Warburton et al., 2007). One potential advantage of this method is that HR_{max} could be determined without direct measurement using Fernhall et al.'s (2001) prediction equation, which is specific to individuals with ID. Therefore, this method provides an opportunity to remotely measure MVPA levels in adults with ID and reduce the overall contact time between researcher and participant, which has been especially important during the COVID-19 pandemic.

Past studies on sedentary behaviour in adults with ID do not have a uniform method of measurement and these studies more typically used subjective or self-reported measurement strategies (Melville et al., 2017). However, as mentioned previously, there is a trend toward the inclusion of objective measures to provide reliable and accurate data (Melville et al., 2017). Of the objective measures used, wrist- or hip-based accelerometers were most common (Melville et al., 2017), and sedentary behaviour was typically estimated using previously determined MET cut-offs. However, one issue with this is that the accelerometer cut-offs used were inconsistent or not reported in various studies (Melville et al., 2011; Spanos et al., 2016; Freedson et al., 2005; Lante et al., 2014). It would be required then, for future studies to establish a uniform series of accelerometer/MET cut-off points. However, given the ability to measure time spent within the various activity levels as seen in Warburton et al. (2007), using continuous heart rate monitoring functions in wearable technology could become a useful innovation in measuring sedentary behaviour (Polar Canada, 2021).

Similar to physical activity and sedentary behaviour, research on sleep in adults with ID has seen both qualitative and quantitative approaches (Surtees et al., 2018). However, it has been suggested that objective measures of sleep should be prioritized in research on persons with ID as it can be difficult to accurately determine one's sleep length (van de Wouw et al., 2012). Unsurprisingly, there has been a trend in contemporary research towards using objective measures like that of actigraphy and polysomnography as noted in Surtees et al.'s (2018) systematic review. One of the most common metrics for sleep quality is sleep length (i.e., total sleep time [TST]), which is a useful tool as it can then be measured using both actigraphy and polysomnography and compared to recommended guidelines (Shanahan et al., 2019). Polysomnography is a comprehensive test that measures several sleep parameters, including brain waves, eye movements, heart rate, breathing, blood oxygenation, and movement (Rundo & Downey, 2019). While polysomnography tends to be the gold standard for sleep research, wrist-based actigraphy devices use sensors to record movements during sleep, which can then be interpreted by specific algorithms to estimate various sleep parameters, such as sleep length (Martin & Hakim, 2011). Furthermore, wrist-based actigraphy tends to be much cheaper in relative cost (Martin & Hakim, 2011). With that, actigraphy is becoming a science of the past as most new commercial fitness watches today have the ability to track sleep, but the validity of these watches is still being investigated (Grifantini, 2014). A recent validation study, however, showed that the technology and algorithms used in Polar's wrist-based devices performed as well as, or better than previously validated devices by Philips Respironics against polysomnography for sleep metrics (Pesonen & Kuula, 2018). The Polar A370 fitness watch (Polar UAE, 2017), or Polar Fitness Tracker (PFT), showed no significant difference in measuring the time between sleep onset and offset (sleep interval) in both young and older age groups when compared with polysomnography ($P = 0.10$ and 0.46), while Philips Respironics' Actiwatch 2 (AW2) underestimated sleep interval in both age groups ($P = 0.04$ and 0.001) (Pesonen & Kuula, 2018). However, when comparing actual sleep %, or the percentage of actual sleep during a sleep period, both the PFT and AW2 devices significantly underreported in young and older age groups when compared to polysomnography (Pesonen & Kuula, 2018). Although there is a need for more studies on the reliability and validity of these devices and their research application, the Polar Ignite smartwatch (Polar Canada, 2021) could prove beneficial in remotely measuring sleep length to compare levels with the 2020 24-Hour Canadian Movement Guidelines.

2.11 Summary

In conclusion, there are countless reasons why maintaining a physically active lifestyle, limiting sedentary behaviour, and achieving enough sleep are all crucially important to a long and healthy life. The Canadian Society of Exercise and Physiology understood these benefits and published the 2020 Canadian 24-Hour Movement Guidelines to provide Canadians with attainable recommendations to gain from these benefits (Ross et al., 2020). Despite the known benefits of maintaining a healthy lifestyle, many people in Canada are not meeting these guidelines, and more specifically, adults with ID are disproportionately living sedentary lives. Of the current literature examining physical activity, sedentary behaviour, and sleep in adults with ID, there is a clear theme; adults with ID are not getting enough physical activity and sleep while spending too much time sedentary. There is also a need for more research focusing on this vulnerable population. The COVID-19 pandemic created additional barriers for adults with ID to achieve enough physical activity and limited the capacity of researchers to conduct studies with this population. However, advancement in wearable technology has enabled researchers to safely conduct valuable research on activity levels and sleep in adults with ID. This study examined the current levels of MVPA, total sedentary time, and sleep length in adults with ID during COVID-19 by piloting the use of commercially available wearable technologies and a novel diary to track physical activity and sleep, while limiting participant-researcher contact.

Chapter 3 Methods

3.1 Participants and Recruitment Procedures

The University of Victoria's Human Research Ethics Board approved the ethics application (protocol #20-0601) for this project prior to the recruitment of participants (Appendix B). The research team consisted of two professors, two graduate students, and two undergraduate students. All members of the research team completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS-2) course (CORE-2022) prior to the start of data collection. Participants were recruited by graduate students from several community programs in Victoria, BC, including, the Garth Homer Society (GHS), Special Olympics (SO), the Greater Victoria Down Syndrome Society (GVDSS), and the Society of Saint Vincent de Paul (SSVP), with no selection for sex or race. Recruitment posters were put up by the graduate students at the GHS and recruitment letters were emailed to the program director (Appendix C). While individuals from SO, GVDSS, and SSVP were recruited via email either directly or through their caregivers (Appendix C). Participants were recruited using convenience and snowball sampling.

Eligible participants were: 1) 18 to 64 years of age; (2) a member of a community program for individuals with ID (see Appendix A); (3) able to perform MVPA; (4) and agreed to wear a Polar Ignite smartwatch (Polar Canada, 2021) for nine consecutive days. Participants were excluded from the project if they were: (1) had major mobility restrictions that prevented them from performing physical activity; (2) or were unable to wear the Polar Ignite smartwatch (Polar Canada, 2021) for nine consecutive days.

Volunteers that were interested and met the eligibility criteria were sent informed consent and assent letters to be signed prior to the beginning of data collection (Appendix D).

3.2 Study Design

The project was a pilot study that followed an observational cross-sectional design and participants were asked to carry on their normal daily activities. Data were collected by the participants with a Polar Ignite smartwatch (Polar Canada, 2021) and a Physical Activity and Sleep Diary. Participants were provided with a Polar Ignite smartwatch (Polar Canada, 2021) to wear for nine consecutive days, as well as a Physical Activity and Sleep Diary (Appendix E) that was completed upon waking and before bed each day. This pilot study is part of a broader study that examined each of the three components of the 2020 Canadian 24-Hour movement guidelines in depth (CSEP, 2020b). This present study will focus on the physical activity and sedentary behaviour aspects of the guidelines.

3.3 Instruments and Measures

Participant demographic characteristics

Participants were measured for height (m) and weight (kg) at the beginning of data collection. Height, in metres, was measured by having the participants stand without shoes beside a wall lined with the Stanley PowerLock Tape Measure (30 ft) (product #33-430). Weight, in kilograms, was measured by having the participants stand without shoes on the Philips Body Analysis Scale (product #DL8781/38), which rested on a flat surface. Body mass index (BMI) was calculated by using the formula in Appendix F. Age, sex, Down syndrome status, and whether the individual had a major mobility restriction that prevented them from completing physical activity were identified by the participant or their caregiver.

Polar Ignite smartwatch

The main instrument used for the pilot study was the Polar Ignite smartwatch with Global Positioning System (GPS) and wrist-based pulse rate (Polar Canada, 2021). It is a small (dimensions: 43 x 43 x 8.5 mm) and lightweight (weight: 35 g with wristband) device with GPS, Bluetooth, and heart rate monitoring capabilities (Polar Canada, 2021). The device is worn on the wrist of the non-dominant hand with the device fitting snugly, but comfortably to the wrist. For data collection purposes, the "Other Indoor" mode on the device was used, which constantly tracked heart rate (1s averages) and total sleep length with interruptions (Polar Canada, 2021). Previous research has demonstrated that heart rate data from the Polar Ignite smartwatch (Polar Canada, 2021) showed strong correlation values ($r > 0.90$) when compared to the Polar H10 chest strap heart rate monitor during exercise (Budig et al., 2021). Furthermore, a similar device by Polar, the A370 fitness watch (Polar UAE, 2017), showed no significant difference when compared to polysomnography in measuring the time between sleep onset and offset (i.e., falling asleep and waking up) in both young and older age groups ($P = 0.10$ and 0.46) (Pesonen & Kuula, 2018).

FlowSync app and Polar Flow

All data collected from the Polar Ignite smartwatches were uploaded to the FlowSync application (Polar Electro, 2021) on a Samsung Tablet for storage purposes. The FlowSync app tracks and organizes all heart rate data (measured in 1s averages) and all sleep data (measured in min). Once uploaded to FlowSync and connected to the internet, the data were automatically synced to the online Polar Flow software (Polar Electro, 2021). The Polar Flow software (Polar Electro, 2021) organized each data collection session (using "Other Indoor" mode) in a training calendar for further analysis. Upon selection of a data collection session, the software chronologically displays the activity of the individual wearing the smartwatch, including duration of the session, heart rate data (1s averages, total average, minimum, and maximum), calories burned (kcal), as well as sleep length and interruptions (Polar Canada, 2021).

Physical Activity, Sedentary Behaviour, and Sleep

Objective Measures. To compare to the recommended guidelines, heart rate data (1s averages) from the Polar Flow software (Polar Electro, 2021) were used to extrapolate time spent performing physical activity (MVPA and LPA) and sedentary behaviour. While total sleep time was taken from the sleep data on the Polar Flow software (Polar Electro, 2021). MVPA and LPA were extrapolated from heart rate data by summating the amount of time spent with a heart rate ≥64% HR_{max} and 50-64% HR_{max}, respectively (Warburton et al., 2007). Maximal heart rate was estimated using Fernhall et al.'s (2001) formula specific for persons with Down syndrome:

$$HR_{max} = 210 - (0.56 \times Age) - (15.5 \times DS)$$

Age: Years

DS: 1 = Diagnosis of Down syndrome, 0 = Diagnosis of all other disabilities

Sedentary behaviour was extrapolated from heart rate data by summating the amount of time spent with a heart rate ≤50% HR_{max}, using the same methodology as above

(Warburton et al., 2007). Data was collected from the participants for 9 consecutive days and the data was transformed to a 7-day average to standardize the data sets. Lastly, total sleep length was taken from the Polar Flow software (Polar Electro, 2021) and used as the metric to compare with the recommended guideline of 7 to 9 hours per night (CSEP, 2020b).

Subjective Measures. The Physical Activity and Sleep diary was used to collect data on the number of bouts and types of physical activity and information about sleep. Sleep was explored in greater detail in the broader study and only total sleep time was used in this pilot study. The sleep portion of the diary was based on the Sleep Foundation's diary (Sleep Foundation, 2022). The physical activity section of the diary used in this pilot study was adapted from Temple and Walkley (2003). There were 8 days included in the diary and the participant was instructed to complete sections 1 and 2 of the diary before getting ready for bed by circling YES or NO for each question, and if YES, provide some extra information where applicable (e.g., soccer for sport played) (Appendix E). The participant was instructed to complete section 3 of the diary upon waking the next morning by circling YES or NO for each question, as well as writing down their sleep and wake time (Appendix E). The participant was also instructed to complete section 4 at any time throughout the pilot study by providing some information regarding their bedtime routine and their sleep overall. Once the diary was complete, all data were organized in an Excel document. For each question, the participant's responses were tabulated, and a weekly total number of YES responses were determined (max 8). For each YES response, the example of the activity (e.g., walk) was also recorded to determine the most common types of activity. Once completed, the number of bouts of physical activity for all types (Sport-related, non-sport-related, household, yardwork) were measured.

3.4 Procedure

Interested participants from local community programs were recruited and informed consent was obtained (Appendix D). Appendix A provides a detailed account of the eligibility requirements for each of the local community programs. Data were collected from each participant for nine days to ensure a total of seven uninterrupted days were included in each data set. On the first day, a graduate student from the research team arrived at the community program centre or predetermined location and introduced themself to the eligible participant while following COVID-19 safety protocols by wearing a mask and using disposable laboratory gloves. The researcher then collected height and weight measurements as well as demographic information from the participant (age and sex). Down syndrome status and any major mobility restriction were identified by the participant or caregiver prior to the start of data collection. Once collected, the participant was fitted with the Polar Ignite smartwatch (Polar Canada, 2021) and the participant was reminded of the data collection protocol. Specifically, one of the graduate or undergraduate students from the research team would return to collect the data onto the Samsung tablet and charge the device every second day. The participant was familiarized with the Polar Ignite smartwatch (Polar Canada, 2021) and practiced putting the smartwatch on and off. The participant and caregiver (if necessary) were instructed on how to charge the device should it run out of battery, and this was practiced. The participant was also familiarized with how to complete the Physical Activity and Sleep diary. Once the participant was instructed on how to use the diary, the researcher asked the participant if they could provide an example for each section to confirm their understanding of the task. The data collection schedule is listed in Table 1.

Table 1

Schedule for Polar Ignite data collection protocol

Day	Action
1	Demographic Information Collected, Smartwatch & Diary Distributed
2	Remote Monitoring
3	Data Collected and Smartwatches Charged
4	Remote Monitoring
5	Data Collected and Smartwatches Charged
6	Remote Monitoring
7	Data Collected and Smartwatches Charged
8	Remote Monitoring
9	Smartwatches & Diary Retrieved

Note. Demographic information included height, weight, and sex. Remote monitoring refers to when the participants are wearing the Polar Ignite smartwatch (Polar Canada, 2021) with active tracking of pulse rate. The diary refers to the Physical Activity and Sleep Diary (Appendix E).

After the participant was familiarized with the researcher, equipment, and data collection procedure, the researcher then verbally confirmed that the participant understood these components of the study. The researcher then initiated the "Other Indoor" mode on the Polar Ignite smartwatch and the nine-day protocol commenced. During the data collection period, the participant was followed up every second day by one of the graduate or undergraduate students to ensure that the diary was being completed properly.

Once the nine-day protocol was completed, the smartwatch and diary were retrieved from the participant and the data for the last two days were uploaded to the Polar Flow software (Polar Electro, 2021). The smartwatch and the diary were stored in a locked cabinet located in the researcher's laboratory. The participant was then provided with a five-dollar gift card to Tim Hortons as a small thank you at the end of the data collection period.

3.5 Data Treatment and Analysis

Participant information was uploaded to a secure Excel document on a password-protected password and a participant number was assigned to the data set to anonymize each participant. Height and weight data were used to determine body mass index (BMI) (Appendix F) for each participant and summarized in a table for the sample population along with demographic information, which was kept in a password-protected computer.

Each Polar Ignite smartwatch (Polar Canada, 2021) had an identifier number, which corresponded to an anonymized participant email (number) and a Polar Flow account (Polar Electro, 2021). Data was stored on the password-protected Polar Flow application (Polar Electro, 2021) for each participant. Heart rate averages (1s) for each data collection period were downloaded and collated on an Excel file for each participant. Total weekly MVPA, LPA, and sedentary time were then calculated by summating the number of 1s HR averages in the respective HR zones (≥64% HR_{max}, 50-64% HR_{max}, and <50% HR_{max}) and converted into minutes. Each data set had a specific start time and date and thus the amount of MVPA, LPA, and sedentary time were determined for weekdays and weekends. Sleep data was uploaded and stored on the Polar Flow software (Polar Electro, 2021) and total sleep time was extracted from the software. Once each participant had a weekly summary for MVPA, LPA, sedentary time, and sleep, descriptive statistics were used to summarize the group's data (mean, standard deviation, 95% CI).

Using IBM SPSS Version 27.0 and a significance level of 0.05 (α), paired *t*-tests with two-tails were used and *p*-values were determined to compare MVPA, LPA, and sedentary behaviour between weekdays and weekends. To compare MVPA, LPA, and sedentary behaviour between males and females, two-sample t-tests with two-tails were used. Spearman's Rank-Order Correlation tests were also performed to compare the total number of physical activity bouts reported in the Physical Activity and Sleep Diary (Appendix E) to the number of guidelines met, weekly sedentary activity, weekly LPA, weekly MVPA, and BMI.

Chapter 4 Results

A total of fifteen participants from Victoria, BC were included in the analysis of this pilot study. Of the fifteen participants, three had Down syndrome. All participants were registered with one or several of the following local community programs: Garth Homer Society, Special Olympics Victoria, Community Inclusion Roads Program, Down Syndrome Society of Greater Victoria, and the Society of St. Vincent de Paul. Participant demographic characteristics can be found in Table 2.

Table 2

Descriptive Statistics of Participant Demographic Characteristics (n = 15)

	Mean	*SD*	Range
Age range (years)	35.9	13.5	20 - 64
Height (cm)	160.1	12.7	140 - 187
Weight (kg)	72.1	17.2	45 - 104

	N	Proportion (%)
Weight Status*		
Underweight	0	0
Healthy weight	6	40
Overweight	5	33
Obese	4	27
Down Syndrome	3	20
Sex		
Male	6	40
Female	9	60

Note. *Based on body mass index (BMI) categories outlined in "Canadian Guidelines for Body Weight Classification in Adults" (Appendix F) (Health Canada, 2003). SD = standard deviation.

4.1 Research Question 1: To what extent are adults with ID in Victoria, BC meeting the 24-hour movement guidelines during COVID-19?

Weekly sedentary activity and MVPA and daily sleep time were determined for each participant, as shown in Table 3. Time spent sedentary ranged from 21.9 hrs to 147.6 hrs over 7 days, while MVPA ranged from 26 min to 1509 min. Mean actual sleep time ranged from 4hrs 43 min to 9hrs 2 min. The number of participants who met each CSEP 24-hour movement guideline are shown in Table 3.

Table 3

Weekly Amounts of Physical Activity, Sedentary Activity, and Total Sleep Time in Adults with ID

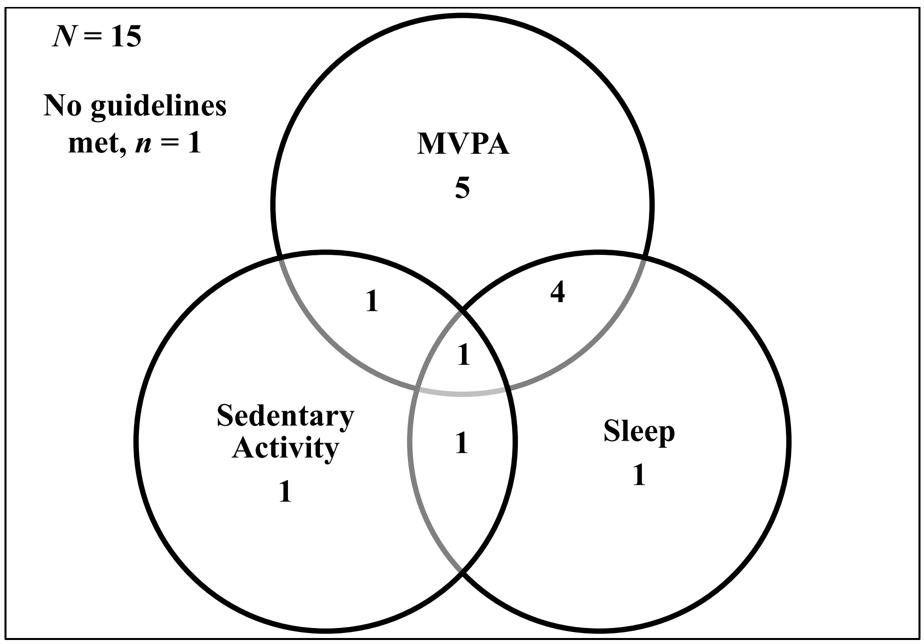
Part. ID	Weekly MVPA (min)	MG	Weekly Sedentary Activity (hr)	MG	Daily Mean Sleep Time (hr: min)	MG	Movement Guidelines Met
1	1283	✓	54.4	✓	7:26	✓	3/3*
3	111		147.6		6:45		0/3
4	900	✓	80.5		6:14		1/3
5	1086	✓	77.9		7:42	✓	2/3
6	1509	✓	21.9	✓	5:41		2/3
7	165	✓	135.5		6:13		1/3
8	144		138.1		9:02	✓	1/3
9	26		51.7	✓	4:51		1/3
10	166	✓	78.5		7:26	✓	2/3
11	1179	✓	96.3		8:24	✓	2/3
12	529	✓	116.5		8:10	✓	2/3
13	905	✓	104.8		4:43		1/3
14	556	✓	114.6		6:30		1/3
15	106		49.1	✓	7:44	✓	2/3
16	362	✓	103.7		6:59		1/3
Mean	602		91.4		6:55		
SD	500		36.7		1:04		
Total MG		11/15		4/15		7/15	1/3**

Note: MVPA = Moderate-to-vigorous physical activity; Sleep time refers to total actual sleep (without interruptions). For adults aged 18-64, CSEP Guidelines suggest maintaining 150 min MVPA/week, limiting sedentary time to 8 hr/day (56 hr/week) or less, and getting 7 to 9 hrs of sleep (CSEP, 2020b). MG = meeting guideline; SD = standard deviation. * = met all guidelines. ** = mode.

Of the fifteen participants, only 1 met all 3 of the CSEP's 24-hour movement guidelines and the modal score for meeting all 3 guidelines (CSEP, 2020b) was 1 (Table 3). Figure 1 illustrates the number of guidelines met by the participants in the study. MVPA was the most common guideline to have been met, while the sedentary activity and sleep guidelines were met the least by participants (Figure 1).

Figure 1

Frequency of Participants Meeting 24-Hour Movement Guidelines



Note. Venn diagram depicting all possible scenarios for CSEP's 24-hour movement guidelines (CSEP, 2020b). Values falling in a single circle depict those individuals who met that guideline only and are not inclusive of those who met several guidelines. MVPA = moderate-to-vigorous physical activity.

When comparing physical activity during weekdays and weekends, there were no significant differences between levels of sedentary activity, LPA, and MVPA, as determined by paired t-tests (Table 4). The effect sizes for the difference between weekdays and weekends were d=0.04, d=0.06, and d=0.22 for sedentary activity, LPA, and MVPA, respectively. These effect sizes are all considered small according to Cohen's guidelines (Lakens, 2013).

Table 4

Daily activity levels in adults with intellectual disability comparing weekdays and weekends

Activity Type	Weekday (min/day)	Weekend (min/day)	*p*-value (α =0.05)
Sedentary Activity	794.07 ± 321.04	781.55 ± 298.27	0.770
LPA	399.40 ± 272.78	414.14 ± 260.51	0.578
MVPA	92.02 ± 77.48	77.57 ± 52.57	0.157

Note: Data values are mean ± SD. P-values were determined using a paired two-tailed *t*-test. LPA = light physical activity; MVPA = moderate-to-vigorous physical activity.

When comparing physical activity levels between male and female participants, there were no significant differences, as determined by two-sample t-tests (Table 5). The effect sizes for the difference between males and females were d=0.03, d=0.59, and d=0.09 for sedentary activity, LPA, and MVPA, respectively. The differences between males and females for sedentary activity and MVPA were considered to have a small effect size, while LPA was considered to have a medium effect size (Lakens, 2013).

Table 5

Weekly activity levels in adults with intellectual disability comparing males and females

Activity Type	Male (min/week) *n* = 6	Female (min/week) *n* = 9	*p*-value (α =0.05)
Sedentary Activity	5524.62 ± 2940.93	5457.72 ± 1753.83	0.481
LPA	3496.54 ± 2468.43	2342.22 ± 1281.40	0.327
MVPA	631.81 ± 617.05	581.81 ± 446.32	0.869

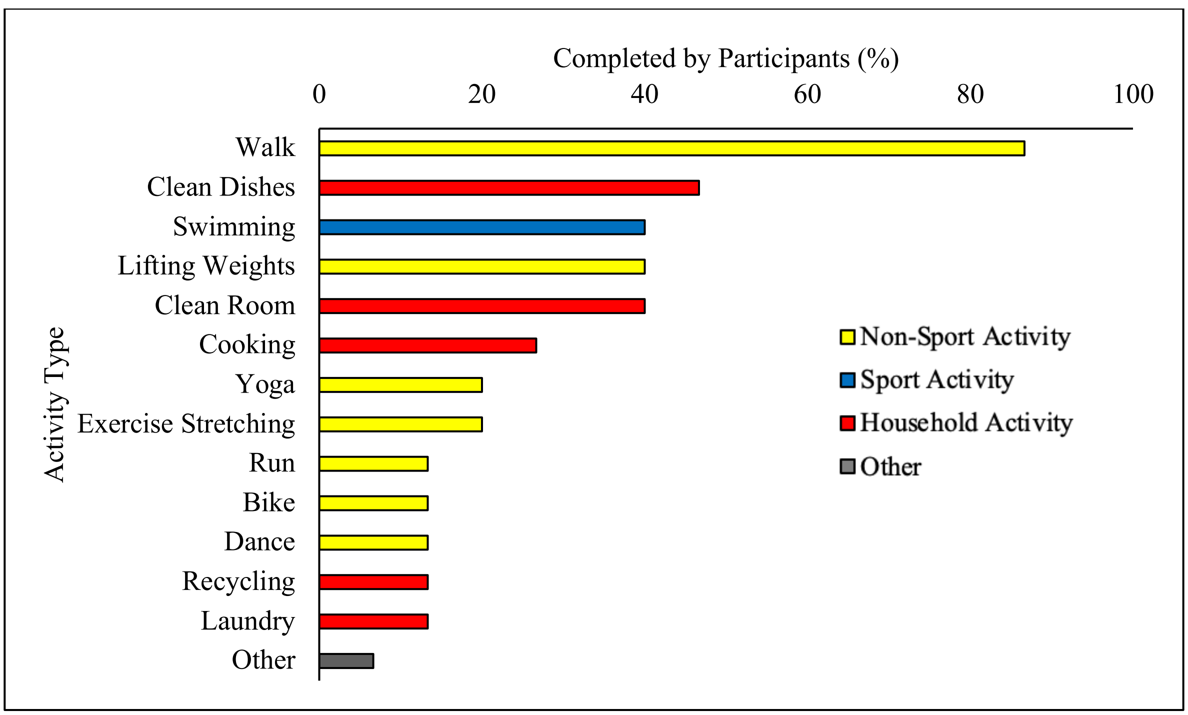
Note: Data values are mean ± SD. *P*-values were determined using an unpaired two-tailed *t*-test. LPA = light physical activity; MVPA = moderate-to-vigorous physical activity.

4.2 Research Question 2: What are the most common modalities for achieving physical activity for adults with ID?

Daily activity diaries were used to understand how participants were getting their physical activity. As shown in Figure 2, walking, cleaning dishes, and swimming were the most common types of physical activity. Non-sport physical activity was the most common modality for physical activity as 72.5% of days recorded for all participants included at least one non-sport-related activity, while yard work was the least common with 0.8% of days recorded. Sports were played on 15.8% of recorded days and household activity was conducted on 52.5%. A breakdown of the number of days with activities completed can be seen in Table 6.

Figure 2

Most Common Types of Physical Activity Performed During a Week



Note. The measures above refer to the percentage of participants who used that activity at least once throughout the week for purposes of attaining physical activity. Participants used the physical activity and sleep diaries to indicate what activity they performed each day.

Table 6

Breakdown of Various Types of Physical Activity Performed by Participants

Activity	***N = 15***
Sports	
Days with sports played	
0	5
1	6
2	0
3	3
4+	1
Total days with activity	15.8%
Non-sport physical activity	
Days with non-sport physical activity completed	
1 - 2	3
3 - 4	1
5 - 6	2
7	8
Total days with activity	72.5%
Household activity	
Days with household activity completed	
0	2
1 - 2	4
3 - 4	2
5 - 6	1
7 – 8	6
Total days with activity	52.5%
Yard work activity	
Days with yard work	
0	14
1+	1
Total days with activity	0.8%

Note. *N* data values refer to the number of participants who participated in the corresponding number of days that included at least one activity. Percentages refer to the percentage of total recorded days with at least one related activity completed. Sports refer to individual or team activities such as swimming, basketball, or golf. Non-sport physical activity refers to activities such as walking, lifting weights, or yoga. Household activities refer to activities such as cleaning one's room, cleaning dishes, or cooking. Yard work refers to activities such as mowing lawns, raking leaves, or planting flowers.

4.3 Research Question 3: What is the relationship between the objective and subjective measures of physical activity in adults with ID?

Physical activity diaries were used as a qualitative instrument to compare with the quantitative data from the Polar Ignite smartwatches (Polar Canada, 2021). Participants were ranked based on their diary entries, along with their weekly sedentary activity, LPA, and MVPA measured quantitatively. Table 7 shows several Spearman's rank correlation tests between the total diary activity entries by participants and several variables measured quantitatively. All four compared variables showed very low weak positive correlations (Table 7).

Table 7

Spearman's Rank Correlation for Physical Activity Diary Entries and Physical Activity Measures

Variables	r_s	*p*-value
Total Diary Activity Entries		
vs Number of 24hMG Met	0.388	0.153
vs Weekly Sedentary Activity	0.059	0.834
vs Weekly LPA	0.231	0.408
vs Weekly MVPA	0.301	0.276
vs BMI	0.073	0.797

Note. Participants were ranked based on the total number of activity entries in diaries and compared to ranks of several variables. The number of guidelines met, BMI, and total weekly amounts of sedentary activity, LPA, and MVPA were used for participant rankings. r_s = Spearman correlation coefficient; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; 24hMG = 24-hour movement guidelines; BMI = body mass index.

Chapter 5 Discussion

Maintaining a physically active lifestyle and reducing the amount of time spent sedentary has been shown to promote overall well-being and reduce the risk of developing chronic disease (U.S. Department of Health and Human Services, 2018). Furthermore, achieving a healthy level of 7-8 hours of sleep has also been shown to provide a plethora of physiological and psychological benefits (Chaput et al., 2020). To promote a healthy lifestyle that focuses on promoting physical activity and sleep while limiting time spent sedentary, the CSEP released the 2020 24-hour movement guidelines with recommendations for all stages of life (Ross et al., 2020). Yet despite the known benefits of maintaining a healthy lifestyle, there is an increased prevalence of physical inactivity, sedentary activity, and poor sleep quality reported among adults with ID (Dairo et al., 2016; Hsieh et al., 2017). Physical inactivity has been linked to health detriments, including cardiovascular disease and obesity (Robertson et al., 2018). Further, the COVID-19 global pandemic prevented adults with ID from accessing community programs and facilities during lockdowns, which exacerbated these issues (Theis et al., 2021). Therefore, there was a need to explore the ways through which individuals with ID are achieving physical activity and getting enough sleep during COVID-19.

The primary aim of this pilot study was to determine the extent to which adults with ID were meeting the physical activity, sedentary activity, and sleep recommendations of CSEP’s 2020 Canadian 24-Hour Movement Guidelines during the COVID-19 global pandemic (CSEP, 2020b). This study also piloted the use of commercially available wearable technology and a novel diary to investigate how participants were achieving physical activity while attempting to reduce the overall contact time between researcher and participant. In this chapter, I discuss the findings of this pilot study, how those findings relate to contemporary literature, as well as the limitations of this study and future directions for this type of work.

1. **To what extent are adults with ID in Victoria, BC meeting the 24-hour movement guidelines during COVID-19?**

Maintaining a weekly amount of 150 min of MVPA is suggested by the Canadian 24-hour Movement Guidelines (CSEP, 2020b) and of the 15 participants, 11 (73%) met this guideline. This finding was unexpected, as previous literature using similar physical activity guidelines has found that only an estimated 9% of adults with ID achieved the equivalent of 150 min of MVPA (Dairo et al., 2016). Furthermore, given the present pilot study was completed during the COVID-19 global pandemic and several studies have shown this to be a negative impact on physical activity levels in adults with ID, these MVPA data were much higher than expected (Theis et al., 2021). These unusual findings could be due to the selectively small sample included in the study. Previous work in this community has revealed considerable variation in physical activity levels of adults with ID (Temple, 2007), including a proportion of participants who are very active (Temple, 2009). Recruitment during this timeframe of this pilot study was difficult because the COVID-19 pandemic had significantly impacted the research team's ability to engage with adults with ID directly or through their community program. Many of the community programs serving adults with ID were operating at a reduced capacity, which made it challenging to reach potential participants. As a result of COVID-19, potential participants with ID may have also been experiencing increased anxiety or social isolation during this timeframe, which could have further impacted their ability or willingness to participate in the study (Lake et al., 2021). These issues related to the pandemic may have also drawn individuals who were particularly active to the study.

Far fewer participants (4/15 or 27%) met the sedentary behaviour guideline of less than 8hrs per day. These findings align more closely with contemporary research as sedentary behaviour is commonly reported among adults with ID and is of concern for both physiological and psychological health (Dairo et al., 2016; Oviedo et al., 2017). It should be noted, however, that the average weekly time spent in LPA in the present study was 2,804 min ± 1,859 min. Although LPA is not a measure included in the CSEP movement guidelines, LPA is favourably associated with lower overall mortality risk and improved health outcomes (Eszter et al., 2017). As mentioned previously, sedentary behaviour is common in this population and may have been exacerbated by the global pandemic restrictions (Theis et al., 2021).

To investigate physical activity further, I compared weekdays and weekends as well as males and females for sedentary activity, LPA, and MVPA (Tables 4 and 5). There were no significant differences between weekdays and weekends for sedentary activity. Indeed, the effect sizes for each of these comparisons were considered small according to Cohen's guidelines (Lakens, 2013). This result is somewhat inconsistent with pedometer-measured physical activity of individuals with ID (Temple & Stanish, 2009) where Sundays were the least active days of the week and Wednesdays were the most active. The Temple and Stanish study occurred when weekday activities routinely included going to work and to day programs, whereas that was not the case during the pandemic. It is possible that weekday versus weekend day routines were not as distinctive during the pandemic. This line of reasoning could also explain the findings from the study by

Oviedo et al. (2017), which indicated a greater amount of LPA and MVPA on weekdays than on weekends in adults with ID ($p < 0.001$). Oviedo et al. also indicated no differences between males and females, which is consistent with this study's findings of no significant differences for sedentary activity, LPA, or MVPA. It should be noted that the effect size for LPA between males and females in this pilot study was considered medium, which could perhaps indicate that males are achieving greater amounts of LPA than females. However, these statistical tests used carried very low power. When testing for power, the paired t-test comparing weekdays and weekends ranged from 3.2% to 8.7% when using an alpha of 0.05. The two-sample independent t-test comparing males and females ranged from 2.8% to 18.3%. Therefore, these findings indicate that the sample size was not large enough to detect true differences between groups. Beyond this pilot study, future studies should attempt to improve upon this pilot study by incorporating a larger sample size, which may increase the statistical power of these comparisons and the generalizability of the findings.

The final recommendation for the 24-hour movement guidelines is achieving seven to nine hours of quality sleep. Using total sleep length as a measure of sleep quality, I found that 7 of the 15 individuals (47%) met the minimum guideline. Although mean sleep time for all participants was 6 hr and 55 min, there was a considerable range of 4 hr and 43 min to 9 hr and 2 min. It is generally understood that sleep disruptions are common among adults with ID, as shown in one meta-analysis by Surtees et al. (2018), who found that 93% of comparisons between individuals with and without ID indicated poorer sleep quality in those individuals with ID. The findings from this pilot study do not fully align with these previous studies as nearly half of the participants were able to maintain an adequate 7 hours of sleep. Overall, when combining all three aspects of the 24-hour movement guidelines (MVPA, sedentary behaviour, and sleep), there was only one participant who met all of the guidelines.

The COVID-19 global pandemic brought on a significant reduction in access to community gyms and facilities (Maugeri et al., 2020). Individuals with ID were particularly vulnerable to the disruption and contemporary research has indicated a significant reduction in physical activity and greater sedentary behaviour (Theis et al., 2021). Consistent with this previous research, the present study found that only 27% of participants met the recommendation for sedentary behaviour. However, the present study also found that 73% of participants were able to meet the recommendation for MVPA, despite the restrictions of COVID-19. These findings are consistent with the "Active Couch Potato" phenomenon, which occurs when individuals are achieving a healthy level of MVPA but are spending too much time sedentary when not exercising (Owen et al., 2010). Despite the known reduction in risk of developing chronic disease from maintaining a healthy level of physical activity, there is growing research indicating an independent, dose-response relationship between sedentary behaviour and risk of all-cause mortality (Fennell et al., 2019). Therefore, this pilot study's findings indicate a real need to address the issue of sedentary behaviour in adults with ID.

There are several other limitations in these findings. One difficulty with the use of the Polar Ignite smartwatches (Polar Canada, 2021) is that they are not fully waterproof, and thus the participants were unable to include their physical activity from swimming, which would likely underestimate their total LPA and MVPA and overestimate their sedentary time. Future studies should look to build upon this pilot study by implementing a larger sample size over several weeks to get a better understanding of the activity levels of participants over a typical week. Given the clear indication from this study that participants were spending too much time sedentary, future studies should attempt to track screen time to compare to guidelines (e.g., 8 hours or less). The present study used only total sleep time as a metric for sleep, but other work done as part of the broader study examined sleep quality and consistency, as well as sleep hygiene behaviours, which allows for a more comprehensive investigation of sleep.

2. **What are the most common modalities for achieving physical activity for adults with intellectual disability?**

The present study investigated how adults with ID achieve regular physical activity. Using the Physical Activity and Sleep diary (Appendix E), data on the types and number of bouts of physical activity were collected over a week and examined for commonalities. Most previous studies that used both self-report and objective approaches to measuring physical activity typically looked at walking/running and/or sport-related activity without a focus on household activities or chores (Dairo et al., 2016). Therefore, it was the focus of this study to include a section in the Physical Activity and Sleep diary (Appendix E) on household activities like cleaning one's room and taking out the garbage.

In this study, the most common type of activity was non-sport-related activity (e.g., walking and lifting weights) followed by household activity (e.g., cleaning dishes and room), sport-related activity (e.g., swimming), and yard work (e.g., racking leaves) (Figure 2). More specifically, walking was the most common modality for physical activity in this study, aligning with contemporary literature on adults with ID (Bouzas et al., 2019). Cleaning dishes, an indoor household chore was the second most reported activity completed by participants in this study (Figure 2). Although not many studies on adults with ID have focused on chore work for achieving physical activity, one study by Barnes et al. (2013) found that indoor chore work was the second most reported activity on self- or proxy-reported physical activity reports (42.5% of participants). However, an observational case study of physical activity behaviours found chores contributed only a small proportion of MVPA among six individuals living in a group home (Temple et al., 2000). Nonetheless, this pilot study's findings support the identification of all forms of moderate- and light-intensity physical activity in future studies, including household chores. Lastly, the third most reported activity in this study was swimming, which has been often reported among this population at all ages, as it is a low-impact activity that improves joint mobility and cardiovascular fitness (Stanish et al., 2019; Asunta et al., 2021). It should be noted, however, that Figure 2 solely reflects the percentage of participants who participated in a specific activity at least once throughout the week, with no indication of the intensity or amount of the exercise. As mentioned previously, access to community gyms and facilities was significantly affected during this period of the global pandemic, leading to a disproportionate decrease in physical activity for adults with ID (Courtenay & Perera, 2020). These restrictions could potentially be a reason for the distribution of the types of physical activity, as activities like lifting weights, yoga, and group dance all typically require the use of a community space, which was restricted during COVID-19.

One limitation of current literature on physical activity in adults with ID is that very few studies focus on the modalities of physical activity used and rather focus on the number of minutes performed to be able to compare to recommendations (Dairo et al., 2016). The present pilot study included a focus on the types of activities that adults with ID are using to achieve physical activity to investigate both the amount and types of physical activity performed throughout a typical week. Lastly, since the 2020 Canadian 24-Hour Movement Guidelines specify that adults should be getting at least two sessions of muscle-strengthening activity (e.g., resistance exercise) per week, future studies should look to include a section in the self-report that highlights this recommendation (CSEP, 2020b).

3. What is the relationship between the objective and subjective measures of physical activity in adults with ID?

There have been several studies on physical activity in adults with ID that have used pedometers, accelerometers, diaries, interviews, questionnaires, or a combination of these (Dairo et al., 2016). The last objective of this pilot study was to compare the usefulness of the physical activity diary for collecting physical activity data when used in conjunction with the Polar Ignite smartwatch. The findings from this portion of the pilot study would allow us to make recommendations for the tools used in future research on physical activity for adults with ID. Spearman's rank correlations were completed and found very weak positive correlations between the total number of diary entries and guidelines met, sedentary activity, LPA, MVPA, and BMI (Table 7). These findings indicate that there was no significant association between the number of times an individual reported completing a physical activity in the diary and their total amount of physical activity or sedentary activity, or their BMI. These findings are not consistent with previous work using self-reports for physical activity, as individuals who self-reported greater amounts of physical activity typically achieved more physical activity when compared to pedometers or accelerometers (Dairo et al., 2016). The lack of association between any of the variables used could also be the result of a lack of power within the calculations due to the small sample size of the pilot study. It is also difficult to compare the findings from this pilot study to previous literature as previous studies typically tracked the total amount of physical activity whereas this pilot study tracked the total number of bouts of physical activity (Dairo et al., 2016). Future studies should look to improve the current diary by including a section to report the amount of physical activity to compare with the Polar Ignite smartwatch data (Polar Canada, 2021).

The novel diary used in this pilot study included YES or NO questions for several types of physical activity each day (sport, non-sport-related, household, yardwork), as well as a section to provide details. The purpose of this was to make it easier for the participant to report the type of activity they performed, which was well received as any time participants circled YES for any type of activity, they submitted a text response 100% of the time (data not shown). The inclusion of this section of the diary contrasts with the International Physical Activity Questionnaire-Short Form (IPAQ-SF), a self-report more typically used in physical activity research with adults with ID, as the IPAQ-SF only asks whether an individual performed a certain intensity of physical activity and not for the specific type of activity (Lee et al., 2011). This provided us with a greater understanding of how adults with ID were achieving physical activity during COVID-19, therefore, we would recommend that future studies attempt to include more details pertaining to the types of physical activity achieved.

Other literature on adults with ID using a self- or proxy report typically make comparisons between minutes of physical activity or steps completed and physical activity guidelines (Dairo et al., 2016). However, it is also widely indicated that when self-reporting, individuals tend to overreport the amount of physical activity achieved (e.g., minutes of MVPA) and underreport time spent sedentary (e.g., watching TV), which is also referred to as the social desirability bias (Cerin et al., 2016). This social desirability bias in self-reporting data was recently seen in one study with adults with autism that compared accelerometer data to the IPAQ-SF, as these adults significantly overreported MPVA ($p < 0.01$) and underreported sedentary time ($p = 0.03$) (Lee et al., 2023). Therefore, it is recommended that objective measures should be used in conjunction with self-reports when attempting to measure the amounts of physical activity and sedentary behaviour. As mentioned previously, future work using this pilot study's diary and smartwatch (Polar Canada, 2021) could attempt to replicate the findings by Lee et al. (2023) and examine the magnitude of agreement between the two tools.

The Polar Ignite smartwatches (Polar Canada, 2021) provided the present study with a technology that allowed for the remote monitoring of activity and sleep, as was crucial for the completion of data collection during the restrictions of the COVID-19 global pandemic. During the present study, 11 of the 15 participants wore the Polar Ignite smartwatches (Polar Canada, 2021) for 7 or more days of data collection, 3 participants wore them for 6 days, and 1 participant wore it for 5 days. Of the days collected, the Polar Ignite smartwatches (Polar Canada, 2021) were able to collect data 89.2% of the time. These findings indicate that the watches were generally well-received and comfortable to wear. However, there were likely some instances where the data were not a true reflection of the participants' overall activity and sleep levels. One limitation of the Polar Ignite smartwatch (Polar Canada, 2021), was that it was easy to unlock the device and play with the touchscreen, as was shown by a few breaks, or stopping and starting, in the data collection for a small number of participants (data not shown). This differs from an individual removing the watch, which was found in a couple of participants, as the latter had the "Indoor other" mode remain activated while the watch was removed. Future studies should attempt to prevent this occurrence by including an update to the device's software that prevents unlocking without the permission of the research team. Lastly, one issue with the current literature is that all the validation studies on devices like the Polar Ignite smartwatch (Polar Canada, 2021) only include individuals without a disability or health condition, and therefore, there is a need for a more inclusive participant population in future validation studies (Evenson et al., 2015; Kerr et al., 2017). However, given there were minimal setbacks with using the Polar Ignite smartwatches (Polar Canada, 2021) during this pilot study, we recommend that these smartwatches be used in future work on physical activity in adults with ID.

Conclusions

I explored the extent to which a sample of adults with ID were meeting the 2020 Canadian 24-Hour Movement Guidelines (CSEP, 2020b), with a greater focus on physical activity and sedentary behaviour. Sleep was investigated in greater detail in other parts of the broader study. My findings revealed that very few participants met the movement guidelines in their entirety. Participants in this study displayed characteristics of what has been colloquially called the "Active Couch Potato" phenomenon (Owen et al., 2010), where participants achieved an adequate amount of MVPA but spent far too much time sedentary. Achieving a healthy level of physical activity has been shown to improve overall heart and brain health, physical fitness, and quality of life, as well as lower the risk of all-cause mortality (U.S. Department of Health and Human Services, 2018). However, despite achieving enough MVPA, active individuals living a sedentary lifestyle are at a heightened risk of developing metabolic disorders and all-cause mortality (Fennell et al., 2019). Secondly, participants did not achieve enough sleep, which is worrisome as lacking adequate sleep can increase the risk of cognitive disorders and decline (Wu et al., 2018; Lo et al., 2016), CHD (Wang et al., 2016), and type II diabetes (Shan et al., 2015). Therefore, the findings from this pilot study indicate that there is a real need to further investigate and address the high level of sedentary behaviour and lack of sleep among adults with ID.

The present study was one of the only recent studies on adults with ID to include household chores as a means to achieve physical activity on a self- or proxy-reported diary. The novel design of the Physical Activity and Sleep Diary (Appendix E) provided a contextual understanding of how participants were achieving their physical activity. Consistent with previous findings (Dairo et al., 2016), walking was the leading modality for achieving physical activity, followed by other non-sport-related activities, household activities, sport-related activities, and yard work. Future studies should attempt to build on the current diary used in this pilot study by including the amounts of physical activity, this could provide researchers with a more holistic and complete view of physical activity in this population. The Polar Ignite smartwatch (Polar Canada, 2021) showed to be a promising research tool for collecting heart rate and sleep data while limiting the intrusiveness to the participant. We also learned that the remote measures used in this pilot study proved to be a useful and viable alternative option to in-person data collection. Improving measures for remote data collection could reduce the geographical barriers to research as well as improve the feasibility of completing studies with vulnerable populations by reducing overall researcher-participant contact time. Future studies will look to replicate this pilot study's procedures with a larger sample size during a time with no global pandemic restrictions for comparison. Achieving an adequate amount of physical activity, limiting sedentary behaviour, and maintaining good sleep hygiene are all incredibly important for overall health and longevity. It is therefore paramount that governments attempt to promote physical activity and sleep for individuals with ID through the support of community inclusion programs like that of Community Living BC, Garth Homer Society, Greater Victoria Down Syndrome Society, Society of St. Vincent de Paul, and Special Olympics Victoria.

Bibliography

American Association on Intellectual and Developmental Disabilities (AAIDD). (2021). *Intellectual Disability*. https://www.aaidd.org/intellectual-disability/definition

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

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., Müller, P., Müller, N., Aloui, A., Hammouda, O., Paineiras-Domingos, L. L., Braakman-Jansen, A., Wrede, C., Bastoni, S., Pernambuco, C. S., … Hoekelmann, A. (2020). Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 international online survey. *Nutrients*, *12*(6). https://doi.org/10.3390/nu12061583

Asunta, P., Rintala, P., Pochstein, F., Lyyra, N., & Mcconkey, R. (2021). The development and initial validation of a short, self-report measure on social inclusion for people with intellectual disabilities-A transnational study the development and initial validation of a short, self-report measure on social inclusion for people with intellectual. *International Journal of Environmental Research and Public Health, 18*(2540), 1-14. https://doi.org/10.3390/ijerph18052540

Barnes, T. L., Howie, E. K., McDermott, S., & Mann, J. R. (2013). Physical activity in a large sample of adults with intellectual disabilities. *Journal of Physical Activity and Health*, *10*(7), 1048–1056. https://doi.org/10.1123/jpah.10.7.1048

Biswas, A., Oh, P. I., Faulkner, G. E., Bajaj, R. R., Silver, M. A., Mitchell, M. S., & Alter, D. A. (2015). Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults a systematic review and meta-analysis. *Annals of Internal Medicine, 162*(2), 123–132. https://doi.org/10.7326/M14-1651

Bouzas, S., Martínez-Lemos, R. I., & Ayán, C. (2019). Effects of exercise on the physical fitness level of adults with intellectual disability: A systematic review. *Disability and Rehabilitation*, *41*(26), 3118–3140. https://doi.org/10.1080/09638288.2018.1491646

Brooker, K., Van Dooren, K., Tseng, C. H., McPherson, L., Lennox, N., & Ware, R. (2015). Out of sight, out of mind? the inclusion and identification of people with intellectual disability in public health research. *Perspectives in Public Health, 135*(4), 204–211. https://doi.org/10.1177/1757913914552583

Budig, M., Keiner, M., Stoohs, R., Hoffmeister, M., & Höltke, V. (2021). Heart rate and distance measurement of two multisport activity trackers and a cellphone app in different sports: A cross-sectional validation and comparison field study. *Sensors*, *22*(1), 180. https://doi.org/10.3390/S22010180

Canadian Society of Exercise Physiology (CSEP). (2020a). *Canadian 24-hour movement guidelines: For adults 65 years or older*. https://csepguidelines.ca/guidelines/adults-65/

Canadian Society of Exercise Physiology (CSEP). (2020b). *Canadian 24-hour movement guidelines: For adults aged 18-64 years*. https://csepguidelines.ca/guidelines/adults-18-64/

Canadian Society of Exercise Physiology (CSEP). (2020c). *Canadian 24-hour movement guidelines: For children and youth*. https://csepguidelines.ca/guidelines/children-youth/

Canadian Society of Exercise Physiology (CSEP). (2020d). *Glossary of Terms Canadian 24-Hour Movement Guidelines*. https://csepguidelines.ca/resources/glossary/

Cappuccio, F. P., D'Elia, L., Strazzullo, P., & Miller, M. A. (2010). Sleep duration and all-cause mortality: A systematic review and meta-analysis of prospective studies. *Sleep*, *33*(5), 585–592. https://doi.org/10.1093/sleep/33.5.585

Centers for Disease Control and Prevention (CDC). (2020). *Facts About Intellectual Disability*. https://www.cdc.gov/ncbddd/developmentaldisabilities/facts-about-intellectual-disability.html

Centers for Disease Control and Prevention (CDC). (2022). *Are you getting enough sleep?*. https://www.cdc.gov/sleep/features/getting-enough-sleep.html

Cerin, E., Cain, K. L., Oyeyemi, A. L., Owen, N., Conway, T. L., Cochrane, T., van Dyck, D., Schipperijn, J., Mitáš, J., Toftager, M., Aguinaga-Ontoso, I., & Sallis, J. F. (2016). Correlates of agreement between accelerometry and self-reported physical activity. *Medicine and Science in Sports and Exercise*, *48*(6), 1075–1084. https://doi.org/10.1249/MSS.0000000000000870

Chaput, J. P., Dutil, C., Featherstone, R., Ross, R., Giangregorio, L., Saunders, T. J., Janssen, I., Poitras, V. J., Kho, M. E., Ross-White, A., Zankar, S., & Carrier, J. (2020). Sleep timing, sleep consistency, and health in adults: A systematic review. *Applied Physiology, Nutrition, and Metabolism*, *45*(10), S232–S247. https://doi.org/10.1139/apnm-2020-0032

Community Living BC. (2018a). *Eligibility – Information for Families*. https://www.communitylivingbc.ca/wp-content/uploads/Eligibility-Info-for-Families-Final.pdf

Community Living BC. (2018b). *Who is CLBC?* https://www.communitylivingbc.ca/who-does-clbc-support/who-is-clbc/

Constandt, B., Thibaut, E., De Bosscher, V., Scheerder, J., Ricour, M., & Willem, A. (2020). Exercising in times of lockdown: An analysis of the impact of COVID-19 on levels and patterns of exercise among adults in Belgium. *International Journal of Environmental Research and Public Health*, *17*(11), 1–10. https://doi.org/10.3390/ijerph17114144

Coppus, A. M. W. (2013). People with intellectual disability: What do we know about adulthood and life expectancy? *Developmental Disabilities Research Reviews*, *18*(1), 6–16. https://doi.org/10.1002/ddrr.1123

Courtenay, K., & Perera, B. (2020). COVID-19 and people with intellectual disability: Impacts of a pandemic. *Irish Journal of Psychological Medicine, 37*(3), 231–236. https://doi.org/10.1017/ipm.2020.45

Dairo, Y. M., Collett, J., Dawes, H., & Oskrochi, G. R. (2016). Physical activity levels in adults with intellectual disabilities: A systematic review. *Preventive Medicine Reports, 4*, 209–219. https://doi.org/10.1016/j.pmedr.2016.06.008

Diekelmann, S., Wilhelm, I., & Born, J. (2009). The whats and whens of sleep-dependent memory consolidation. *Sleep Medicine Reviews, 13*(5), 309–321. https://doi.org/10.1016/j.smrv.2008.08.002

Evenson, K. R., Goto, M. M., & Furberg, R. D. (2015). Systematic review of the validity and reliability of consumer-wearable activity trackers. *The International Journal of Behavioral Nutrition and Physical Activity*, *12*(1). https://doi.org/10.1186/S12966-015-0314-1

Fennell, C., Lepp, A., & Barkley, J. (2019). Smartphone use predicts being an "active couch potato" in sufficiently active adults. *American Journal of Lifestyle Medicine*, *15*(6), 673–681. https://doi.org/10.1177/1559827619861383

Fernhall, B., McCubbin, J. A., Pitetti, K. H., Rintala, P., Rimmer, J. H., Millar, A. L., & De Silva, A. (2001). Prediction of maximal heart rate in individuals with mental retardation. *Medicine and Science in Sports and Exercise*, *33*(10), 1655–1660. https://doi.org/10.1097/00005768-200110000-00007

Finlayson, J., Turner, A., & Granat, M. H. (2011). Measuring the actual levels and patterns of physical activity/inactivity of adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, *24*(6), 508–517. https://doi.org/10.1111/j.1468-3148.2011.00633.x

Fogel, S. M., Smith, C. T., & Cote, K. A. (2007). Dissociable learning-dependent changes in REM and non-REM sleep in declarative and procedural memory systems. *Behavioural Brain Research*, *180*(1), 48–61. https://doi.org/10.1016/j.bbr.2007.02.037

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the computer science and applications, inc. accelerometer. *Medicine and Science in Sports and Exercise*, *30*(5), 777–781. https://doi.org/10.1097/00005768-199805000-00021

Freedson, P., Pober, D., & Janz, K. F. (2005). Calibration of accelerometer output for children. *Medicine & Science in Sports & Exercise*, *37*(11), S523–S530. https://doi.org/10.1249/01.mss.0000185658.28284.ba

Frey, G. C. (2004). Comparison of physical activity levels between adults with and without mental retardation. *Journal of Physical Activity and Health*, *1*(3), 235–245. https://doi.org/10.1123/jpah.1.3.235

Eszter, F.E., Engeroff, T., & Banzer, W. (2017). Health benefits of light-intensity physical activity: A systematic review of accelerometer data of the national health and nutrition examination survey (NHANES). *Sports Medicine*, *47*. https://doi.org/10.1007/s40279-017-0724-0

Gallè, F., Sabella, E. A., Da Molin, G., De Giglio, O., Caggiano, G., Di Onofrio, V., Ferracuti, S., Montagna, M. T., Liguori, G., Orsi, G. B., & Napoli, C. (2020). Understanding knowledge and behaviors related to covid−19 epidemic in Italian undergraduate students: The EPICO study. *International Journal of Environmental Research and Public Health*, *17*(10). https://doi.org/10.3390/ijerph17103481

Gallicchio, L., & Kalesan, B. (2009). Sleep duration and mortality: A systematic review and meta-analysis. *Journal of Sleep Research*, *18*(2), 148–158. https://doi.org/10.1111/j.1365-2869.2008.00732.x

Gao, Z., & Lee, J.E. (2019). Emerging technology in promoting physical activity and health: Challenges and opportunities. *Journal of Clinical Medicine*, *8*(11), 1830. https://doi.org/10.3390/jcm8111830

Garth Homer Society. (2023). *Our Mission and Values*. Retrieved January 2, 2023, from https://www.garthhomersociety.org/about-us/our-mission-and-values

Greater Victoria Down Syndrome Society. (2023). *About Us*. Retrieved January 15, 2023, from https://gvdss.org/about-us/

Grifantini, K. (2014). How's my sleep?: Personal sleep trackers are gaining in popularity, but their accuracy is still open to debate. *IEEE Pulse*, *5*(5), 14–18. https://doi.org/10.1109/MPUL.2014.2339252

Guo, C., Zhou, Q., Zhang, D., Qin, P., Li, Q., Tian, G., Liu, D., Chen, X., Liu, L., Liu, F., Cheng, C., Qie, R., Han, M., Huang, S., Wu, X., Zhao, Y., Ren, Y., Zhang, M., Liu, Y., & Hu, D. (2020). Association of total sedentary behaviour and television viewing with risk of overweight/obesity, type 2 diabetes and hypertension: A dose–response meta-analysis. *Diabetes, Obesity and Metabolism*, *22*(1), 79–90. https://doi.org/10.1111/dom.13867

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Harris, J. C. (2006). *Intellectual disability: Understanding its development, causes, classification, evaluation, and treatment*. Oxford University Press.

Health Canada. (2003). *Canadian Guidelines for Body Weight Classification in Adults*. https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/healthy-weights/canadian-guidelines-body-weight-classification-adults/body-mass-index-nomogram.html

Heikura, U., Taanila, A., Olsen, P., Hartikainen, A. L., Von Wendt, L., & Järvelin, M. R. (2003). Temporal changes in incidence and prevalence of intellectual disability between two birth cohorts in Northern Finland. *American Journal on Mental Retardation*, *108*(1), 19-69. https://doi.org/10.1352/0895-8017(2003)108<0019:TCIIAP>2.0.CO;2

Hollis, J. L., Sutherland, R., Williams, A. J., Campbell, E., Nathan, N., Wolfenden, L., Morgan, P. J., Lubans, D. R., Gillham, K., & Wiggers, J. (2017). A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons. *International Journal of Behavioral Nutrition and Physical Activity,* 14(1). https://doi.org/10.1186/s12966-017-0504-0

Hosking, F. J., Carey, I. M., Shah, S. M., Harris, T., Dewilde, S., Beighton, C., & Cook, D. G. (2016). Mortality among adults with intellectual disability in England: Comparisons with the general population. *Public Health*, *106*, 1483–1490. https://doi.org/10.2105/AJPH.2016.303240

Hossain, M. M., Sultana, A., & Purohit, N. (2020). Mental health outcomes of quarantine and isolation for infection prevention: A systematic umbrella review of the global evidence. *Epidemiology and Health*, *42*. https://doi.org/10.4178/epih.e2020038

Hsieh, K., Rimmer, J. H., & Heller, T. (2014). Obesity and associated factors in adults with intellectual disability. *Journal of Intellectual Disability Research*, *58*(9), 851–863. https://doi.org/10.1111/jir.12100

Hsieh, K., Hilgenkamp, T., Murthy, S., Heller, T., & Rimmer, J. (2017). Low levels of physical activity and sedentary behavior in adults with intellectual disabilities. *International Journal of Environmental Research and Public Health*, *14*(12), 1503. https://doi.org/10.3390/ijerph14121503

Huang, Y., Li, L., Gan, Y., Wang, C., Jiang, H., Cao, S., & Lu, Z. (2020). Sedentary behaviors and risk of depression: A meta-analysis of prospective studies. *Translational Psychiatry, 10*(1), 1–10. https://doi.org/10.1038/s41398-020-0715-z

Kerr, J., Marinac, C. R., Ellis, K., Godbole, S., Hipp, A., Glanz, K., Mitchell, J., Laden, F., James, P., & Berrigan, D. (2017). Comparison of accelerometry methods for estimating physical activity. *Medicine & Science in Sports & Exercise*, *49*(3), 617–624. https://doi.org/10.1249/MSS.0000000000001124

Kirszenblat, L., & Van Swinderen, B. (2015). The yin and yang of sleep and attention. *Trends in Neuroscience*, *38*(12), 776–786. https://doi.org/10.1016/j.tins.2015.10.001

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*(863). https://doi.org/10.3389/FPSYG.2013.00863/ABSTRACT

Lante, K., Stancliffe, R. J., Bauman, A., Van Der Ploeg, H. P., Jan, S., & Davis, G. M. (2014). Embedding sustainable physical activities into the everyday lives of adults with intellectual disabilities: A randomised controlled trial. *BMC Public Health*, *14*(1), 1038. https://doi.org/10.1186/1471-2458-14-1038

Lee, D., Frey, G. C., Cothran, D. J., Harezlak, J., & Shih, P. C. (2023). Concordance between accelerometer-measured and self-reported physical activity and sedentary time in adults with autism. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-022-05862-y

Lee, P. H., Macfarlane, D. J., Lam, T. H., & Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(15), 1-11. https://doi.org/10.1186/1479-5868-8-115

Lo, J. C., Groeger, J. A., Cheng, G. H., Dijk, D. J., & Chee, M. W. L. (2016). Self-reported sleep duration and cognitive performance in older adults: A systematic review and meta-analysis. *Sleep Medicine, 17*, 87–98. https://doi.org/10.1016/j.sleep.2015.08.021

Lynch, L., McCarron, M., McCallion, P., & Burke, E. (2021). Sedentary behaviour levels in adults with an intellectual disability: A systematic review protocol. *HRB Open Research*, *3*(2). https://doi.org/10.12688/hrbopenres.13123.1

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest, 139*(6), 1514–1527. https://doi.org/10.1378/chest.10-1872

Matthews, L., Hankey, C., Penpraze, V., Boyle, S., Macmillan, S., Miller, S., Murray, H., Pert, C., Spanos, D., Robinson, N., & Melville, C. A. (2011). Agreement of accelerometer and a physical activity questionnaire in adults with intellectual disabilities. *Preventive Medicine*, *52*(5), 361–364. https://doi.org/10.1016/j.ypmed.2011.02.001

Maugeri, G., Castrogiovanni, P., Battaglia, G., Pippi, R., D'Agata, V., Palma, A., Di Rosa, M., & Musumeci, G. (2020). The impact of physical activity on psychological health during Covid-19 pandemic in Italy. *Heliyon*, *6*(6). https://doi.org/10.1016/j.heliyon.2020.e04315

Maulik, P. K., Mascarenhas, M. N., Mathers, C. D., Dua, T., & Saxena, S. (2011). Prevalence of intellectual disability: A meta-analysis of population-based studies. *Research in Developmental Disabilities, 32*(2), 419–436. https://doi.org/10.1016/j.ridd.2010.12.018

McDonald, K. E., Conroy, N. E., Olick, R. S., Carroll, A., Cuddy, M., Fialka-Feldman, M., Flanigan, D., Fratangelo, P., Gonzalez, L., Kennedy, M., King, K., Mansfield, C., McGowan, D., Romer, R., Turk, M., Velez, S., Walker, P., & Worral, P. (2016). Is it worth it? Benefits in research with adults with intellectual disability. *Intellectual and Developmental Disabilities*, *54*(6), 440–453. https://doi.org/10.1352/1934-9556-54.6.440

Melville, C. A., Boyle, S., Miller, S., MacMillan, S., Penpraze, V., Pert, C., Spanos, D., Matthews, L., Robinson, N., Murray, H., & Hankey, C. R. (2011). An open study of the effectiveness of a multi-component weight-loss intervention for adults with intellectual disabilities and obesity. *British Journal of Nutrition*, *105*(10), 1553–1562. https://doi.org/10.1017/S0007114510005362

Melville, C. A., Oppewal, A., Schäfer Elinder, L., Freiberger, E., Guerra-Balic, M., Hilgenkamp, T. I. M., Einarsson, I., Izquierdo-Gómez, R. H., Sansano-Nadal, O., Rintala, P., Cuesta-Vargas, A., & Giné-Garriga, M. (2017). Definitions, measurement and prevalence of sedentary behaviour in adults with intellectual disabilities — A systematic review. *Preventive Medicine, 97*, 62–71. https://doi.org/10.1016/j.ypmed.2016.12.052

Merriam-Webster. 2023. Sleep. In *Merriam-Webster.com dictionary*. Retrieved February 20, 2023, from https://www.merriam-webster.com/dictionary/sleep

Mikulovic, J., Dieu, O., Fardy, P. S., Bui-Xuan, G., & Vanhelst, J. (2014). Influence of sleep timing behavior on weight status and activity patterns in adults with intellectual disabilities. *Research in Developmental Disabilities*, *35*(12), 3254–3259. https://doi.org/10.1016/j.ridd.2014.08.008

Morgan, K., & Hartescu, I. (2019). Sleep duration and all-cause mortality: Links to physical activity and prefrailty in a 27-year follow up of older adults in the UK. *Sleep Medicine*, *54*, 231–237. https://doi.org/10.1016/j.sleep.2018.11.008

Nieman, D. C., & Wentz, L. M. (2019). The compelling link between physical activity and the body's defense system. *Journal of Sport and Health Science, 8*(3), 201–217. https://doi.org/10.1016/j.jshs.2018.09.009

O'Leary, L., Cooper, S. A., & Hughes-McCormack, L. (2018). Early death and causes of death of people with intellectual disabilities: A systematic review. *Journal of Applied Research in Intellectual Disabilities*, *31*(3), 325–342. https://doi.org/10.1111/jar.12417

Ohayon, M. M., Reynolds, C. F., & Dauvilliers, Y. (2012). Excessive sleep duration and quality of life. *Annals of Neurology*, *73*(6), 785–794. https://doi.org/10.1002/ana.23818

Okano, K., Kaczmarzyk, J. R., Dave, N., Gabrieli, J. D. E., & Grossman, J. C. (2019). Sleep quality, duration, and consistency are associated with better academic performance in college students. *Npj Science of Learning*, *4*(1). https://doi.org/10.1038/s41539-019-0055-z

Orzech, K. M., Salafsky, D. B., & Hamilton, L. A. (2011). The state of sleep among college students at a large public University. *Journal of American College Health*, *59*(7), 612–619. https://doi.org/10.1080/07448481.2010.520051

Oviedo, G. R., Travier, N., & Guerra-Balic, M. (2017). Sedentary and physical activity patterns in adults with intellectual disability. *International Journal of Environmental Research and Public Health*, *14*(9). https://doi.org/10.3390/ijerph14091027

Owen, N., Healy, G. N., Matthews, C. E., & Dunstan, D. W. (2010). Too much sitting: The population-health science of sedentary behavior. *Exercise and Sport Sciences Reviews*, *38*(3), 105–113. https://doi.org/10.1097/JES.0b013e3181e373a2

Park, J. H., Moon, J. H., Kim, H. J., Kong, M. H., & Oh, Y. H. (2020). Sedentary lifestyle: Overview of updated evidence of potential health risks. *Korean Journal of Family Medicine, 41*(6). https://doi.org/10.4082/kjfm.20.0165

Pesonen, A. K., & Kuula, L. (2018). The validity of a new consumer-targeted wrist device in sleep measurement: An overnight comparison against polysomnography in children and adolescents. *Journal of Clinical Sleep Medicine*, *14*(4), 585–591. https://doi.org/10.5664/jcsm.7050

Phillips, S. M., Cadmus-Bertram, L., Rosenberg, D., Buman, M. P., & Lynch, B. M. (2018). Wearable technology and physical activity in chronic disease: Opportunities and challenges. *American Journal of Preventive Medicine*, *54*(1), 144–150. https://doi.org/10.1016/j.amepre.2017.08.015

Polar Canada. (2021). *Polar Ignite*. Polar. https://www.polar.com/ca-en/ignite

Polar Electro. (2021). *Polar Flow Software*. Polar. https://flow.polar.com/

Polar UAE. (2017). *Polar A370 Fitness Tracker*. Polar. https://www.polar.com/ae-en/products/sport/A370-fitness-tracker

Prince, S. A., Melvin, A., Roberts, K. C., Butler, G. P., & Thompson, W. (2020). Sedentary behaviour surveillance in Canada: Trends, challenges and lessons learned. *International Journal of Behavioral Nutrition and Physical Activity, 17*(34). https://doi.org/10.1186/s12966-020-00925-8

Public Health Agency of Canada. (2014). *Economic burden of illness in Canada, 2010*. https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/science-research/economic-burden-illness-canada-2010/economic-burden-illness-canada-2010.pdf

Rhodes, R. E., Liu, S., Lithopoulos, A., Zhang, C. Q., & Garcia-Barrera, M. A. (2020). Correlates of perceived physical activity transitions during the COVID-19 pandemic among Canadian adults. *Applied Psychology: Health and Well-Being*, *12*(4), 1157–1182. https://doi.org/10.1111/aphw.12236

Richdale, A. L., & Baker, E. K. (2014). Sleep in individuals with an intellectual or developmental disability: Recent research reports. *Current Developmental Disorders Reports, 1*(2), 74–85. https://doi.org/10.1007/s40474-014-0010-x

Robertson, J., Emerson, E., Baines, S., & Hatton, C. (2018). Self-reported participation in sport/exercise among adolescents and young adults with and without mild to moderate intellectual disability. *Journal of Physical Activity and Health*, *15*(4), 247–254. https://doi.org/10.1123/JPAH.2017-0035

Ross, R., Chaput, J. P., Giangregorio, L. M., Janssen, I., Saunders, T. J., Kho, M. E., Poitras, V. J., Tomasone, J. R., El-Kotob, R., McLaughlin, E. C., Duggan, M., Carrier, J., Carson, V., Chastin, S. F., Latimer-Cheung, A. E., Chulak-Bozzer, T., Faulkner, G., Flood, S. M., Gazendam, M. K., … Tremblay, M. S. (2020). Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years or older: An integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, *45*(10), S57–S102. https://doi.org/10.1139/apnm-2020-0467

Rundo, J. V., & Downey, R. (2019). Polysomnography. In K. H. Levin & P. Chauvel (Eds.), *Clinical Neurophysiology: Basis and Technical Aspects: Handbook of Clinical Neurology* (3rd ed., Vol. 160, pp. 381–392). https://doi.org/10.1016/B978-0-444-64032-1.00025-4

Schalock, R. L. (2010). *Intellectual Disability: Definition, Classification, and Systems of Supports* (11th ed.). AAIDD.

Shan, Z., Ma, H., Xie, M., Yan, P., Guo, Y., Bao, W., Rong, Y., Jackson, C. L., Hu, F. B., & Liu, L. (2015). Sleep duration and risk of type 2 diabetes: A meta-analysis of prospective studies. *Diabetes Care*, *38*(3), 529–537. https://doi.org/10.2337/dc14-2073

Shanahan, P. J., Palod, S., Smith, K. J., Fife-Schaw, C., & Mirza, N. (2019). Interventions for sleep difficulties in adults with an intellectual disability: A systematic review. *Journal of Intellectual Disability Research, 63*(5), 372–385. https://doi.org/10.1111/jir.12587

Sleep Foundation. (2022). *Sleep Diary*. https://www.sleepfoundation.org/sleep-diary

Society of St. Vincent de Paul (SSVP). (2018). *Adults with Diverse Abilities*. https://www.ssvpvancouverisland.ca/adults-with-disabilities

Spanos, D., Hankey, C. R., & Melville, C. A. (2016). The effectiveness of a weight maintenance intervention for adults with intellectual disabilities and obesity: A single stranded study. *Journal of Applied Research in Intellectual Disabilities, 29*(4), 317–329. https://doi.org/10.1111/jar.12181

Special Olympics British Columbia. (2019). *Eligibility for Participation Policy*. https://www.specialolympics.ca/sites/default/files/SOBC_ADMINISTRATION_EligibilityForParticipation_0.pdf

Special Olympics British Columbia. (2023) *Our Mission, Vision, and Values*. https://www.specialolympics.ca/british-columbia/who-we-are/mission-vision-values

Stanish, H. I., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. G. (2019). Does physical activity differ between youth with and without intellectual disabilities? *Disability and Health Journal*, *12*(3), 503–508. https://doi.org/10.1016/J.DHJO.2019.02.006

Surtees, A. D. R., Oliver, C., Jones, C. A., Evans, D. L., & Richards, C. (2018). Sleep duration and sleep quality in people with and without intellectual disability: A meta-analysis. *Sleep Medicine Reviews, 40*, 135–150. https://doi.org/10.1016/j.smrv.2017.11.003

Temple, V. A., Anderson, C., & Walkley, J. W. (2000). Physical activity levels of individuals living in a group home. *Journal of Intellectual & Developmental Disability*, *25*(4), 327–341. https://doi.org/10.1080/13668250020019601

Temple, V. A., & Walkley, J. W. (2003). Physical activity of adults with intellectual disability. *Journal of Intellectual and Developmental Disability*, *28*(4), 342–353. https://doi.org/10.1080/13668250310001616380

Temple, V. A. (2007). Barriers, enjoyment, and preference for physical activity among adults with intellectual disability. *International Journal of Rehabilitation Research, 30* (4), 281-287. https://doi.org/10.1097/MRR.0b013e3282f144fb

Temple, V. A. (2009). Factors associated with high levels of physical activity among adults with intellectual disability. *International Journal of Rehabilitation Research, 32* (1), 89-92. https://doi.org/10.1097/MRR.0b013e328307f5a0

Temple, V. A., & Stanish, H. I. (2009). Pedometer-measured physical activity of adults with intellectual disability: Predicting weekly step counts. *American Journal on Intellectual and Developmental Disabilities*, *114*(1), 15–22. https://doi.org/10.1352/2009.114:15-22

Theis, N., Campbell, N., De Leeuw, J., Owen, M., & Schenke, K. C. (2021). The effects of COVID-19 restrictions on physical activity and mental health of children and young adults with physical and/or intellectual disabilities. *Disability and Health Journal, 14*(3). https://doi.org/10.1016/j.dhjo.2021.101064

Thivel, D., Tremblay, A., Genin, P. M., Panahi, S., Rivière, D., & Duclos, M. (2018). Physical activity, inactivity, and sedentary behaviors: Definitions and implications in occupational health. *Frontiers in Public Health*, *6*. https://doi.org/10.3389/fpubh.2018.00288

Tremblay, M. S. (2018). The consequences of sedentary behaviors: Keeping interpretations anchored in evidence. *Exercise and Sport Sciences Reviews, 46*(1), 4. https://doi.org/10.1249/JES.0000000000000128

U.S. Department of Health and Human Services. (2018). *Physical Activity Guidelines 2nd Edition*. https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf

Wang, D., Li, W., Cui, X., Meng, Y., Zhou, M., Xiao, L., Ma, J., Yi, G., & Chen, W. (2016). Sleep duration and risk of coronary heart disease: A systematic review and meta-analysis of prospective cohort studies. *International Journal of Cardiology*, *219*, 231–239. https://doi.org/10.1016/j.ijcard.2016.06.027

Warburton, D. E., Katzmarzyk, P. T., Rhodes, R. E., Shephard, R. J., Warburton, D., Katzmarzyk, P., Rhodes, R., & Shephard, R. (2007). Evidence-informed physical activity guidelines for Canadian adults. *Applied Physiology, Nutrition, and Metabolism, 32*, S16-S68. https://doi.org/10.1139/H07-123

Warburton, D. E. R., & Bredin, S. S. D. (2017). Health benefits of physical activity: A systematic review of current systematic reviews. *Current Opinion in Cardiology, 32*(5), 541–556. https://doi.org/10.1097/HCO.0000000000000437

World Health Organization (WHO). (2020). *WHO guidelines on physical activity and sedentary behaviour*. https://www.who.int/publications/i/item/9789240015128

van de Wouw, E., Evenhuis, H. M., & Echteld, M. A. (2012). Prevalence, associated factors and treatment of sleep problems in adults with intellectual disability: A systematic review. *Research in Developmental Disabilities*, *33*(4), 1310–1332. https://doi.org/10.1016/J.RIDD.2012.03.003

Wu, L., & Sun, D. (2017). Sleep duration and falls: A systemic review and meta-analysis of observational studies. *Journal of Sleep Research*, *26*(3), 293–301. https://doi.org/10.1111/jsr.12505

Wu, L., Sun, D., & Tan, Y. (2018). A systematic review and dose-response meta-analysis of sleep duration and the occurrence of cognitive disorders. *Sleep and Breathing, 22*(3), 805–814. https://doi.org/10.1007/s11325-017-1527-0

Zhai, L., Zhang, Y., & Zhang, D. (2015). Sedentary behaviour and the risk of depression: A meta-analysis. *British Journal of Sports Medicine, 49*(11), 705–709. https://doi.org/10.1136/bjsports-2014-093613

Appendix A – Diagnostic Criteria for Intellectual Disability and Eligibility Requirements for Community Programs in Victoria, BC

Intellectual Disability (Intellectual Developmental Disorder) Diagnostic Criteria

Intellectual disability is characterized by deficits in both intellectual and adaptive functioning in conceptual, social, and practical domains, which originates before 18 years of age (American Psychiatric Association, 2022). More specifically, the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) states that all three of the following criteria must be met:

A) "Deficits in intellectual functions, such as reasoning, problem solving, planning, abstract thinking, judgment, academic learning, and learning from experience, confirmed by both clinical assessment and individualized, standardized intelligence testing."
B) "Deficits in adaptive functioning that result in failure to meet developmental and sociocultural standards for personal independence and social responsibility. Without ongoing support, the adaptive deficits limit functioning in one or more activities of daily life, such as communication, social participation, and independent living, across multiple environments, such as home, school, work, and community."
C) "Onset of intellectual and adaptive deficits during the developmental period."

The APA uses the term "intellectual developmental disorder" to clarify its relationship with the World Health Organization ICD-11 classification system, which uses the term "disorders of intellectual development" (APA, 2022). However, the equivalent term, "intellectual disability", is used more commonly amongst educational and advocacy groups, and the public. Therefore, for the purposes of this thesis, the term "intellectual disability" will be used.

Community Program Descriptions and Eligibility Requirements for Membership

Community Program	Description	Eligibility
Community Living British Columbia (CLBC)	A provincial crown corporation that provides aid and services to adults with developmental disabilities, and other developmental disorders. CLBC works with individuals, families, and service providers to help foster a greater sense of belonging for all B.C. communities (CLBC, 2018b)	• Family member of the individual must provide an assessment completed by an approved professional such as a medical doctor or psychologist. • Assessment must clearly state that the individual meets all three DSM-5 criteria for intellectual disability (see above) (CLBC, 2018a).

Garth Homer Society (GHS) – Community Inclusion Program	Non-profit organization, based in Victoria, BC, that provides day services and programming for adults with developmental disabilities. The goal of GHS is to enable people with disabilities to make friends, connections, and a life in this world (GHS, 2023)	• Must be 18 years of age. • Must be diagnosed with developmental disability and referred by Community Living British Columbia (CLBC). • Have appropriate funding to participate in programs (GHS, 2023)
Special Olympics BC (SOBC) - Victoria	Non-profit organization dedicated to using sport to create inclusive communities across British Columbia. SOBC aims to enrich the lives of individuals with intellectual disabilities through participation in various sports (SOBC, 2023)	• Must satisfy <u>all</u> the following requirements: • Typically, an IQ score of approximately 70 or below. • Deficits in the general mental abilities which limit and restrict participation and performance in one or more aspects of daily life such as communication, social participation, functioning at school or work, or personal independence. • Onset during the developmental period (before the age of 18 years) (SOBC, 2019).
Greater Victoria Down Syndrome Society (GVDSS)	Registered charity that provides individuals with Down syndrome and their families with educational, vocational, and life enhancement assistance. GVDSS strives to enhance public awareness and understanding of Down syndrome (GVDSS, 2023)	• Must either be diagnosed or know someone who has been diagnosed with Down syndrome (GVDSS, 2023).
Society of St. Vincent de Paul (SSVP) – Vancouver Island	Canadian Catholic organization that provides programs and services for marginalized communities. At The Frederic Ozanam Centre in Victoria, BC, the SSVP helps integrate adults with developmental disabilities into the community (SSVP, 2018).	• Must be diagnosed with intellectual disability and referred by Community Living British Columbia (CLBC) (SSVP, 2018).

Note. All community programs are in Victoria, BC.

Appendix B – Human Research Ethics Board Certificate of Approval

University of Victoria

Office of Research Services | Human Research Ethics Board
Michael Williams Building Rm B202 PO Box 1700 STN CSC Victoria BC V8W 2Y2 Canada
T 250-472-4545 | F 250-721-8960 | uvic.ca/research | ethics@uvic.ca

Certificate of Approval - Amendments

PRINCIPAL INVESTIGATOR:	**Lynneth Stuart-Hill** (Supervisor)	**ETHICS PROTOCOL NUMBER** Expedited review - delegated	**20-0601**
PRINCIPAL APPLICANT:	**Cooper Coats Master's student**	ORIGINAL APPROVAL DATE:	01-Oct-2021
		APPROVED ON:	01-Apr-2022
UVIC DEPARTMENT:	**Exercise Science, Physical and Health Education EPHE**	APPROVAL EXPIRY DATE:	30-Sep-2022

PROJECT TITLE: **The success of Adults with Intellectual Disability or on the Autism spectrum in meeting the new Canada's 24 hour movement guidelines**

RESEARCH TEAM MEMBERS:
Cara Butler - Research Assistant, UVic
Stefanie Sajko - Research Assistant, UVic
Matthew Coxon - Principal Applicant, UVic
Viviene Temple - Principal Investigator, UVic

DECLARED PROJECT FUNDING:
Canadian Institutes of Health Research (CIHR), Canadian Institutes of Health Research (CIHR)

DOCUMENTS INCLUDED IN THIS APPROVAL:
tcps2_core_certificate.pdf - 14-Jun-2021
Research Ethics_TCPS 2_Core.pdf - 18-Jun-2021
Email-Recruitment-Script.docx - 20-Jul-2021
Sleep-Hygiene-and-Physical-Activity-Diary.pdf - 20-Jul-2021
UVic ethics letter from Garth Homer.pdf - 23-Sep-2021
Garth Homer Society Visitor Protocol.PNG - 23-Sep-2021
Recruitment Poster.docx - 23-Sep-2021
Recruitment Poster for GVDSS.docx - 17-Feb-2022
Email Recruitment Script GVDSS.docx - 17-Feb-2022
Consent and Assent Form Version 2.docx - 28-Feb-2022
UVICStudyLetter.pdf - 28-Feb-2022
2022-03-29 UVic Research Project Approval Letter.pdf - 29-Mar-2022
Recruitment Poster (General Use).docx - 29-Mar-2022
SOBC_Victoria_March2022.pdf - 30-Mar-2022

Conditions of approval

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Amendments
To make changes to the approved research procedure in your study, please submit "Amendments" or "Annual renewal with amendments" form. You must receive research ethics approval before proceeding with your amended protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a “Request for Renewal” form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a “Notice of Project Completion” form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria's policies for research involving human participants.

Dr. Sandra Gibbons	Dr. Matthew Murphy
Chair, Human Research Ethics Board	Vice-chair, Human Research Ethics Board

Certificate Issued On: 01-Apr-2022

Appendix C – Recruitment Poster and Email for Participants

University of Victoria

Are you getting enough exercise? Are you spending too much time on the couch? Are you getting enough sleep?

If you are 18 years or older, this study may be for you.

Study for adults with intellectual disabilities within the Greater Victoria region through the School of Exercise Science, Physical Health & Education, University of Victoria. We are looking for adults 18 years and older with an existing intellectual disability to examine their current physical activity levels, time spent sedentary, and sleep duration.

Many individuals with intellectual disabilities have been unable to regularly participate in physical activity due to the impact of the COVID-19 pandemic. This research seeks to observe physical activity levels and examine the existing relationship with sedentary time and sleep duration by using smartwatch technology.

Participants will be asked to participate in:

- 1 preliminary visit from the team to receive equipment
- 3 separate phone calls to provide progress updates
- 9 days of wearing the smartwatch both day and night
- 1 final visit from the team to return equipment

Participants will receive:

- $5 Tim Hortons Gift Card
- The oppurtunity to wear a smartwatch for one week

Location

- Progress updates will take place remotely via phone calls or Zoom check-ins
- Data recording will take place wherever you go through the wearable smartwatch

Are you eligible?

- 18 years or older
- No existing physical condition that prevents movement
- Existing intellectual disability

If you are unsure if you meet the requirements, call or email a member of the study team:

- mwcoxon@uvic.ca or 778-887-7862
- jcoopercoats@uvic.ca or 902-237-5568

Dear parents and caregivers,

We are conducting a research project on the sleep and physical activity patterns of individuals who participate in Garth Homer Society programs.

What is required: Participants will wear a Polar Ignite wristwatch for nine days, both during the day and at night. Participants will also complete a sleep hygiene and physical activity diary. In the diary, participants will record, independently or with assistance, sleep habits such as what time they went to bed and got up in the morning and whether they used electronics such as an iPad before bedtime.

What will happen: We will show participants how to wear the watch and how to keep the diary. Every two days we will come to the Garth Homer Society and download the data and recharge of the watch. We will collect the diary at the end of the nine days.

If you know someone aged between 18 and 50 years who might be interested in participating in this study, or you would like more information, please contact Matthew Coxon at the University of Victoria, at **778-887-7862** or **mwcoxon@uvic.ca** or Cooper Coats at the University of Victoria, at **902-237-5568** or **jcoopercoats@uvic.ca**

Appendix D – Informed Consent and Assent

Levels of Physical Activity, Sedentary Activity, and Sleep in Adults with Intellectual Disability during COVID-19: A Pilot Study on the 2020 Canadian 24-Hour Movement Guidelines

Adults with an intellectual disability (ID), aged 18 to 50 years, are invited to participate in a study entitled *"Levels of physical activity, sedentary activity, and sleep in adults with intellectual disability in Victoria, BC during COVID-19: A pilot study on the 2020 Canadian 24-hour movement guidelines"* that is being conducted by Mr. Cooper Coats and Mr. Matthew Coxon who are graduate students at the University of Victoria, and Dr. Viviene Temple and Dr. Lynneth Stuart-Hill, who are professors at the University of Victoria.

If you have further questions, you may contact any of the following contacts:

Cooper Coats	902-237-5568	jcoopercoats@uvic.ca
Matthew Coxon	778-887-7862	mwcoxon@uvic.ca
Dr. Viviene Temple	250-721-7846	vtemple@uvic.ca
Dr. Lynneth Stuart-Hill	250-721-7884	lstuhill@uvic.ca

Purpose and Objectives

The aim of this study is to see, on average, how much time you're spending sedentary or doing physical activity during the day. Furthermore, we also want to know how much sleep you're getting each night.

Importance of this Research

Achieving regular physical activity has many short- and long-term benefits, such as a decrease in blood pressure, a lowered risk of cardiovascular disease and dementia, as well as improvements to overall bone health and quality of life.[1] Sleep is also a crucial factor in maintaining health life, as regular sleep has been shown to reduce the risk of heart disease and type II diabetes, as well as improving immune function, mood, and learning.[1] Understanding the current level of physical activity, sedentary activity, and sleep for adults with an intellectual disability, will provide policymakers and community outreach programs within Victoria, BC with salient information for public health provisions.

What is Involved?

If you agree to be in this project, you will be asked to do these things:

1. You wear a Polar Ignite smartwatch for 9 consecutive days as shown in the picture below.

2. On the first day, your body height and weight will be measured in person by one of our researchers and information like age, sex, medication use, and medical diagnosis will be collected.

3. Every two days after that, a researcher from our team will come to you and borrow the watch for an hour in order to charge it and download the data. After this, the watch will be returned to you.

Inconvenience

Participation in this study may cause some inconvenience to you because you will be asked to wear a wristwatch for 9 consecutive days during the day and at night. There will be a total of 5 visits of an hour each from the researchers during those 9 days which may also cause some inconvenience.

Risks

Given the current circumstances with the COVID-19 global pandemic, the risk is potentially getting the virus. However, researchers coming meet with you to complete the data collection will be wearing masks, maintaining social distancing when possible, sanitizing hands before and after each visit, and wearing disposable gloves at all times.

Benefits to You

- You will learn on average how much physical activity you're getting
- You will learn on average how much time you spend sedentary during the day
- You will learn on average how much sleep you're getting
- The societies involved with the study will know the overall results of the study, which will help the staff with programming
- You will receive a $5 Tim Hortons gift card

Benefits to Community

- The societies involved with the study will know how much, on average, their members are moving, staying sedentary, and sleeping
- Novel experimental design will provide a valuable framework for future studies with vulnerable populations, limiting contact time through the use of wearable technologies

Voluntary Participation

It is important that you understand that you don't have to participate in this project if you don't want to and you can stop at any time. You can tell any one of the researchers, staff at the organization you are affiliated with, or care-providers that you want to quit, and you can. If you decide to leave the study at any time, you must return the watch to the researchers, care-providers, or staff at the organization you are affiliated with, and it will be collected by someone from the research team.

If you decide to stop being in the project, you can decide if the information we have already collected can be used in our research, or you want it destroyed. If you decide we can use the information, we will write you a letter asking to use the information and the letter will be mailed to you. You can sign the letter and mail it back to us if you are comfortable with us using the information. If we do not receive a signed letter in return, we will throw away the information.

Anonymity and Confidentiality

The research team will not tell anyone you are in the study. However, other persons may know that you are a part of a study given you will be wearing a smartwatch. All the information we collect from you (e.g. your age, height, weight, activity levels) will be put into a password-protected computer and Polar Flow online software it will not have your name on it. Your information will be kept safe in a locked cabinet and on a password protected computer and password-protected online software for a long time in case the researchers want to look at it again. In five years, the information will be destroyed.

Dissemination of Results

After we have collected the information from many different participants, we will share what we learned about physical activity, sedentary behaviour, and sleep length. We will talk about it at meetings so other people learn about our project. We will write about it a professional magazine. However, your name will not be used, so no one will know you were in the study. The researchers can also provide to you the results from our study including your average level of physical activity, time spent sedentary and sleep.

In addition, you may check the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

COVID-19 Contract Tracing

Participants will be advised if they have or may have come into contact with an individual who has tested positive for COVID-19. Contact information for participants will be stored in a separate file from research data in the event that follow up is needed.

Your signature below shows that you understand and agree with what is written in this form, and that you have had the opportunity to have your questions answered by the researchers.

Resources

[1] U.S. Department of Health and Human Services. (2018). *Physical Activity Guidelines 2nd Edition*. 118.

Name of Participant	*Participant Signature*	*Date*

Name of Parent/Guardian/Caregiver	*Parent/Guardian/Caregiver Signature*	*Date*

Levels of Physical Activity, Sedentary Activity, and Sleep in Adults with Intellectual Disability during COVID-19: A Pilot Study on the 2020 Canadian 24-Hour Movement Guidelines

I agree to work with Cooper, Matthew, Viviene, and Lynneth who work at the University of Victoria on a project about the 2020 Canadian 24-hour movement guidelines and whether these guidelines are being adhered to in Victoria, BC by adults with intellectual disability during the COVID-19 pandemic. The project will collect data for physical activity, sedentary activity, and sleep hygiene. I will participate in the following for the project:

1. I will be weighed and measured for my height.
2. I will answer some questions about what kind of support I need every day, my age, and the sports I play.
3. I will wear the Polar Ignite wristwatch for nine consecutive days, including during the day and at night.
4. I will return the Polar Ignite wristwatch to the researcher for data collection and charging every two days during the nine-day data collection period.
5. I will return the Polar Ignite wristwatch to the researcher at the end of the data collection period.

I understand that none of the things I will be asked to do will hurt me, but it may be inconvenient to wear a wristwatch for nine days.

I understand that I don't have to participate in this project if I don't want to, and I can stop at any time. I can tell any one of the researchers, care-providers, or staff at the organization I am affiliated with, that I want to quit, and I can. I will still keep the Tim Hortons gift card for my participation regardless of the time at which I quit. I will return the watch to the researchers, care-providers or staff at the organization I am affiliated with once I quit.

If I decide to quit, the researchers will ask me if they can use my data. If I tell them that they can, they will send my caregiver/parent a letter asking if they can use the data that they got from the time that I was participating. If I am okay with them using my data, my caregiver/parent and I will sign the letter and send it back to the researchers. If I am not okay with my data being used, I do not have to mail the letter back, and my results will be thrown away.

All of my data, numbers, and other information collected from me will not be shared with anyone except for the researchers. After five years, all my data, numbers, and other information will be destroyed.

The researchers will share what they learned about the levels of physical activity, sedentary activity, and sleep at meetings and in professional journals, but my name will not be used, so no one will know I was in the study. The researchers will also share the information with me. I can also ask Cooper, Matthew, Lynneth, or Viviene to share with me how much physical activity, sedentary activity, and sleep I achieved during the nine days of data collection.

I may be advised if I have come or may have come into contact with a person who has tested positive for COVID-19. My contact information will be stored in a separate file from the research data in the event that a follow up is needed.

If I have any questions, my parent/guardian/service provider or I can call Viviene at 250-721-7846 or email her at vtemple@uvic.ca.

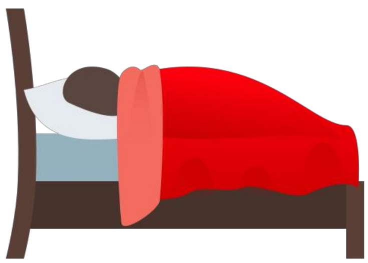
Your signature below shows that you understand and agree with what is written in this form, and that you have had the opportunity to have your questions answered by the researchers.

______________________	______________________	__________
Name of Parent/Guardian/Caregiver	*Parent/Guardian/Caregiver Signature*	*Date*

______________________	______________________	__________
Name of Participant	*Participant Signature*	*Date*

Appendix E – Physical Activity and Sleep Diary

Physical Activity and Sleep Hygiene Diary



Please complete this diary each day
and show it to Matthew or Cooper
each time your watch is charged

Name: ____

PHYSICAL ACTIVITY

1. **Complete Before Going to Bed Each Day**

Answer the questions by circling YES or NO, then tell us what those activities were

	Day of the week							
SPORT								
Did you play a **sport** today? Like soccer, golf, 5-pin or 10-pin bowling, gymnastics	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
If yes, what sport did you play?								
Was this sport part of Special Olympics?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
PHYSICAL ACTIVITIES AND EXERCISE (NOT SPORT)								
Did you do **physical activities or exercise** today? Like walking, yoga, club fit, riding a bicycle, or lifting weights	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
If yes, what physical activities or exercises did you do?								
Who did you do the activities or exercise with? Like Garth Homer Society (GHS), family, recreation centre program, physiotherapist								

HOUSEHOLD ACTIVITIES								
Did you do **housework** today? Like washing dishes, sweeping floors, cooking, or vacuuming	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
If yes, what housework did you do?								
Did you do **yard work** or **gardening** today? Like mowing the lawn, raking leaves, planting flowers, or weeding	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
If yes, what yard work did you do?								

Is there anything else you want to tell us about your physical activity?

___

___

___

___

___

2. Complete Before Going to Bed

Answer the questions by circling YES or NO

	Day of the week							
Activity								
Did you use technology within 30 minutes of going to bed? (like TV, phone, computer, iPad)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you eat or drink any caffeine within 4 hours of going to bed? (like coffee, tea, chocolate or cola)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you exercise or play sports within 3 hours of going to bed?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you do calming activities before going to bed (like listening to music or meditating)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you do you usual sleep routine before going to bed?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you take medication to help you sleep?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Are you using a sleep device tonight? (like a CPAP)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No

3. <u>Complete When You Wake Up</u>

Answer the questions by circling YES or NO

	Day of the week							
Activity								
Did you have trouble falling asleep?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you wake up during the night?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Did you wake up earlier than planned?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
Were you too hot or too cold during the night?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No

3. What time did you go to bed last night and get up today? (Write the hour and minutes e.g. 9.35 pm)

	Day of the week							
Activity								
What time did you go to bed at night?								
What time did you get up in the morning?								

4. Sleep routine

Please describe your usual sleep routine? Including:

What time do you usually go to bed and wake up? Are the times different on different days? What do you do before going to bed? (like, clean my teeth and put on pajamas, do some yoga and deep breathing, put on my CPAP).

Is there anything else you want to tell us about your sleep?

Please provide the following information:

Did someone help you fill in this diary? If so, can you provide their name and contact information

Name: ____

How best to contact?

Email:

Phone number:

If you have any questions or concerns, contact Matthew Coxon at mwcoxon@uvic.ca or Cooper Coats jcoopercoats@uvic.ca

Appendix F – Body Mass Index Health Risk Classification

Health Risk Classification According to Body Mass Index

Classification	BMI Category (kg/m^2)	Health Risk
Underweight	< 18.5	Increased
Normal weight	18.5 - 24.9	Least
Overweight	25.0 - 29.9	Increased
Obese class I	30.0 - 34.9	High
Obese class II	35.0 - 39.9	Very high
Obese class III	>= 40.0	Extremely high

Note. BMI is calculated by diving body weight in kilograms (kg) by height in metres squared (m^2). Health risk refers to the risk of developing health problems. Classifications are based on Health Canada's (2003) "Canadian guidelines for body weight classification in adults."

Formula for BMI Calculation (Health Canada, 2003):

$$\text{Body Mass Index (BMI)} = \text{Body Weight (kg)} \div (\text{Height (m)})^2$$