**­Title:** Physical activity and sedentary behavior in children and adolescents with healed Legg-Calve-Perthes Disease, Slipped Capital Femoral Epiphysis (SCFE), and Developmental Dysplasia of the Hip (DDH).

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**Project Summary:**

Once children or adolescents with Legg-Calve-Perthes (Perthes) disease, Slipped Capital Femoral Epiphysis (SCFE), or Developmental Dysplasia of the Hip (DDH) have healed, they are no longer restricted in their participation in physical activity. Generally, these patients are expected to return to normal activity levels after recovery; however, whether or not this actually occurs is unknown. There is currently no data on the amount of physical activity or sedentary behavior that these patients engage in or if their activity levels are adequate. This has impeded the ability for orthopedic surgeons to provide recommendations that prevent poor health outcomes associated with physical inactivity and sedentary behavior without compromising hip joint function or accelerating the development of osteoarthritis.

This cross-sectional observational pilot study seeks to fill this gap by assessing the activity patterns of healed pediatric hip patients. It will focus on understanding how these patients meet or fail to meet the current guidelines for physical activity and sedentary behavior, as outlined in the 24-Hour Canadian Movement Guidelines. An additional component of this study will also explore the role of resistance training, an often-overlooked but potentially vital aspect of rehabilitation. While resistance training is widely recognized for its benefits in preventing injury and aiding in rehabilitation, little research has focused on its specific role in post-treatment hip patients. This study aims to assess the prevalence and frequency of this form of training, with the goal of accumulating information which can help in determining whether such training can help reduce the risk of re-injury, promote recovery, and improve musculoskeletal health.

We anticipate that these patients will demonstrate inadequate physical activity levels and elevated sedentary behavior. By exploring these patterns, this study will contribute to a broader understanding of how hip patients engage in physical activity post-recovery and how to improve outcomes through evidence-based activity guidelines.

Ultimately, we hope this study will provide critical insights that will inform larger, multisite projects, resulting in an international database on physical activity and sedentary behavior in pediatric hip patients. This knowledge will pave the way for prospective cohort and interventional studies aimed at developing standardized, disease-specific recommendations for physical activity, including resistance training, to optimize long-term health outcomes for these patients.

**BACKGROUND**

Legg-Calve-Perthes (Perthes) Disease, Slipped Capital Femoral Epiphysis (SCFE), and Developmental Dysplasia of the Hip (DDH) are three of the most prevalent hip conditions affecting children and adolescents. Of these, DDH is the most common, with 1-3% of all newborns diagnosed at birth (Mulpuri et al., 2016). DDH represents a spectrum of disorders, from mildly dysplastic to fully dislocated hips, where there is a complete loss of contact between the femoral head and acetabulum (Aronsson et al., 1994; Dezateux & Rosendahl, 2007). Hip dysplasia is a leading cause of early onset hip osteoarthritis in people under 60 years (Jacobsen and Sonne-Holm, 2005; Pun, 2016).

Perthes is a disease of an unknown etiology where there is a disruption of blood supply to the hip joint, leading to the collapse and flattening of the femoral head (Kim, 2011). Incidence of Perthes in the general population is quite rare, ranging from 0.2 to 19.1 per 100,000 (Perry et al., 2012). Long-term prognosis is generally good, (Canavese & Dimeglio, 2008), nevertheless, long-term studies have found that adults who had Perthes during childhood or adolescence are more likely to develop osteoarthritis later on in life (Heesakkers et al., 2015).

SCFE is another common pediatric hip condition that is characterized by the slippage of the femoral head off the neck of the femur at the physeal plate. SCFE is relatively uncommon, with an incidence between 0.71 and 10.8 per 100,000 children (Novais et al., 2012); however, it is the most common hip disorder in adolescents. Early diagnosis is essential for a good outcome, but early onset osteoarthritis is a potential consequence of disease (Bitersohl et al., 2015).

To protect the hip joint and facilitate healing, patients with SCFE, Perthes, and DDH are restricted in their sports and physical activity until they have healed. In SCFE cases, activity is restricted until the physis has closed. For Perthes and DDH patients, healing is contingent on the containment of the femoral epiphysis within the acetabulum and the shape of the femoral head. After healing, children can generally return to normal activity; however, many patients are left with residual deformity, experience hip symptoms and functional limitations, and may go on to develop hip osteoarthritis.

Physical activity (PA) is any bodily movement produced by skeletal muscles that results in

energy expenditure (Caspersen et al., 1885; Aubert et al., 2021). PA plays a critical role in bone and joint health, body composition, cardiovascular health, and mental health (Janz et al;, 2010; Specker et al., 2015; Janssen & Leblanc, 2010; Stricker et al., 2020). The positive effects of PA are especially important during youth, as it has been shown to reduce risks of future chronic diseases in adulthood (Raitakari et al., 1994; Twisk et al., 1997). PA habits at this time may also be carried on into adulthood, making it important that health-promoting behaviors are established (Telama et al., 2005). Physical inactivity, on the other hand, is associated with many chronic diseases including obesity, diabetes, cardiovascular disease, bone and joint diseases, cancer, and mental illnesses such as anxiety and depression (Booth, Roberts, & Laye, 2012).

Resistance training, a cornerstone of modern fitness and rehabilitation, has gained recognition in recent years for its positive impact on children's and adolescents' physical health (Stricker et al., 2020). Initially associated with bodybuilding and powerlifting, resistance training now encompasses a variety of exercises designed to improve strength, endurance, and power. This can include free weights, resistance bands, weight machines, and body-weight exercises. Emerging research underscores the benefits of resistance training for youth, including improved motor skills, increased strength and speed, reduced injury risk, and enhanced cardiovascular health, bone mineral density, and body composition. Additionally, resistance training plays a crucial role in rehabilitation, particularly for musculoskeletal conditions like knee osteoarthritis and chronic tendinopathy (Kristensen & Franklyn-Miller, 2011). It’s been determined that exercise therapy has a positive effect on reducing pain and improving function in individuals with hip osteoarthritis (Teirlinck et al., 2023). Strengthening the muscles around the affected joints can help stabilize the hip, reduces the risk of re-injury, and improves mobility (Skou et al, 2018).

Further, participating in resistance training has been shown to boost physical activity levels, even in children who are generally inactive (Meinhardt et al., 2013). This suggests that incorporating strength exercises could be an effective intervention to encourage more movement in pediatric patients during their recovery phase. Resistance training has been increasingly incorporated into competitive sports training for children at younger ages (Stricker et al., 2020). As such, a growing body of evidence supports the safety and efficacy of age-appropriate resistance exercises, particularly when performed under proper supervision to prevent injury (Faigenbaum et al., 2009). Research has shown that the benefits of strength training in youth are comparable to those in adults, emphasizing the importance of fostering strength reserves early in life to improve physical performance and reduce the likelihood of future injuries.

While physical inactivity is associated with poorer health outcomes, sedentary behavior is also as important to consider. Increased sedentariness has been linked to not only metabolic syndrome, hypertension, and lowered self-esteem and pro-social behavior scores, but also has been strongly linked to cardiovascular disease and diabetes (Tremblay et al., 2010; Park et al., 2020). Prolonged sedentary behavior has a notable negative association with bone mineral density (BDM)in the hip, particularly in the total femur and all hip sub-regions (Park et al., 2020). In adult women, increased sedentary time is strongly correlated with lower BMD in the femur, with the impact being more related to the duration of inactivity than its frequency. Sedentary behavior also negatively affects musculoskeletal health, leading to reduced muscle glucose transporter activity, decreased lipoprotein lipase activity in muscles, impaired muscle function, and increased risk of chronic pain in weight-bearing joints. In fact, sedentary screen time has been associated with risk of being overweight and poorer metabolic health, regardless of how long one exercises (Engberg et al., 2019; Owen et al., 2010). Thus, the benefits of PA may only exist if sedentary behavior is also limited.

The CSEP *Canadian 24-Hour Movement Guidelines for Children and Youth* were developed with an understanding of the health benefits related to maximizing PA and minimizing sedentary behavior. The guidelines suggest that children and adolescents should accumulate at least 60 minutes of daily moderate to vigorous physical activity (MVPA) and no more than 2 hours of recreational screen time per day (CSEP, 2016). In more recent studies, meeting these requirements has been operationalized as having average at least 60 min of MVPA or less than 2 hours of recreational screen time per day. Although the benefits of increased PA and reduced sedentary behavior in children and youth, such as bettering physical and psychosocial health outcomes, have been well established, adherence to the guidelines is low. Specifically with the recent COVID-19 pandemic, there have been studies done which observed a significant decline in daily step counts and PA in children, specifically those with pre-existing health concerns (Hemphil et al., 2020). Despite the overall physical activity levels being below Canadian guidelines even before the pandemic, the reductions in physical activity during the pandemic due to public health measures raised concerns about potential long-term health impacts. Research done to look at identifying specific characteristics that influenced adherence and non-adherence to movement behavior recommendations during the pandemic suggested that non-adherence was additionally associated with low parental control over screen time, older youth (12–17 years), reduced outdoor PA and sports, and low parental support for sleep and PA. Data from the Canadian Health Measures survey of children and youth aged 5-17 indicated that in 2023, only 43.9% of children accumulated at least 60 minutes of MVPA on average (Statistics Canada). Reports in 2017 indicate that just over half (53%) met the recommendation for 2 hours or less of average recreational screen time.

In pediatric hip patients, the same health benefits of PA exist; however, PA has the added benefits of improving hip physical function, reducing pain, and reducing the risk of future disability (Ayers, Franklin, & Ring, 2013; Fransen et al., 2014; Stricker et al., 2020). In addition to the health benefits, the resulting consequences of inactivity may be more severe in hip patients. For example, weight gain adds stress to the affected hip joint and can worsen hip symptoms and function (Cooper et al., 1998). This can lead to a vicious cycle where hip symptoms/osteoarthritis further prevent an individual from being active, resulting in weight gain that leads to the further worsening of hip symptoms (Issa & Griffin, 2012).

Studies of other pediatric conditions, including juvenile arthritis and pediatric asthma have shown that these patients engage in even less PA compared to their healthy peers (Henderson et al., 1995; Bourdier et al., 2019; Glazebrook et al., 2006; Lang et al., 2004; Lelieveld et al., 2008; Williams et al., 2008). These studies examined many factors that predict PA, including parent/child perceptions of the disease and activity limitations, time of disease onset, disease outcome, and disease severity (Pianosi et al., 2004; Glazebrook et al., 2006; Takken et al., 2003). From these studies, as well as the known impacts of hip disease, one can infer that the pediatric hip population may similarly have reduced PA due to real and/or perceived limitations stemming from their disease (Riner & Sellhorst, 2013; Walker et al., 2015). Despite this possibility, only one study has examined activity pediatric hip patients; however, it only focused on Perthes disorder and did not use any objective measures of physical activity (Hailer et al., 2014).

This study will fill the current gaps in the literature by examining physical activity and sedentary behavior in three of the most common pediatric hip disorders. Since the orthopedic surgeon only provides care/guidance up to the end of adolescence, our target population will include children and adolescents only. We will examine the proportion of pediatric patients that are currently meeting the Canadian physical activity and sedentary behavior guidelines. We also hope to further understand the factors that affect physical activity and sedentary levels in order to make suggestions for surgeons when guiding hip patients in the future.

**Research Objectives & Hypotheses**

**Primary objective:** Understand levels of physical activity and sedentary behavior in healed pediatric hip patients.

Hypothesis 1: We hypothesize that the proportion of hip patients meeting the CSEP guidelines for average daily MVPA will be lower than nationally reported values (43.9%). We also hypothesize that the proportion of hip patients meeting the CSEP guidelines for average daily recreational screen time will be no different than or less than nationally reported values (53%).

We believe that our population of hip patients will have a lower proportion meeting the MVPA guidelines, as previous studies on other pediatric disorders have shown that patients have lower levels of physical activity than their normal peers. Additionally, the impact hip disease may have on activity (Riner & Sellhorst, 2013) and previous clinical experience further lead us to believe that this population may be less active than their unaffected peers.

With regards to sedentary behavior, there have been no studies in this population. Studies in other pediatric disorders have been inconsistent, with most finding no difference between their patients and unaffected peers.

Hypothesis 2: Time since healed, disease laterality, disease severity at presentation, radiographic outcome, parental support of PA, and HOOS scores, will be significant predictors of activity levels.

These factors have been chosen in accordance with previous studies assessing disease-specific predictors of physical activity in other pediatric disease populations.

**Secondary Objective:** Evaluate the validity of Physical Activity Questionnaires (PAQ-C and PAQ-A) in children and adolescents with healed hip disorders.

Hypothesis 1: There will be moderate to strong positive correlation between PAQ scores and accelerometry-derived physical activity metrics (rho>0.3).

A previous study by Voss et al. (2017) showed that the PAQ-C and PAQ-A were valid for use pediatric hip patients diagnosed with congenital heart defects. In this study, they found that the strength of correlation between PAQ score and total PA was 0.52 while the correlation between PAQ score and average MVPA was 0.48 (Voss et al., 2017)

**Methodology**

**Study Design:** This will be a cross-sectional, observational, correlational study design.We will be observing and describing sedentary behavior and physical activity levels in a population of healed pediatric hip patients at one time point. The study will determine the proportion of patients meeting the CSEP MVPA and sedentary behavior guidelines. We will also be examining the relationships between activity levels (PA and sedentary behavior), which are our criterion variables, with multiple predictor variables.

**Inclusion Criteria:** Participants will include patients of the BC Children’s Hospital Orthopaedic Clinic, aged 6 to 18, with a history of Developmental Dysplasia of the Hip (DDH), Slipped Capital Femoral Epiphysis (SCFE), or Legg-Calve-Perthes (Perthes) disease that has since healed. Healed is operationalized as at least one year since a successful intervention. A parent/guardian must provide informed consent for both their own participation and that of their child. Children must provide informed assent.

**Exclusion criteria:** Participants will be excluded if the patient has a comorbidity that limits their ability to be physically active. These comorbidities include cerebral palsy, muscular dystrophy, spinal deformity, lower limb deformity, osteogenesis imperfecta, or any lower limb surgery within the past year. Participants will be excluded if they cannot commit to returning the device, questionnaires, and activity log within 2 weeks of the appointment.Participants will also be excluded if they plan to travel during the time of accelerometry wear, as travelling may cause atypical levels of physical activity.

**Recruitment:** Participants will be recruited during their yearly follow-up visits at the Orthopedic clinic at BC Children’s Hospital (BCCH). It does not matter when after recovery the patient is recruited, as long as they have reached the healed stage. We will use a form of criterion sampling, where patients will be pre-identified from the orthopaedic department clinic lists based on the inclusion criteria. The pre-identified patient and their families will be approached in the clinic by a research assistant and invited verbally and with a formal invitation letter. Since all pediatric hip patients are followed-up with yearly until skeletal maturity or the age of 18, we do not foresee any recruitment bias where patients with certain disorders or more severe disorders are more likely to be recruited.

Participants will be recruited during their yearly follow-up visits at the Orthopedic clinic at BC Children’s Hospital (BCCH). A total of 20 participants will be enrolled in this study, with 6-7 participants from each of the three hip pathologies: Perthes, SCFE, and DDH. As this is a pilot, cross-sectional observational study, the focus is on data collection rather than experimental manipulation, so no control group will be included. The recruitment process will involve criterion sampling, where patients will be pre-identified from the orthopedic department clinic lists based on the inclusion criteria. Once a potential participant is identified, they and their families will be approached by a research assistant in the clinic and invited to participate verbally, followed by a formal invitation letter.

Participants will be eligible as long as they have reached the healed stage of their respective hip condition, regardless of when after recovery they are recruited. Since all pediatric hip patients are followed up with yearly visits until skeletal maturity or the age of 18, there is no expected recruitment bias with regard to the severity of the condition. The goal is to ensure a balanced representation of the three pathologies within the study cohort to better understand activity patterns across this population of healed pediatric hip patients.

**Assent and consent:** We will obtain written informed parent/guardian consent and written informed participant assent to study participation and access to patient medical records. There will be two versions of the assent form: one for children and one for adolescents. Participants will be reminded that consent/assent is continuous and that they can withdraw at any point.

**Anthropometry:** The researcher will measure stature (cm) and body weight (kg) in order to calculate Body Mass Index (BMI). BMI will be calculated with the formula kg/m2 and will be used to determine Z scores that classify the participants ordinally as underweight (<-2SD) normal weight (between -1 and +1 SD), overweight (>+1SD), or obese (>+2 SD) in accordance with age and sex-specific tables (WHO).

**Chart Review**: We will categorically classify the laterality of disease (unilateral vs. bilateral) and determine the time since the patient has reached the healed stage (rounded to nearest year). An orthopaedic surgeon will examine past radiographs to classify the disease as mild, moderate, or severe at initial presentation using the following disease-specific grading scales:

Developmental Dysplasia of the Hip: IHDI Grade (Narayanan et al., 2015)

Legg-Calve-Perthes: Catterall classification (Catterall, 1971)

Slipped Capital Femoral Epiphysis: Southwick Slip Angle (Southwick, 1967)

The orthopaedic surgeon will also determine radiographic outcome using the following measures:

Developmental Dysplasia of the Hip: Tonnis, Severin classification

Legg-Calve-Perthes: Stulberg, SDI, Moses

Slipped Capital Femoral Epiphysis: AP alpha angle

**Subjective Hip Outcome:** Patients will fill out the International Perthes Study Group (IPSG) Modified Hip Osteoarthritis Outcome Score (HOOS), which is a 16-item questionnaire that asks about symptoms, pain, quality of life, function during everyday life, and function during sports and recreation (IPSG). This version of the HOOS has been previously modified for use in pediatric hip patients. The HOOS is scored on an interval scale ranging from 0-100, with higher scores indicating better hip function. In a systematic review by Thorborg et al. (2010), the HOOS was found to have adequate measurement qualities for test–retest reliability, floor and ceiling effects, construct validity, and responsiveness.

**Physical Activity and Sedentary Behavior:** The Physical Activity Questionnaire for Children (PAQ-C) and Adolescents (PAQ-A) are widely used 7-day recall questionnaires designed to assess general physical activity levels (Kowalski et al., 2004). The PAQ-C is used for children 13 years old or younger, while the PAQ-A is for those 14 years old or older. For patients 8 years old or younger, the PAQ-C is completed by parent proxy. The PAQ-C has been extensively studied in various English-speaking populations, including Canadian, British, Euro-American, and African-American children, demonstrating strong psychometric properties. Recent research continues to validate its use across different populations and cultures, including a validation study in Saudi Arabia, which showed the questionnaire's reliability and validity through measures like Cronbach’s alpha and favorable item analysis (Sirajudeen et al., 2022). The PAQ-C is particularly effective for younger participants due to its use of memory cues, which help children recall their activities over the past week (Biddle et al., 2011). This makes it an ideal tool for assessing physical activity in pediatric populations.

The PAQ-C is scored on a continuous interval scale from 1 to 5 (1 = low physical activity, 5 = high physical activity). The first question, which asks participants to select the types and frequencies of activities they engage in, is not scored but provides context for subsequent questions.

To measure sedentary behavior, patients will self-report their average daily recreational screen time. They will also be asked to indicate how much time they spend on each of six screen-based activities (e.g., watching TV/movies, playing electronic games), using a survey adapted from the Harris lab. Parents will be asked to report their child’s average physical activity and sedentary behaviors in terms of minutes of moderate-to-vigorous physical activity (MVPA) per day and minutes of recreational screen time per day.

While the PAQ-C is a practical and valid tool, some limitations exist, such as the need for concurrent validation with objective measurement tools like accelerometers. However, it remains one of the most suitable self-report instruments for measuring physical activity in youth, due to its demonstrated reliability, ease of administration, and effectiveness in different cultural contexts.

**Accelerometry:** Each participant will be outfitted with a triaxial accelerometer (GT3X+; ActiGraph LLC, Pensacola FL). The ActiGraph monitor has repeatedly demonstrated good validity in children and adolescents (de Vries et al., 2006; Khurshid et al, 2022). The ActiGraph GT3X has also demonstrated acceptable reliability and validity for use in a patient population of children with cerebral palsy (O’Neil et al., 2014), reliability for measuring PA in free-living adults (Aadland et al., 2015), and is also the most commonly used accelerometer in published studies (Wijndaele et al., 2015).

The device will be worn over the right hip from the time the individual wakes up until the time they go to bed with the exception of water-based activities such as bathing or swimming. There is evidence to show that placement of the device on the hip performs better than wrist placement when classifying activities into intensity categories (Ellis et al., 2016; Rosenberger et al., 2013). The hip placement is particularly advantageous for accurately classifying activity intensities, which is crucial for assessing both physical activity and sedentary behavior in post-treatment patients (Neishabouri et al, 2022). The accelerometer offers superior objective measurement capabilities compared to traditional questionnaire-based assessments, providing comprehensive data in free-living environments with minimal participant burden. This feature ensures the collection of ecological and reliable data while avoiding the biases inherent in self-reporting.

The ActiGraph has demonstrated strong validity and reliability across diverse populations, including both children and adults, making it suitable for this cohort of post-hip treatment patients (Neishabouri et al, 2022). Its widespread use in published studies further establishes it as the gold standard for activity monitoring, facilitating meaningful comparisons with existing research and ensuring standardized measurements.

The participant will wear the device for 7 consecutive days. A study by Trost et al. (2000) indicated that a 7-day monitoring period was enough to produce acceptable estimates of daily MVPA participation and account for differences in weekday and weekend physical activity. Although it may seem logical to collect more days, protocol adherence decreases with more days of wear. The 7-day wear protocol strikes a balance between gathering sufficient data and maintaining participant compliance.

It is up to the discretion of the parent whether or not the child will wear the device during contact sports. We will recommend that the participant consult with their coach if they have concerns; however, there is no evidence to show that the device poses any significant physical harm.

**Activity Log:** In addition to the accelerometer data, participants will maintain a daily “activity diary" to document their resistance training activities and device specificities. This diary will help provide specific insights into their engagement with strength exercises, crucial for understanding how resistance training impacts their rehabilitation and physical activity levels.

Participants will be asked to record the start and end times of any resistance training sessions, along with the types of exercises performed, such as weightlifting, bodyweight exercises, or resistance band training. They will also document the intensity of the workout (e.g., light, moderate, heavy) and the number of sets and repetitions completed for each exercise, which will allow for an analysis of training volume and load. Additionally, participants will note the frequency of their resistance training sessions, as well as any changes based on factors like fatigue, pain, or the availability of equipment. To capture the subjective intensity, they will rate their perceived effort for each session on a scale (e.g., 1-10) and indicate any perceived improvements in strength or mobility over time.

Alongside the resistance training documentation, participants will approximate the time they put on and took off the accelerometer each day, ensuring consistency with the activity data. The diary will also include sections for participants to note reasons for missed wear time, such as device removal during specific periods, and to document any irregularities in their daily routine (e.g., illness or injury) that could have influenced their training or physical activity patterns. This detailed diary will supplement the objective accelerometer data, providing a more comprehensive view of the participants' resistance training behaviors and helping to better understand their overall physical activity during the study.

**Data Collection and Management**: All patient participants will be coded with a study identification number. Personal identifiers will be stored separately from the data. Documents containing patient information will be stored either in a locked drawer in the research lab or will be encrypted and stored on a BCCH computer. Data will only be accessed by trained members of the research team.

**Procedure:** Once written consent is received from the parent/guardian and patient assent is received, the researcher will take the participant’s anthropometric measurements. The participants will then be fitted with an accelerometer and given verbal device instructions. The participants will be instructed on how to fill out the questionnaires (parent and patient questionnaires) and will be sent off with a page of instructions for accelerometer wear and return, the activity log, and a copy of the both the parent and the patient questionnaires. The parent/guardian will also be asked if they would prefer to return the materials after in-person or via mail). Those who choose to return the study materials by mail will be provided with a pre-paid courier package with the clinic address.

The patient will then wear the device and fill out the activity log for 7 consecutive days in their normal environment. Each patient will receive two elastic belts so that they can be rotated and washed if necessary. During the first day of wear, a research assistant will call the parent to ensure that the protocol is being followed and to answer any additional questions. Reminders will be sent out in the days following via text. At the end of the 7 days, the parent and the patient will complete their respective questionnaires at home. The parent questionnaire asks about parental support, their report of child’s activity, and additional sociodemographic factors. The patient questionnaire consists of the HOOS and PAQ questionnaire, as well as self-reported screen time and basic questions about schooling. Once the questionnaires are complete, the device and all documents will be returned to the research lab. If the device is not received within 2 weeks of the clinic visit, the research assistant will call the parent to follow-up. If there are any incomplete responses to the questionnaire, the research assistant will contact the parent via phone or email to ask if the question was intentionally left blank or accidentally missed. In the case of the latter, we will obtain the missing response from the participant.

Participants will be compensated with a $250.00 CAD for partaking in the study. The parent will also be emailed the patient’s individual report card, which will provide individual accelerometry data (average MVPA) as well as information about national averages and recommended activity.

The questionnaires will be scored and data will be inputted onto the computer by trained members of the research team. The accelerometer will be wiped down with alcohol wipes and the elastic belts will be washing thoroughly after each use.

**Data Analysis:** The ActiLife 6 software (ActiGraph LLC, Pensacola FL) will be used for accelerometer initialisation (30 Hz), file download (15s epoch), processing, and data analysis. A day is considered valid if the device was worn for a minimum of 600 minutes—this criteria is recommended and has been previously shown to maximize reliability (Penpraze et al., 2006).

All participants who have at least 4 days of active days of wear (including one weekend day) will be included in the analyses. A study by Rich et al., (2013) demonstrated that a reliability coefficient of 0.93 can be achieved if the device is worn for at least 4 days. The reliability decreases slightly (0.90) when the minimum wear time decreases to 3 days (Rich et al., 2013). So, if there are few participants who meet this 4 day criteria, we will compare to less stringent criteria (3 valid days)(Voss et al., 2017). It is important to collect both weekdays and weekend days, as studies of children and adolescents show significant differences in weekend vs. weekday MVPA, with children exhibiting higher levels of MVPA on weekends and adolescents exhibiting lower MVPA on weekends (Trost et al., 2000).

We will compare the wear time with the activity log. If the time does not match up (>2 hour difference in wear time) or if the patient documented a day as “atypical,” the day will be excluded from analysis.

We will use Evenson cut-points to define PA intensity: MVPA (>2296 CPM), sedentary (<100 CPM)(Evenson et al., 2008). Although there are many cut points designed specifically for use in youth, a study by Trost et al. (2011) determined that only the Evenson cut-points performed among all age levels and provided acceptable classification accuracy for all levels of PA intensity. Physical activity levels will be operationalized as the total number of MVPA minutes from all valid days divided by the number of valid days. Sedentary levels will be operationalized as the average between the parent report and patient’s self-reported daily recreational screen time. Adherence to PA guidelines will be operationalized as having an average daily MVPA greater than or equal to 60 minutes. Adherence to sedentary behavior guidelines is defined as having both the parent and child report average daily screen time as less than or equal to 120 minutes.

**Statistical Analysis:** Pearson correlation will be used to assess the association between PAQ score and MVPA. Descriptive statistics will be calculated for applicable variables, including levels of MVPA, hours of screen time, PAQ, and HOOS scores. Using results from question 1 of the PAQ, we will also identify the most common sports/activities among our study sample. We will also determine the overall and age (child and adolescent) specific proportion of patients who meet the Canadian 24-Hour Movement guidelines for physical activity and/or sedentary behavior and conduct hypothesis testing to compare to previously reported Canadian population proportions (Statistics Canada).

In order to analyze predictors of physical activity levels, we will also conduct a 2-step analysis. First, we will do a univariate analysis with each predictor variable in order to identify important factors that are contribute the MVPA levels. We will then take the important factors and apply them to a multivariate analysis. We will control for age, sex, BMI, and household socioeconomic status.

**Significance**

This project will provide critical data on the amount of PA and sedentary that healed hip patients currently engage in. In most of orthopaedic research, a return to health is primarily regarded as the absence of symptoms (Ayers, Franklin, & Ring, 2013). However, it is important to take into account other factors (such as PA) that have an effect on overall health but specifically on hip health, even though the effects are not evident until long after these patients are out of pediatric care. Previous studies that have examined PA levels in this population have focused on how the patients’ activity levels change pre and post-intervention, with the purpose of the studies to use PA as an evaluation tool for a certain surgical procedure rather than as important health outcome in and of itself. This study will hopefully inform current orthopaedic practice on the importance of understanding PA in their patients.

While the vast majority of studies have demonstrated improved PA in hip patients post-surgical intervention, no study has actually examined the adequacy of these levels or the factors that contribute to these levels. Only one study so far has examined PA levels as a health outcome; however, it only focused on only PA in Perthes and did not use objective PA measures (Hailer et al., 2014).

Our understanding of PA and sedentary behavior is particularly important in pediatric hip patients because they are at greater risk of a more physically inactive and sedentary lifestyle. In addition to the increased risk, the consequences are more severe. Besides the risk of chronic diseases, inactivity and increased sedentariness can worsen hip joint function and aid in the progression or development of hip osteoarthritis, which these patients are already at risk for as a result of their disease. Osteoarthritis or any hip symptoms in adulthood would add significant financial and social burden to these patients.

Resistance training is an important aspect of PA for these patients, as it has been shown to improve muscle strength, joint stability, and overall function. Incorporating resistance training into the rehabilitation process may not only enhance the recovery of these hip patients but also help in reducing the risk of future injuries, improving mobility, and potentially delaying the onset of hip OA. This project will also evaluate the role of resistance training in the long-term health of hip patients, further emphasizing the importance of including strength-building exercises as part of a comprehensive recovery plan.

Therefore, it is vital to better understand how pediatric hip patients engage in PA and sedentary behavior, and the factors that influence these behaviors. This knowledge will help inform orthopaedic practices, emphasizing the need to incorporate PA as a key component of patient care and to promote greater activity while minimizing sedentary time. Specifically, resistance training should be considered an integral part of rehabilitation, helping patients regain function and reduce the risk of long-term complications.

A secondary goal of this study is to assess the validity of the Physical Activity Questionnaire (PAQ) in this population. Although the PAQ-A and PAQ-C have been validated in general pediatric populations, their validity in hip patients has not yet been established. This study will determine whether the PAQ can effectively substitute accelerometry as an assessment tool for PA in this specific cohort. If successful, this would offer a cost-efficient, lower-burden alternative to accelerometry for PA assessment (Warren et al., 2010; ).

Given the relatively small pediatric hip patient population in British Columbia, we plan to collaborate with other centers to develop a multisite registry that tracks PA and sedentary behavior. This registry could support future interventional studies aimed at preventing or delaying the onset of hip OA by improving joint function and promoting the health benefits of PA. Ultimately, this research could lead to the development of standardized guidelines for orthopaedic surgeons and healthcare providers, recommending PA strategies that optimize overall health and minimize the risk of future hip-related problems. These recommendations may involve tailored approaches to activity modification, exercise intensity, and volume, including resistance training, considering the various predictors of PA levels. Such guidelines have the potential to influence the management and care of pediatric hip patients worldwide.