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Moving and Improving: Investigating Physical Activity Patterns for Children with Autism Spectrum Disorder (ASD)

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MKin Thesis

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ABSTRACT

The primary characteristics of ASD fall into three broad categories: communication problems, difficulty relating to people, things and events, and repetitive body movements and behaviours. According to the Government of Canada, in 2015, the prevalence of ASD was approximately 1% in North America and rising. The Canadian Physical Activity guidelines state clearly that the majority of elementary and secondary school aged children and youth (5-17 years old) should participate in 60 minutes of moderate-to-vigorous physical activity daily. Unfortunately, only 9% of this general population has been successful in obtaining the suggested amount of physical activity daily. However, for individuals with ASD, potential barriers of achieving the physical activity goal set by the Canadian Society for Exercise Physiology may be due to the characteristics of ASD.

The overarching purpose of the current study was to explore the influence that families, motor skills, and physical activity programming have on the physical activity patterns of children with ASD. This was achieved by quantifying physical activity patterns through questionnaires and interviews with members of families with children with ASD, by descriptively examining the motor performance and step count of children with ASD and their siblings, and finally by obtaining the perspectives of instructors for physical activity programs for children with ASD.

Four families and seven physical activity instructors participated in this study. The primary caregivers, children with ASD, siblings, and instructors completed questionnaires and participated in semi-structured one-on-one interviews. The children

with ASD and the siblings were also asked to participate in motor testing comprised of three tasks: aiming and catching, balance, and visual-motor integration.

Two noticeable themes emerged from the data describing physical activity for children with ASD which included (1) physical activity, regardless of ability, and (2) the nature of ASD: programming and family challenges. The participants suggested that physical activity can have both positive and negative effects on children with ASD, however, many participants recognized that some of the difficulties children with ASD have with physical activity is no different than the typically developed (TD) population. Many of the participants in this study expressed perceptions that participation in physical activity improved physical skills in children with ASD, including motor skills. Unfortunately, the current study did not conduct motor testing with the children at more than one time; thus, improvements in motor skills through participation in physical activity cannot be concluded from this study. Interestingly, the objective measure of physical activity utilized in this study (pedometers), indicated that the more steps a participant took did not relate to motor skill proficiency or the perceptions of physical activity provided by the family.

Overall, this study presented potential improvements to physical activity programming for children with ASD, and described the physical activity patterns of children with ASD and their families. Further research is warranted to develop reliable and valid motor testing methods for this population.

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CHAPTER 1: REVIEW OF THE LITERATURE

1.1 Introduction

Autism Spectrum Disorder (ASD) has been most simply defined as a developmental disorder affecting an individual's language skills and ability to think, feel, and relate to others (American Psychiatric Association [APA], 2014). Worldwide, approximately 1 in 160 children have been diagnosed with ASD (World Health Organization [WHO], 2016). According to the Government of Canada (2015) the prevalence of ASD was approximately 1% in North America and rising. Moreover, ASD was approximately five times more prevalent in males than in females (Centre for Diseases Control and Prevention [CDC], 2014).

According to the Canadian Physical Activity Guidelines, children between the ages of five and 11 years of age and youth from 12 to 17 years of age should participate in 60 minutes of moderate-to-vigorous physical activity daily (Canadian Society of Exercise Physiology [CSEP], 2012). However, only 9% of children and youth five to 17 years old met these recommendations (Statistics Canada, 2015). Unfortunately, no specific physical activity guidelines have been created in Canada for individuals with ASD (CSEP, 2012). In addition, despite the wide availability of public elementary school education in Ontario, the physical education curriculum in Ontario lacks specific guidelines for children with ASD (Ontario Ministry of Education, 2015). The diagnostic criteria for ASD, in particular, points to possible barriers of physical activity for this population. However, physical education programs within Ontario schools may potentially be a key point for physical activity intervention implementation for the vulnerable population of children and youth with ASD.

The following sections will provide a comprehensive review of Autism Spectrum Disorder (ASD), the importance of physical activity in Canadian children and youth, and the factors, such as the physical activity programming environment, motor skill proficiency, and the familial involvement, that influence this population's access to meeting physical activity guidelines.

1.2 Autism Spectrum Disorder

The primary characteristics of ASD fall into three broad categories: communication problems, difficulty relating to people, things and events, and repetitive body movements and behaviours (APA, 2014). The variation of abilities and characteristics among individuals with ASD markedly define it as a spectrum disorder.

Diagnosed in childhood, ASD persists throughout the lifetime (APA, 2014). A diagnosis of ASD is determined by medical professionals using the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), which was recently updated in May 2013 (Autism Canada, 2015). Previously in the DSM-4, classification of ASD fell into five distinct subcategories on the autism spectrum: Asperger syndrome, pervasive developmental disorder not otherwise specified (PDD-NOS), childhood disintegrative disorder, Rett's syndrome, and autistic disorder (APA, 2000). The current diagnostic tool, the DSM-5, still includes four of the five diagnoses from the DSM-4 (Asperger, PDD-NOS, childhood disintegrative disorder, and autistic disorder), but all diagnoses have been termed ASD. Due to the difference in classification, each research study discussed in this literature review will utilize the terminology used in each respective publication. Individuals diagnosed with ASD using the DSM-5 must manifest all three of the following criteria: deficits in social-emotional reciprocity, deficits in nonverbal

communicative behaviour and deficits in developing, maintaining and understanding relationships. In addition to demonstrating these three criteria, individuals must have at least two of the following four criteria: repetitive motor movements, insistence on sameness, highly restricted and fixated interests, and/or hyper- or hypo-reactivity to sensory inputs. Furthermore, a diagnosis of ASD assigns a severity level to each individual. Severity level 1 deems the individual only "requiring some support", severity level 2 "requiring substantial support" and severity level 3 "requiring very substantial support" (Autism Canada, 2015).

Children with ASD have been known to manifest many comorbid conditions, some of which may directly relate to issues with physical activity participation. Comorbid conditions may include, but were not limited to, attention-deficit hyperactivity disorder (ADHD), anxiety disorders, and chronic sleeping problems (Goldin, Matson, Tureck, Cervantes, & Jang, 2013; Richdale & Schreck, 2009; White, Oswald, Ollendick, & Scahill, 2009). ADHD was the most common comorbidity, with estimates of co-occurrence ranging from 14-78% (Goldin et al., 2013). Children with ADHD show persistent inattention and/or hyperactivity-impulsivity (CDC, 2014). Moreover, presenting with both ASD and ADHD places individuals at a higher risk of presenting other comorbidities, such as anxiety, depression and phobias (Goldin et al., 2013). Anxiety disorders in children with ASD can include simple phobias, generalized anxiety disorder, separation-anxiety disorder, obsessive-compulsive disorder and social phobias (White et al., 2009). To further connect these three comorbidities, the main sleep problems including sleep onset and sleep duration in children with ASD can be linked to increased levels of anxiety (Richdale & Schreck, 2009). Unfortunately, there has been no

pharmacological or psychosocial treatment or cure for ASD, but early intervention and control of associated medical conditions can help the child's development and daily functioning (CDC, 2014; White et al., 2009).

1.3 Physical Activity in Canadian Children and Youth with ASD

Based on recent literature, the Canadian Society for Exercise Physiology developed The Canadian Physical Activity Guidelines to emphasize the important link between physical activity and the overall health benefits. The guidelines state clearly that the majority of elementary and secondary school aged children and youth (5-17 years old) should participate in 60 minutes of moderate-to-vigorous physical activity daily (CSEP, 2012). Unfortunately, only 9% of this population has been successful in obtaining the suggested amount of physical activity daily (Statistics Canada, 2015). The Canadian Physical Activity Guidelines regrettably do not include standards for individuals with developmental disabilities, more specifically children and youth with ASD (CSEP, 2012).

Potential barriers of achieving the physical activity goal set by the Canadian Society for Exercise Physiology may be due to characteristics of ASD. For example, repetitive motor movements, difficulties in social situations, and sensitivities to sensory inputs are possible impediments to participation in physical activity. The influence of comorbid conditions on physical activity for children with ASD, however, warrants further research. It has previously been found that the presence of ADHD, mental health conditions, and other conditions increase the odds of meeting physical activity guidelines, while the presence of an intellectual disability decreases the odds of obtaining physical activity guidelines (Covey, Menear, Preskitt, Goldfarb, & Menachemi, 2016). On the contrary, it has been found that comorbidities (e.g., mood disorders, ADHD, epilepsy,

and medical disorders) have contributed to changes in physical functioning, perhaps due to additional burden of medical and/or psychiatric disorders or other confounding variables (Memari et al., 2012).

After reviewing the literature, there was an ambiguous relationship between children with ASD and their time engaged in physical activity. There was evidence both in favour (Bandini et al., 2013; Covey et al., 2016) and in opposition (McCoy, Jakicic, & Gibbs, 2016; Pan, 2009; Pan, 2011; Pan & Frey, 2006; Pan, Tsai, Chu, & Hsieh, 2011) of children with ASD achieving their recommended amount of daily physical activity compared to their typically developed (TD) counterparts. Worth noting is the evidence that children with ASD were at least capable of obtaining physical activity guidelines much like their TD peers (Tyler, MacDonald, & Menear, 2014).

Pan and Frey (2006) conducted a study to investigate physical activity patterns in children with ASD. They recruited 30 participants between the ages of ten and 19 years of age which were then divided into three subgroups based on school level: elementary (n=9), middle (n=9) and high (n=12) school. In order to maintain a homogeneous sample, all youth were considered to be high functioning on the autism continuum, according to parent reports. Participants were asked to wear an accelerometer for seven consecutive days during waking hours and parents of the participants were asked to complete the child/adolescent activity log questionnaire on the same days the accelerometer was worn. Pan and Frey (2006) obtained results that indicated that youth with ASD were less active than their peers without disabilities. Overall, the researchers determined that youth with ASD did not regularly engage in continuous moderate-to-vigorous physical activity, therefore predisposing them to similar health risks associated with inactivity as

individuals without disabilities. In the discussion, it was evident that accessibility and delivery of physical activity could be a barrier to children and youth with ASD. They suggested there was merit in concentrating on the quality of instruction provided for children with ASD from teachers with proper certifications. Moreover, according to Pan and Frey (2006), outside of the school environment, access to extracurricular activities for children with ASD proved to be an issue.

In 2009, Pan conducted another study to examine the associations of age, social engagement and physical activity in children with ASD considering both structured (physical education) and unstructured (recess) opportunities. They recruited 25 males with ASD ranging in age from seven to 12 years old. Accelerometers were used to measure physical activity and direct observation was used to assess social engagement. Results concluded that overall physical activity levels were not dependent on social engagement. However, Pan (2009) stated that symptoms of ASD were modifiable when in a favourable environment (structured and supervised), suggesting that physical education can provide an ideal opportunity to promote social engagement in children. Furthermore, there was evidence that adult non-interactive engagement for children with ASD increased their levels of physical activity, which could be attributed to the instructor encouraging social and physical activity engagement (Pan, 2009).

Pan (2011) further identified correlates of physical activity for students with ASD in physical education classes. Pan obtained 19 participants with ASD and 76 participants without disabilities. Physical activity was measured through the use of an accelerometer and social engagement was directly observed. Pan (2011) determined, in parallel to previous studies (Pan and Frey, 2006; Pan et al., 2011), that children with ASD had lower

levels of physical activity than TD individuals. This study was able to identify the teacher, environment, and content characteristics as important correlates of physical activity for children with ASD in physical education classes. The findings by Pan (2011) provided variables (i.e., environment and social interactions) that can be addressed to implement interventions and improve the physical activity levels of individuals with ASD, both in and out of school.

In agreement with Pan and Frey (2006) and Pan (2011), a secondary data analysis from the National Survey of Children's Health (NSCH) conducted by McCoy et al. (2016) determined that youth with ASD had lower physical activity levels. The purpose was to determine the relationship between sedentary behaviours, daily physical activity, and body mass index (BMI) in adolescents with ASD (n = 915) compared to TD peers (n = 41879) 10-17 years of age. Parents were asked to report their children's diagnosis as Asperger's, PDD-NOS, ASD, or autism, and further provide a severity rating (mild, moderate, or severe). The BMI for each child was calculated using height and weight data. Other information obtained from the NSCH was physical activity, screen time, computer usage, access to electronics in the bedroom, sports participation, and club participation. In the data analysis, covariates included comorbid ADHD, age, sex, race, education setting, household income, and highest education completed in the household. McCoy et al. (2016) concluded that when compared to TD peers, youth with ASD were more likely to be overweight and/or obese and were less likely to participate in physical activity, however, there appeared to be no difference between the two groups in terms of sedentary behaviours (e.g., screen time and computer usage).

Contrary to McCoy et al. (2016), Bandini et al. (2013) provided evidence that physical activity levels between children and youth with ASD may not be completely different than TD individuals. Bandini et al. (2013) compared the activity levels between 53 children with ASD and 58 TD children between the ages of three and 11 years old. Physical activity participation was measured via accelerometers over seven consecutive days from morning until night. In addition, parents of the participants were asked to complete a questionnaire concerning the child's participation in organized and unstructured physical activity and the parent's own participation in physical activity over the seven days of the study. Results from the accelerometers demonstrated that although there was not a significant difference between physical activity between children with ASD and TD children, parents reported significantly fewer hours of physical activity for their children with ASD. Bandini et al. (2013) explained (or suggested) that the physical activities children with ASD engaged in daily might not be captured on a questionnaire (for example: roaming, pacing, repetitive behaviours, etc.), pointing to the limitation of their methodology to measure physical activity, however this would require further research.

Another secondary data analysis from the NSCH by Corvey et al. (2016) investigated the outcomes of obesity/overweight, sedentary behaviours, and physical activity levels among children and youth with and without ASD, taking into consideration severity of ASD. Data was obtained from 95677 phone interviews with parents that had children between 0 and 17 years of age. The total weighted sample included data on children 6-17 years of age (n = 49586134), with an ASD diagnosis for approximately 2% of the sample (n = 517797 mild severity, n = 333287 moderate

severity, and n = 135268 severe severity). Information from the NSCH also included secondary conditions including intellectual disabilities, ADHD, developmental delays, mental health conditions, and physical health conditions. Corvey et al. (2016) found that there was no significant association between the presence of ASD or severity of ASD and physical activity. In addition, it was found that children with intellectual disabilities had decreased odds of obtaining physical activity guidelines, while the presence of ADHD, mental health conditions, and other conditions increased the odds of the children achieving the recommended physical activity guidelines. However, conflicting evidence regarding the negative effect of comorbid conditions on physical activity provided by Memari et al. (2012) suggests further investigation of the influence of comorbidities on physical activity in children with ASD.

Arguably Tyler et al. (2014) provided the most encouraging evidence for children with ASD achieving their daily physical activity recommendations. The purpose of their study was to compare the physical activity and physical fitness of children and youth with ASD and TD individuals. Researchers recruited 17 participants with ASD (nine males, eight females) and 12 without ASD (six males, six females). After completing assessments including developmental, aerobic fitness, flexibility, strength, physical activity and anthropometric, Tyler et al. (2014) concluded that overall, there was no significant difference between children with ASD and TD children in certain aspects of physical fitness. More specifically, children with ASD had significantly weaker strength and less physical activity, but their flexibility, aerobic fitness and BMI results were similar to peers without disabilities, which was statistically insignificant. Tyler et al. (2014) concluded that there was no significant difference between the group's physical

fitness. This suggests that although children with ASD face health disparities, there were certain aspects of physical fitness that were attainable for children with ASD and comparable to TD youth.

In a later study, Pan et al. (2011) were able to conclude that adolescents with ASD had lower physical activity levels than adolescents without ASD. Here, the purpose was to measure physical activity and motivational processes between adolescents with and without ASD within an inclusive physical education environment. Participants for this study were all male, 25 participants with ASD and 75 without a disability from grades seven, eight, and nine in Taiwan. To objectively measure physical activity, the participants were asked to wear an accelerometer during their two physical education classes during the week. Obtaining physical activity information only during the physical education classes however appeared to be a major limitation of this study. During the same week the accelerometer was worn, participants were asked to respond to a modified version of the Motivation in Physical Education Scale to measure motivation. Results concluded that adolescents with ASD had lower self-determined motivation towards physical education and in turn, lower physical activity levels. Within the discussion, it was evident that physical education teachers had a great ability to influence students in terms of the physical education content, social interactions, self-determined motivation, and motor skill acquisition. Overall, Pan et al. (2011) suggested that the influences on youth with ASD from physical education and the physical education teachers had the potential to positively effect attitudes towards physical education and leisure time physical activity.

Nevertheless, the studies examining physical activity patterns for children with ASD had limitations. The primary limitation was the small sample size, and more specifically the small number of participants with ASD, in many of the studies previously reviewed. It was difficult to conclude if any results that were obtained were statistically significant due to the extremely small sample sizes. The secondary data analyses conducted by McCoy et al. (2016) and Covey et al. (2016) were the only two studies with large sample sizes. Furthermore, with regards to sample sizes, unequal participant groups, and unmatched controls were seen as limitations (Tyler et al., 2014) and were apparent across all studies discussed. Many of the studies discussed above (Pan, 2009; Pan et al., 2011; Pan & Frey, 2006) restricted participant recruitment to children with high-functioning ASD, limiting the generalizability of their findings. McCoy et al. (2016) and Corvey et al. (2016) did control for level of severity of ASD, however all data from their secondary data analyses was self-reported, noted as a limitation in both studies. Another major limitation that affected the ability to generalize results was the cross-sectional designs of the studies by Bandini et al. (2013), Corvey et al. (2016), and Pan and Frey (2006) in particular. These researchers discussed the limitations of obtaining information at only certain points in a year (school year vs. summer), only during certain physical activities (i.e., the inability to measure water activities), and the restriction of the timeline provided in original data set.

1.4 Motor Skill Proficiency in Children with ASD

Although the current diagnosis of ASD with the DSM-5 does not include motor difficulties as a criterion, many researchers have determined that motor impairment have had an observable characteristic in the population of children with ASD (e.g., Dewey,

Cantell, & Crawford, 2007; Downey & Rapport, 2012; McPhillips, Finlay, Bejerot, & Hanley, 2014; Provost, Lopez, & Heimerl, 2007). The majority of previous research has utilized standardized testing methods (i.e., Movement Assessment Battery for Children [MABC], Bruininks–Oseretsky Test of Motor Proficiency [BOTMP], and the Peabody Developmental Motor Scales Second Edition [PDMS]) to determine the level of motor impairment in children with ASD. Despite the common use of standardized tests, it has been shown that there were test-retest reliability issues with these testing methods for children with motor difficulties (Venetsanou et al., 2011). Furthermore, motor difficulties have been attributed to problems with visual-motor integration in individuals with ASD (Ament et al., 2014; Baker, Boyczuk, Cinelli, & Bryden, 2015; Miller, Chukoskie, Zinni, Townsend, & Trauner, 2014). Interestingly, the deficits in fundamental motor skills in children have been shown to predict physical activity behaviour in adolescence, making motor skill proficiency important to examine not only in the general population, but also in individuals with ASD (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009).

Dewey et al. (2007) conducted a study to compare the differences among groups of individuals with Developmental Coordination Disorder (DCD), ASD, and ADHD, with a control group of TD children. The researchers obtained children between five and 18 years old including 49 participants with ASD, 38 with a diagnosis of ADHD and DCD, 46 with only DCD, 27 participants with only ADHD, and 78 TD children. The BOTMP assessed fine and gross motor skills and The Gestures Test was used to determine gestural errors. The Gestures Test required the child to complete a gesture after verbal command (for example “show me how you brush your teeth with a toothbrush”) or imitate the researcher’s action. The results indicated lower motor performance in each

group (DCD, ASD and ADHD) compared to the TD control group, and more specifically, the children with ASD scored significantly lower on motor skill proficiency than all other groups. Furthermore, the children with ASD scored the lowest on gestural performance, irrespective of their motor skill results, which researchers attributed to deficits in the mirror neuron system, sensory processes, and language processes. Dewey et al. (2007) indicated the importance of these results in distinguishing individuals with ASD from other groups with motor difficulties. Provost et al. (2007) also conducted a similar study (except using the PDMS) to Dewey et al. (2007), analogously concluding that in comparison to children with other developmental disabilities, children with ASD had the greatest motor impairment.

In agreement with Dewey et al. (2007) and Provost et al. (2007), McPhillips et al. (2014) determined that children with ASD had clear motor impairments. Using a standardized behavioural motor measure, the purpose was to determine to what extent the motor deficits experienced by children with autism were syndrome-specific. Researchers selected 28 children with ASD, 27 children with Specific Language Impairment (SLI), and 28 children that were TD. Multiple questionnaire measures were used to assess the non-verbal IQ, receptive and expressive vocabulary, and the presence of ASD and/or ADHD. More relevant for this literature analysis, the MABC-2 was used to assess the child's fine and gross motor skills, which includes three component areas with a total of eight subtests (three tests of manual dexterity, two tests of aiming and catching and three tests of static and dynamic balance). The overall results obtained by McPhillips et al. (2014) indicated that children with ASD and SLI have significant deficits in motor abilities, specifically ball skills and balance, when compared to TD children. More

importantly, 61% of the ASD group scored in the bottom 15% of the MABC-2, with 50% scoring in the bottom 5% indicating definite motor impairment requiring motor intervention. Another study conducted by Green et al. (2009) utilizing the MABC, also confirmed that children with ASD had clear motor deficiencies. These results once again revealed that motor difficulty was a distinguishing feature of children with ASD (Green et al., 2009).

It was important to recognize, however, that the previously discussed studies utilized standardized testing methods to determine motor impairments in children with ASD. Dewey et al. (2007) used the BOTMP, Provost et al. (2007) used the PDMS, McPhillips et al. (2014) used the MABC-2, and Green et al. (2009) used the MABC, all concluding that children with ASD have greater motor impairments than TD children. Unfortunately, Venetsanou et al. (2011) determined that standardized tests were not sufficient to determine motor impairments in children with ASD. This study examined the MABC-2 in particular, determining that the test-retest reliability and validity of the test does not justify it as a "gold-standard" for the assessment of children with motor difficulties (Venetsanou et al., 2011).

A more specific aspect of motor impairments in children with ASD, were the difficulties with visual-motor integration. This concept was a main finding in a study conducted by Ament et al. (2014) which aimed to compare the motor functioning between three groups: children with ASD (n=56), children with ADHD (n=63), and TD children (n=81), ranging in age from eight to 13 years old, to further define the motor deficits. Motor skills were measured using the MABC-2. Consistent with the previously discussed literature, children with ASD and ADHD demonstrated motor impairments

compared to TD children, and children with ASD had the greatest impairment. Furthermore, deficits involving visual feedback and static balance were more aligned with a diagnosis of ASD. Also, the ASD-associated impairment on the catching task, which requires rapid integration of visual feedback, suggested that children with ASD were less likely to rely on visual feedback when learning novel movement patterns. The difficulties with visual feedback may also be correlated with autism-associated difficulties with learning social skills through imitation (Ament et al., 2014). In agreement with these findings, a study conducted by Miller et al. (2014) concluded that an important finding of their study was the visual-motor integration deficit in children with ASD, highlighting one of the important aspects of praxis problems in children with ASD: integration.

To further investigate visual-motor integration in children with ASD, Baker et al. (2015) conducted a study to determine whether deficits associated with ASD could be identified using a visual motor task on an iPad application. Participants included ten children with ASD (ages six to 11) and 18 TD children (ages five to eight). The children completed a task on an iPad that was designed to measure target acquisition accuracy. The results indicated that children with ASD performed less accurately than the TD group, with the greater accuracy deficit in females with ASD. Overall, Baker et al. (2015) identified that a visual-motor integration task can help identify motor deficits in children with ASD, but further research was required to determine the efficacy of implementing an intervention protocol using tablet technology.

Finally, Barnett et al. (2009) conducted a study connecting motor skill proficiency to physical activity patterns in TD children and adolescents. Their longitudinal study aimed

to examine childhood motor skill proficiency and subsequent physical activity duration, type of activity, and physical activity intensity in adolescence. A total of 1045 participants were recruited for this study to complete the "Get Skilled Get Active" protocol to assess motor proficiency and the Adolescent Physical Activity Recall Questionnaire to determine physical activity duration, type, and intensity. The results indicated that fundamental motor skill proficiency in childhood predicted adolescent physical activity behaviour. Furthermore, having greater motor skill competence as a child may increase self-esteem resulting in greater enjoyment and participation in physical activities. Barnett et al. (2009) also suggested merit in implementing motor skill interventions at a young age to help increase physical activity levels. Although this study did not include children with ASD, the findings can be extrapolated to other populations. In closing, Barnett et al. (2009) provided clear evidence of a correlation between motor skill proficiency and physical activity, which could be examined in children with ASD.

The previously discussed articles demonstrated that children with ASD have motor difficulties; however, the articles were not without limitations. First and foremost, the use of standardized testing methods, specifically by Dewey et al. (2007), Provost et al. (2007), McPhillips et al. (2014), and Green et al. (2009) may limit the credibility of the results obtained as children were able to complete the tasks using very different motor strategies. The restricted range of functioning for children with ASD was also identified as a possible study limitation (Ament et al., 2014; Baker et al., 2015). To be able to complete motor testing, many participants that were recruited were diagnosed with high-functioning ASD, therefore limiting the generalizability of their findings to the entire spectrum.

1.5 Family Influence on Physical Activity in Children with ASD

Based on the determinants of health described by the WHO, the physical environment (including safe housing) and social support networks have a large influence on the health of individuals (WHO, 2015). Outside of the school environment, children spend the majority of their evenings and weekends at home with family members. At home, parents were known to play a number of key roles in supporting their children's participation in physical activity (Thompson et al., 2010). Despite evidence of the influence families have on children's physical activity in the general population (e.g., Xu, Wen, & Rissel, 2015), research on the familial influences of physical activity for children with ASD was limited. In the current literature, there was clear evidence that a child's participation in physical activity was affected by parental influences in the home environment (Hume, Salmon & Ball, 2005; Maitland, Stratton, Foster, Braham, & Rosenberg, 2014; Maitland, Stratton, Foster, Braham, & Rosenberg, 2014; Thompson et al., 2010). More specifically for children with ASD, there was evidence that parents can be considered both a barrier and a facilitator for physical activity (Obrusnikova & Cavalier, 2011).

Hume et al. (2005) conducted a two-part study, that first aimed to qualitatively explore children's perceptions of their home and neighbourhood environments, and second, to quantitatively assess the association between these perceptions and participation in physical activity. In the first part of the study, 147 TD participants (77 males, 70 females), each ten years of age, were recruited. The children were asked to draw a map of their home and their neighbourhood. A random subsample of 44 participants were also provided a disposable camera and asked to take photographs (approximately eight) of what was important to them in their home and neighbourhood.

Researchers analyzed the maps and photographs together and concluded six major themes: the family home, opportunities for physical activities and sedentary pursuits, food items and locations (at home and in the neighbourhood), green space and outside areas (at home and in the neighbourhood), the school and, opportunities for social interaction. These themes suggested that a shared space within the family home, and opportunities for physical activity and sedentary behaviour, played important roles in the lives of the children (Hume et al., 2005).

The second part of the study conducted by Hume et al. (2005) used the same sample of participants to assess the association between the maps drawn by children and objectively measured physical activity. Accelerometers (valid and reliable devices to measure physical activity and physical activity related energy expenditure) were utilized to measure physical activity in children (127 provided complete accelerometer data for three days). In order to compare the data obtained from accelerometers and the map information, data on the drawn maps were quantified, based on the frequency that particular items and locations appeared. Places and items for physical activity and sedentary behaviours represented opportunities for those behaviours and were analyzed accordingly. From both studies, Hume et al. (2005) were able to conclude that children's perceptions of certain aspects of their home and neighbourhood may be significantly associated with their participation in physical activity. However, due to the fact that this study was one of the first to utilize a map-drawing task, more research was required to assess physical activity environments for children. Similarly, Maitland et al. (2013 & 2014) were able to determine that parents played an important role in influencing their children's physical and sedentary behaviours, and families perceived the physical

environment of the home space as an influence on their children's physical and sedentary behaviours, which reaffirms the importance of the home environment for physical activity for children as determined by Hume et al. (2005).

Thompson et al. (2010) sought to qualitatively assess how physical activity fits into family life and the ways in which families may be active together. This study was part of a larger project assessing physical activity influences in children 10-11 years old, but for the purposes of this study, 30 parents were recruited to participate via telephone interview. Questions focused on the importance of being physically active as a family, family activities done indoors and outdoors on weekdays after school and on weekends, and barriers to the family participating in physical activity together. Parents consistently noted that parent-child communication and spending time together as a family were positive aspects of joint physical activity. Many parents discussed the wide range of activities their families engaged in during the week, although weekdays tended to consist of children participating in sports or clubs that were not conducive to family participation. Parents suggested that their families participated in more physical activity during the weekend and that shared activities during the week tended to be sedentary. Finally, the two most common barriers to participating in physical activity reported by parents were the differing ages and interests of their children, and the challenge of living busy lives which contributed to a general lack of time to participate in activities together as a family. Overall, Thompson et al. (2010) concluded that the majority of parents considered family engagement in physical activity as important or very important for family life. Furthermore, the findings by Thompson et al. (2010) suggested that the social aspects of physical activity participation as a family, particularly the opportunity to

expand and improve communications could be perceived as a benefit for parents. In support of Thompson et al. (2010), a review by Xu et al. (2015) determined that parent's encouragement and support positively affected their TD children's physical activity.

Uniquely, Obrusnikova and Cavalier (2011) examined the barriers and facilitators of physical activity from the perspective of children with ASD. The purpose of this study was to assess the barriers and facilitators of after-school participation in moderate-to-vigorous physical activity as perceived by children with ASD and to determine if physical activity patterns exist in relation to these barriers. Participants included 12 boys and two females with ASD, ranging in age from 8-14 years old. Ten participants were diagnosed with Asperger syndrome, three with PDD-NOS and one with autism. Accelerometers were used to measure physical activity for a total of seven days for a minimum of ten hours each day. The photovoice methodology was used to elicit children's perceptions of barriers and facilitators of after-school physical activity, which included digital photography, an online questionnaire, and a semi-structured interview. Participants were instructed to take photos of things that made it easy or hard for them to exercise after school. The online questionnaire and semi-structured interviews were conducted following the participant taking their photos. On average, participants reported 9.9 barriers (including intrapersonal, interpersonal, physical, community and institutional) and 12.9 facilitators (including physical, intrapersonal, interpersonal, community and institutional). The factors most commonly found affecting physical activity participation were intrapersonal and interpersonal in nature. For example, technology was the largest intrapersonal barrier, and parents, pets, and peers were considered interpersonal factors that were both facilitators and barriers. Availability of

physical activity resources also proved to facilitate participants' engagement in physical activity after school. Lastly, support from parents was a strong facilitator among participants with higher levels of moderate to vigorous physical activity. Participants with lower levels of moderate to vigorous physical activity, though, expressed frustration with their parent's encouragement to be physically active, as the children stated they would rather engage in a sedentary activity rather than a physical activity suggested by their parents. The findings from this study indicated the importance of familial influences on physical activity patterns in children with ASD (Obrusnikova & Cavalier, 2011).

Once again, literature regarding the familial influence on physical activity patterns for children with ASD and TD children does have limitations. Small sample size continued to be of concern for the studies conducted by Thompson et al. (2010) and Hume et al. (2005), which may have affected the statistical power of the results that were obtained. The recruitment of participants from a single city was indicated as a possible limitation to generalizing results (Thompson et al., 2010). Also, Obrusnikova and Cavalier (2011) discussed the limitation of only including participants with average cognitive and verbal abilities. The restricted range of functioning of participants with ASD affected the ability to extrapolate the results across the autism spectrum.

1.6 Gaps in the Literature

A review of the current literature has clearly shown a lack of literature pertaining to physical activity for children with ASD, and more specifically the role that physical activity programming, motor skill proficiency, and family influence plays in physical activity patterns for children with ASD. Information regarding physical activity patterns in children with ASD was inconclusive. Some researchers have determined that children

with ASD were capable of attaining physical activity guidelines, while others have concluded that children with ASD were not obtaining sufficient physical activity daily, even though the children were capable of doing so. Further, limited research on physical activity interventions and programming for children with ASD has been conducted. Researchers have also determined that children with ASD have motor impairments, specifically issues with visual-motor integration. In addition, a link has been shown between motor skill proficiency and physical activity participation, indicating the potential for motor skill interventions to improve physical activity. However, there was limited information regarding the link between physical activity and motor skill abilities for children with ASD. The most notable gaps in the literature pertain to assessments of the familial influence on children with ASD's physical activity involvement, and the connection between motor skills and physical activity duration, frequency, and participation for children with ASD. Researchers have determined that parents can be both facilitators and barriers to physical activity participation for children with ASD, indicating that parents play an important role in influencing children with ASD in regards to physical activity. However, to date there appears to be no evidence comparing the components that greatly influence physical activity in children with ASD – physical activity programming, motor skill proficiency, and family involvement.

1.7 Research Purpose

The overarching purpose of the current study was to explore the influence that families, motor skills, and physical activity programming have on the physical activity patterns of children with ASD. This was achieved by quantifying physical activity patterns through questionnaires and interviews with members of families with children

with ASD, by descriptively examining the motor performance and step count of children with ASD and their siblings, and finally by obtaining the perspectives of instructors for physical activity programs for children with ASD. For this study, children were referred to as age five to 14, as defined by Statistics Canada (2012). Physical activity patterns were described by the duration, frequency, and overall participation in physical activity by the children in and out of school. By investigating physical activity for children with ASD through multiple perspectives and methodologies, it was possible to measure the motor skill development in the children, assess the success of physical activity programming for children with ASD to suggest recommendations to improve interventions, and understand potential barriers and facilitators to physical activity for this population. Further evaluation of the family unit of each child with ASD provided more comprehensive information on the factors influencing physical activity for children with ASD. The research questions addressed in the current study were:

1. How does physical activity influence children with ASD?
2. Are there any measurable motor skill improvements through participation in physical activity for children with ASD?
3. How do families influence physical activity patterns in children with ASD?

The current study provided a comprehensive view of the influences that affect physical activity patterns in children with ASD. Furthermore, physical activity involvement at home, in the community, and at school were all taken into consideration. Taken together, the current study contributed to the literature on physical activity for children with ASD, including factors influencing their participation, and the antecedents and outcomes of physical activity involvement.

CHAPTER 2: PERCEPTIONS OF PHYSICAL ACTIVITY

2.1 Research Design

A qualitative methodology was the most appropriate approach to investigate the influences of families and physical activity programming on the physical activity patterns in children with ASD (research questions 1 and 3). The research was conducted using a case-study methodological approach, which was defined as an "approach in which the investigator explores a real-life contemporary bounded system (a case) or multiple bounded systems (cases) over time" (Creswell, 2013, p. 97). Thematic analysis was chosen to guide how the themes in the data were identified, analyzed, and reported (Braun & Clarke, 2006). For the current study, to best illustrate the experiences of physical activity for children with ASD, a case was defined as a child with ASD and people relevant to exploring his/her experiences with physical activity (i.e., primary caregiver, siblings, instructors). The tools used for the current study included background questionnaires, semi-structured one-on-one interviews, field notes, journaling, and member checks.

2.1.1 Ethics

All research procedures were approved by the Wilfrid Laurier University Research Ethics Board (see Appendix A for approval and modification letters). After approval, participants were provided an information letter outlining the methods of the research and signed an informed consent form if they agreed to participate. Due to the fact that the children with ASD were considered a vulnerable population, the primary caregivers provided written consent for their children, and the children provided verbal assent at the time of data collection. All participants were given the opportunity to ask

questions prior to their participation in the study. It was clearly communicated that participants could withdraw from the study at any point in time without penalty.

2.2 Participants

To best understand how physical activity was influenced in children with ASD, purposeful sampling was used. Creswell (2013) described purposeful sampling as recruiting participants who were "information-rich" about the phenomenon of interest. The researcher recruited four children with ASD, and as such, would be information-rich in the experiences of physical activity for children with ASD. Additionally, the sample was considered to be a convenience sample, as the researcher obtained participants in close geographic proximity, and through prior personal connections of the principal researcher and/or the principal researcher's supervisors. In particular, criterion sampling was utilized to ensure that all participants that were included met some criterion (Creswell, 2013), namely (due to the nature of the required tasks) having a high functioning child with ASD, as reported by the primary caregiver, currently enrolled in elementary or secondary school. To obtain information regarding physical activity programming, physical activity program instructors were also recruited. Criterion for instructors included involvement in a physical activity program for children with ASD.

Recruitment of the participants occurred through word of mouth. The children with ASD that participated in the study were six to 14 years old, currently enrolled in elementary or secondary school, and with a diagnosis of ASD as reported by their primary caregivers.

Participants consisted of the children with ASD, primary caregivers of each child, siblings of each child, and a variety of physical activity program instructors. The children

with ASD were asked to participate in motor skill testing, the use of pedometers, and the collection of their perceptions of physical activity (elements included: interviews, member checks, self-report physical activity journals, and physical activity questionnaires). The primary caregivers were asked to participate only in the perceptions of physical activity component of this study. The siblings were asked to participate in the motor testing and the perceptions of physical activity components. Finally, the instructors were asked to participate in some elements of the perceptions of physical activity component (background questionnaires, interviews, and member checks). The goal of recruiting this group of participants was to gain each unique perspective on physical activity duration, frequency, and participation of the children with ASD in the study, and the influences that affect their physical activity patterns.

2.3 Research Tools and Methods

Background Questionnaires. Prior to the interviews, participants completed background questionnaires (see Appendix C) covering demographic information such as age, education, and employment. The background questionnaire was the first approach to build rapport with the participants. The primary caregivers of the children were asked to provide information pertaining to: (1) the diagnosis of their children with ASD; (2) their personal physical activity patterns; (3) their children's physical activity patterns; (4) the dynamics of their family; and (5) the physical activity patterns of the family as a unit. Physical activity program instructors were asked to provide information regarding: (1) their experiences with children with ASD; (2) their perspectives on physical activity for children with ASD; and (3) any effects physical activity provides the children with ASD.

The information obtained from these background questionnaires provided context, which helped to guide the one-on-one semi-structured interviews.

Interviews. The researcher conducted one-on-one semi-structured interviews with the primary caregivers, siblings, physical activity program instructors, and the children with ASD if possible (see Appendix D for interview guides). Interviews were completed face-to-face at a convenient and comfortable place for each of the participants. Each interview was audio recorded and transcribed verbatim. The interviews allowed participants to provide their unique perspectives on their experiences with the children with ASD and physical activity. The primary caregivers were asked open-ended questions that covered topics including: background and demographic information, their relationship to and relevant information about their children with ASD, their perceptions of physical activity and education, and physical activity patterns within their family units. For physical activity program instructors, open-ended questions explored: his/her background and demographic information, and his/her experiences with the physical activity program for children with ASD. Interviews with the siblings investigated: background information, their relationship with family members, and their experiences with physical activity. Finally, the interviews with the children with ASD examined: the activities they participate in with their family, and their personal experiences with physical activity. Completed interviews were transcribed verbatim and analyzed to examine recurring themes.

Field Notes. The information obtained through data collection was enriched through the use of field notes. The researcher recorded any relevant information prior to, during, and after each interview. Relevant information included the participants' body

language, facial expressions, emotions to particular questions, and other non-audible reactions. The field notes allowed the researcher to record "feelings, reactions to the experience, and reflections" (Patton, 2002, p. 303) during the research process.

Journals. To further enhance the data obtained from the interviews and researcher observations, the researcher kept a reflexive journal over the course of the entire study period. The purpose of a reflexive journal was to record decisions and justifications for the chosen methods, and allowed the researcher to reflect on one's biases and thoughts regarding the research (Lincoln & Guba, 1985).

Member Checks. After interviews were transcribed verbatim, participants were provided with their completed transcripts. Participants had the opportunity to clarify any information that may have been discussed during the interview and allowed the researcher to probe further in areas lacking information. Participants were given the chance to "correct, amend, or extend" any information within their transcripts (Lincoln & Guba, 1985, p.236). Transcripts were sent to the participants in their most desired form (paper or e-mail). If participants did not return member checks within the allotted three weeks, data analysis continued with the original transcript.

Physical Activity Questionnaires. To obtain information regarding the physical activity behaviours in the child/adolescent participants and provide context for the interviews, the Modifiable Activity Questionnaire for Adolescents (MAQ-A) was chosen (see Appendix E; Pereira et al., 1997). The TD siblings filled out the questionnaire if they were capable to complete it on their own, otherwise a primary caregiver assisted with the completion of the MAQ-A. For the child with ASD, the primary caregiver completed the MAQ-A. Each primary caregiver provided information regarding his/her physical activity

behaviours over the past 12 months and completed the CARDIA questionnaire (see Appendix E; Jacobs, Hahn, Haskell, Pirie, & Sidney, 1989). In addition to items on the CARDIA questionnaire regarding vigorous physical activity, this questionnaire obtained information from the participants regarding leisure and job activities (i.e., carrying heavy objects, shovelling snow, non-vigorous activities, and home maintenance). The CARDIA questionnaire provided a comprehensive view of the physical activities the primary caregiver of a child with ASD engages in regularly. Due to the fact that these questionnaires required participants to recall activities from the past 12 months, the measurement quality may have been skewed by time, maturation, and differing behaviours of the participants. However, these self-report measures were useful in determining the stability of physical activity behaviours (Kohl, Fulton, & Caspersen, 2000). No further analysis was completed on these questionnaires, as the purpose was to provide the principal researcher contextual information on the physical activity of the participants prior to the interviews.

Self-Report Physical Activity Journals. Each family member (child with ASD, primary caregivers, and siblings) was asked to complete a self-report physical activity journal during one week of the study (see Appendices B and F, for timeline and journals respectively). Children were able to complete the journals independently if they were capable, however the primary caregivers were instructed to provide assistance to their children in completing the journals each day, if needed. The participants were asked to complete the journal daily from Monday to Sunday. This self-report journal investigated the type of physical activities participants completed, the duration of each activity, whether they participated alone or with others (family or peers), where the physical

activity occurred, and the perceived exhaustion of each activity. These journals provided information about the physical activity of the children with ASD outside of school during the evenings and weekends, and also provided information about the physical activity participation of their family members.

2.4 Trustworthiness

Trustworthiness addresses the issue of how an inquirer can ensure his/her audience that the findings of the inquiry were worthy. Lincoln and Guba (1985) contended that trustworthiness was essential in establishing a study's significance. The three areas in which trustworthiness were established are: credibility, transferability, and confirmability (Lincoln & Guba, 1985). Each will be discussed in turn.

2.4.1 Credibility

Lincoln and Guba (1985) described credibility as the confidence in the truth of the findings. According to Patton (2002), three elements determine the credibility in a study: (a) rigorous methods, (b) researcher credibility, and (c) belief in the value of qualitative inquiry. Triangulation, field notes, and member checks were methods of credibility that were used to establish trustworthiness (Lincoln & Guba, 1985).

Triangulation was used to provide corroborating evidence about a theme or perspective utilizing multiple and different sources, methods, investigators, and theories (Creswell, 2013). Methodological triangulation was employed in this research by using multiple data methods: background questionnaires, field notes, semi-structured one-on-one interviews, journal entries, and member checks. The researcher utilized data triangulation to compare data from several different sources (Creswell, 2013): children with ASD, primary caregivers, siblings, and physical activity program instructors. The

final form that was used by the researcher was investigator triangulation. This was achieved through collaboration with other qualitative researchers, including students and professors, to analyze the data and reduce researcher bias (Creswell, 2013). Specifically, the principal researcher analyzed the data, with the assistance and feedback from the principal researcher's supervisors. In addition, a qualitative research group, comprised of graduate students currently employing qualitative methodologies within their own research, provided feedback.

In addition to triangulation, field notes, and member checks (discussed in sections 2.4.1, 2.3 and 2.3 respectively), the primary researcher was recognized as another tool in the research process. Therefore, the primary researcher completed qualitative research and research methods courses, and completed an extensive search of the current literature on physical activity for children with ASD.

The researcher also practiced epoché – the act of recognizing biases that needed to be noted during the research process – by recording in a reflexive journal to maintain neutrality throughout the research process (Creswell, 2013). The principal researcher had prior knowledge of some of the participants and the nature of ASD in a physical activity context. Thus, recording in a reflexive researcher journal before and after interviews allowed the researcher to acknowledge preconceived perceptions of the participants. It was important to allow the data from the participants to guide the research process, regardless of the researcher's relationships with the participants.

2.4.2 Transferability

Transferability had been described as the potential for findings to be applied to other contexts. This was achieved by providing a thick description of the phenomenon of

interest (Lincoln & Guba, 1985). As such, in the current study, transferability was achieved by including cases that were information-rich via purposeful sampling, instead of aiming to satisfy a certain sample size. Including information-rich cases provided a thick description of physical activity patterns in children with ASD and therefore had the potential to be applied in other contexts (Creswell, 2013).

2.4.3 Confirmability

The concept of confirmability was described as the degree of neutrality within a study (Lincoln & Guba, 1985). In other words, the participants and their responses should shape the data, without researcher bias. Lincoln and Guba (1985) contended that the use of triangulation and reflexive research journals are methods to establish confirmability in a study (discussed in sections 2.4.1 and 2.3 respectively).

2.5 Data Treatment

Thematic analysis was used to identify, analyze, and report the patterns found within the data to provide a rich description of the entire data set (Braun & Clarke, 2006). Specifically, inductive thematic analysis was used to link the themes to the data collected specifically for the research, regardless of the findings in previous literature. Themes were determined using a semantic approach, focusing on the surface level meanings, and not analyzing beyond what was said by the participants (Braun & Clarke, 2006).

Data gathered from the background questionnaires provided context during the interview. For example, information from the background questionnaires was used to have participants elaborate on certain topic areas. In addition, the field notes, reflexive researcher journal, and self-report physical activity journals helped to provide context and enhance information obtained from the interviews. Once the interviews were transcribed

verbatim, the researcher and supervisors familiarized themselves with the data by reading and re-reading the transcripts. Next, initial codes and themes were determined by collecting all data relevant to each theme. Themes were determined as important aspects of the data in relation to the research questions. The themes were reviewed, generating a thematic map of the analysis. Themes were then defined and named to refine the specifics of each theme. After final analysis, a selection of examples relating back to the research questions and purpose were used to produce a report of the analyses. This process followed the thematic analysis framework of Braun and Clarke (2006).

2.6 Participant Summaries

Four families and seven physical activity instructors participated in this study. All families and instructors were residents of various Ontario cities. For each family unit, the self-identified primary caregiver from each family, the child with ASD, and the TD sibling were asked to participate. All of the children with ASD that participated in this study were high functioning. The instructors were from different physical activity programs for children with ASD in Southern Ontario. Each family unit and instructor has been summarized briefly. In order to further protect the anonymity of the participants, pseudonyms were utilized.

The "White" Family. Erica is a single mother of two, Matthew (age 11) and Amanda (age nine). Matthew was diagnosed with ASD at age four, and Amanda has no health conditions. They live in Southern Ontario in City A, while the children's father lives in City D, also in Southern Ontario. Matthew and Amanda spend the week with their mother in City A, and virtually every weekend they went to City D to spend time with their father. Matthew and Amanda attended an extra-curricular fitness class weekly,

and also each child participated in three other out of school activities. Matthew attended physical education classes at school a couple times per week, and Amanda was involved in physical education classes at school as well.

The "Murphy" Family. Karen is a mother of four children: Justin (age 21), Maddy (age 17), Ryan (age nine) and Drew (age seven). Ryan was diagnosed with ASD at three years old, and no other children have any known health conditions. Justin no longer lives at home. Maddy was involved in two physical activities outside of school, and did not participate in physical education classes at school. Ryan was participating in four extra-curricular physical activities, and participated in physical education at school, along with short active breaks during the day. Drew also participated in four out of school physical activities, and attended physical education classes at school one or two times per week.

The "Smith" Family. Heather is a married mother of two children, Jack (age 14) and Tessa (age 12). Jack was diagnosed with ASD at age 13 and does not have any co-morbidities. At the time of the study, Jack was actively involved in three physical activities outside of school, but only participated in physical education in school for one semester of the school year. Tessa participated in four physical activities outside of school and was participating in physical education at school on a regular basis.

The "Williams" Family. James is a married father of two daughters, Samantha (age 10) and Jessica (age six). Both Samantha and Jessica were diagnosed with ASD (at age four and three respectively), with Samantha being higher functioning than Jessica. Samantha was actively involved in two out-of-school physical activities, while Jessica only participated in one. Samantha participated in physical education classes at school

twice a week. Jessica attended physical education class at school that was offered once per week.

Instructors. There were seven instructors of distinct physical activity programs that participated in this study. Darren is a physical education teacher for a physical education class exclusively for children with ASD. Christina is an instructor of a fitness/dance class for children with varying disabilities alongside her colleague Erin. Patricia is a coach of a large skating program that welcomed children with varying disabilities. Bruce was the previous coach of a soccer program exclusively for children with ASD; he has since passed the torch onto a new coach. Bruce's interview was analyzed, however no quotations were included in the write-up due to the uncertainty of his cognitive status. Alexis is a fitness instructor and founder of a company that offered physical activity programs for individuals with many different disabilities. She primarily instructed fitness classes. Amy is a yoga instructor for children with disabilities.

2.7 Results

The purpose of Chapter 2 was to determine the various perceptions of physical activity from three different participant groups: children (children with ASD and TD siblings), primary caregivers, and physical activity program instructors. The mean minutes of transcribed interviews per group of children with ASD, siblings, primary caregivers, and instructors were approximately 14.50 minutes, 16.29 minutes, 38.95 minutes, and 52.83 minutes respectively. While a shorter interview time may indicate less information was obtained from the participants, the demographics of these participants should be considered.

After analysis, two themes emerged from the data describing physical activity for children with ASD: (1) Physical activity, regardless of ability, and (2) The nature of ASD: programming and family challenges. The themes and subthemes (outlined in Table 2.1 at the end of Chapter 2) will be described in turn.

2.7.1 Physical activity, regardless of ability

Interviews with primary caregivers, children with ASD, TD siblings, and physical activity program instructors for children with ASD provided differing perspectives on physical activity. The perspectives were not only regarding physical activity for children with ASD, but also perceptions of physical activity for TD populations. This theme focused on the antecedents and outcomes of physical activity, and how some of the perspectives of physical activity for children with ASD may not be drastically different than for a TD population. Three subthemes addressed these various experiences: "Now it's easy to see the effects", "To fill the gap", and "It's no different than anyone else".

"Now it's easy to see the effects."

This subtheme examined the different perceptions that participants had about the effects of physical activity participation. Here, individuals discussed the positive and negative effects of physical activity participation. Most primary caregivers, and all instructors indicated that physical activity positively affected children with ASD. Instructors and caregivers indicated that the positive effects associated with participation in physical activity included physical, social, cognitive, and psychological benefits. Below, Erica expressed the benefits she saw with physical activity for both her children, regardless of their abilities:

> Well I know that it helps them with their, obviously their physical well-being but also with their concentration cognitively. I know it makes a big impact

> emotionally too, like their moods of feeling better and feeling, you know, so the effect is not just having healthy muscles, I know it effects their ability to think and also their mood, you know *–Erica White, caregiver*

Physical and motor benefits of physical activity were also seen through the instructor's perspectives. For example, Carrie expressed the following:

> Well first off, because like I said, one of the biggest goals was just trying to get them to participate. Right? To participate and follow instructions, so that I definitely saw, that from week 1 to week 6 that would be better. Motor skills, yeah it was really exciting because you would see a child who maybe couldn't jump, and then is able to jump. Or a child who couldn't skip, but then is able to skip. So developing some of those motor skills, which I think are a direct result of having the opportunity to practice those skills in a dance setting, or another physical activity setting. *–Carrie, dance*

Above, Carrie mentioned that children were better able to follow instructions through participation in her dance class, in addition to physical improvements. Through his physical education class and in class testing, Darren also noted improvements physically.

> Definitely improvements. Definite improvements, I mean like as I said we do a little bit of testing in terms of run forward, run backwards, hop on one foot, hop on two foot. Side shuffle, gallop. I mean back at the beginning they couldn't, besides run forward, they couldn't do anything. And now they can all do those things. Some better than others, but they can all do all those movements. We'll start working on some throwing and kicking. We've looked at that, they can't all, most of them can throw, very few of them can catch. *–Darren, PE teacher*

Alexis, Amy, and Christina concurred with Carrie and Darren's perceptions. Further, Christina described not only physical benefits, but also the social implications that physical activity programs may have on children with ASD.

> … For an example Johnny has been in there for so long. Like seeing him last week do the squats and stuff like that, that was good, like he was doing, that was like I think a really big improvement, or a change. So I think yeah, for all physical, social, cognitive, I think that they're all very positive. I think I can see, I can see from the beginning of the class. Like not so much like a physical change in the body, but I can definitely see that they are doing more crunches than they are doing before. Social, I think they're definitely becoming more social with each other, they're more interactive. Like for an example I saw Megan and Johnny like kind of talking a bit last week – *Christina, fitness instructor*

Carrie and Darren also indicated the social benefits that different physical activity programs have on children with ASD. Below is an example from Darren:

> Well I see the kids outside playing with others so I mean they've obviously learned to play with others and that's partly through the Phys. Ed. class. *–Darren, PE teacher*

Carrie suggested social benefits might differ based on the structure of the class:

> The kids that are integrated within a regular class, definitely I feel will have a bigger improvement in their social abilities because they have the modelling of the other children. And I think I mean, the other thing too is it's supposed to be, as I said our goal is that they get to come to dance class like their peers, and that they're having fun, so I think in terms of their psychological health, to say "I go to dance class" and then they come and they love it, right? *–Carrie, dance*

As mentioned above by Carrie, there were also psychological benefits that instructors reported were accrued through participation in physical activity for children with ASD. Carrie indicated that participation in dance class has allowed the children with ASD to relate to peers outside of the dance studio, encouraging acceptance by peers and therefore improving their psychological well-being. Amy also explained these psychological changes (in addition to physical changes):

> … I'd say psychological for sure. I see differences in their demeanour. Yep, just being present, just showing up and being present. Definitely physical as well, I've seen changes within their balance and coordination, well we don't hold poses for a long time with children, because their bodies are still growing and that sort of thing, but them able to participate that much longer in a pose as opposed to you know, maybe trying it and then moving onto the next thing. So staying a bit more engaged I would say. *–Amy, yoga*

Patricia echoed this sentiment regarding the psychological benefits of physical activity:

> Some of these kids come and they're negative, well we can turn that around and make it into a positive experience, and so if that takes them onto maybe trying something else newer somewhere else even, at home or in their school. So with a program with this, it will benefit them outside of our program, um for life *–Patricia, skating*

Alexis also suggested the development of confidence through participation in physical activity. Similar to Patricia, she was adamant that the skills the children with ASD had developed in the fitness classes translated into their lives outside of the program.

> Confidence, I feel like, you know we've got a lot of feedback its nice reading. We have a lot of kids who write blogs. And they've written a few blogs about working with us and working with their coach and their support worker and coming to our classes and how it's changed them. You know, they have never been able to go into a gym before, it was never a possibility, and now they're coming into gyms and they're doing cool things like weightlifting! And you know, participating in programs that, you know make them feel good…You know, just little things like that, how positive here can transition to taking it into the real world. It's really cool! –*Alexis, fitness*

Interestingly, all the effects of physical activity noted by instructors were positive in nature.

From the perspectives of the children, opinions on physical activity varied. All children contended there were positive outcomes from participating in physical activity. Samantha described the physical benefits of participating in physical activity: "Because if you don't challenge your muscles to it, you'll never gain! No pain no gain!" Jack expressed long-term physical effects of participation: "It keeps your body healthy and makes you live longer. It's fun!" Finally, when asked why he thought physical activity was good, Matthew also expressed that he knew that "…it keeps you healthy and strong". The TD siblings also echoed their understanding of the physical benefits of physical activity. For example, Amanda indicated that physical activity was better than sedentary activities: "…it gets you healthy and if you just do not, let's just say you stare in front of the TV, it wouldn't get you exercise and you wouldn't stay healthy!" Although the children agreed that the benefits of physical activity were positive, when asked how

physical activities made them feel, Jack indicated negative feelings. “Kind of, a little bit tired… Otherwise, accomplished.”

Primary caregivers also shared some negative outcomes that physical activity had on their children with ASD. Heather stressed that being physically active was not easy for her son with ASD, Jack, and this took a toll on him emotionally.

> I don’t know if it’s positive or negative. For [Jack] the physical activity doesn’t come naturally. So always before he gets to the enjoyment of the activity he has to overcome the challenge. So there’s always tears, and it doesn’t come easily so he has to try extra hard. Harder than other kids or his sister, so it’s, it’s not an easy journey. – *Heather Smith, caregiver*

However, primary caregivers Heather and Karen both expressed that regardless of the difficulty their children with ASD had with certain physical activities, once they were able to overcome the challenges, their participation in physical activity appeared positive. Heather voiced her perspective on physical activity for her son, Jack: “But when he gets to overcome the challenge I think it’s good for him. The confidence, it gives him the confidence.” Karen had a similar sentiment when discussing her son overcoming a physical activity challenge:

> I’d say physical above anything, seeing him bike and the first time… And he was just so proud of himself. So I think that’s why it’s not just so important to his physical health, but psychologically when he masters it. So proud! *–Karen Murphy, caregiver*

Through the different perspectives of participants, the effects of physical activity were primarily positive in nature. Even though primary caregivers indicated negative outcomes resulting from physical activity participation, they recognized the benefits of overcoming the challenges their children faced in order to accrue the benefits physical activity afforded their children.

"To fill the gap."

Alternatively, many participants indicated that the intrinsic abilities of the children with ASD negatively affected their ability to engage in physical activity. Some of these abilities included: physical, social, and psychological characteristics. Primary caregivers James and Karen specifically commented on the physical deficits affecting their children's participation in physical activity. Karen suggested that her son had motor delays that were inhibiting his ability to learn to bike.

> For example, there was a biking camp last summer through [children's facility]. He was very frustrated that he couldn't learn to bike. … he had gross motor and fine motor delays and so balance, coordination and endurance was big with gross motor, and he just wasn't able to learn. [Wes] had taught [Maddy] but he couldn't, neither of us could teach [Ryan] and [Drew] was starting to figure it out! And he would get so frustrated because he's a perfectionist. – *Karen Murphy, caregiver*

In addition to the motor impairments Karen had mentioned, she stressed that the inability to successfully learn to bike had psychological effects on her child with ASD. Further, she expressed that her youngest son, Drew, was soon to surpass his older brother with ASD, Ryan, which may have repercussions in the family relationships. Similarly, James reported that his daughter was unable to make the transition from t-ball to the next age group as of result of her inability to hit the ball thrown by a pitcher (rather than on the tee). Samantha became quite frustrated by this, which led to her dropping out of league before the end of the season.

> She started with tee-ball when she was four and she played an extra year of tee-ball which I think kind of hit us in the ass by the end because, it meant that when she moved up from tee-ball to softball she only got one year of the coach pitched league, and then she immediately bumped up to the next age group where it was the girls pitching and that kind of, that sort of turned her off the game…. It was bad pitching and she didn't have a lot of practice hitting bad pitching…. The fun part of the game was hitting for her and she wasn't doing very good at that. And since she wasn't doing good at that, she didn't want to do the other stuff, and she

> just, we had a lot of fights and meltdowns going to the field or on the field. So she lasted up until, she made it up until about 2/3 the way through the season before we just decided ok, we've had enough. – *James Williams, caregiver*

Heather also indicated that her son had deficits in physical abilities, but suggested that his social skills also affected his physical activity patterns.

> Like after gym class he might be more stressed and you might see him crying because it's hard for him. I think it's physically hard for him. Also, because he doesn't have social skills to join the group, so it's hard for him. So it's two things, [pause] physically he's not there, socially he's not there, so it's hard for him to be there. – *Heather Smith, caregiver*

The children with ASD also noted these deficits in abilities. For example, Jack and Samantha expressed how their diminished abilities impaired their physical activity patterns. It was evident that Jack was apprehensive in discussing his lack of abilities in physical activity, and he expressed how his peers excluded him from activities.

> Well I don't really like, well I'm not really, I'm not, I like, I'm good at playing sports, but I'm not really good because sometimes I mess up and my, sometimes my teammates kind of, well my friends kind of like exclude me from. Well it's not by the, it's not just with me, at, with, when it's with me, or just, not at school they include me, but when we're playing like at gym class when we're playing, like football, like not football but any sport, they kind of disclude me a little bit because they know I'm not really the, as good as the person next to me, so they kind of… [quietly] Yeah, they don't really include me. – *Jack Smith, child with ASD*

Although Samantha did not explicitly state the difference in her abilities from her peers, she expressed the psychological influences that her ability to play softball had on her.

> It was how, it was the matter of strikes, it was, it was like most of the stuff was a big change from when I did softball a year earlier…It went from 5 strikes to 3 strikes and the girls had to pitch instead of the coach had to pitch… And, and the only upside was, and I barely even got a hit, any half the time! I was so flustered! It was just, it's just making me tear up a bit thinking about it – *Samantha Williams, child with ASD*

From a sibling perspective, when Tessa was asked what she believed her brother's thoughts of physical activity were, she stated that she noticed that her brother differed in his physical abilities compared to his peers.

> I think his thoughts might be a little different but, cause like he, he's active and all that but, he is not much of a physical activity person because, like cause everybody is sort of faster than him but he's like going at his own pace which is good – *Tessa Smith, sibling*

Maddy echoed Tessa's perceptions, stating that her brother Ryan was not physically able to do certain tasks pertaining to physical activity.

> …I don't think he should be, like especially because he has some things that make it hard for him to exercise, I don't think he should be pushed to do exercises he's not comfortable doing. Like he can't do certain things like catching balls, or like certain things like that, so he shouldn't be put on a baseball team. But, he probably could like run well or something like that, so I think he should like, push to do the activities that he feels comfortable doing that he can excel in by himself and hopefully he'll get out his energy. – *Maddy Murphy, sibling*

From each unique perspective, compromised abilities (physical, social, and psychological), affected physical activity participation for children with ASD.

"It's no different than anyone else."

Finally, participants expressed that some elements of their experiences of physical activity for children with ASD were no different than physical activity for TD children. This was seen from both the family context, and from the physical activity instructors' perspectives. Interestingly, fitness instructor Christina stated that one of her tactics while running a physical activity program was to hone in on the interests of the participants.

> I think if we can find out what they enjoy, and apply that to what's going on that's huge. Like for an example [Erin] figured out that [Johnny] is obsessed with Harry Potter, I don't know if he still is, he was, but putting Harry Potter into yoga, that was a huge thing. So finding out what their passion is, and then applying it. – *Christina, fitness*

Similarly Darren said:

> We've tried to learn how to play "What time is it Mr. Wolf". So with a game like "What time is it Mr. Wolf" we'll turn that into something that's of interest to them. So instead of being a wolf they get the opportunity to be the character that they like to be for the day, so they might be a vampire or they might be a zombie or they might be a Pokemon or whatever [interviewer laughs]. So instead of saying "what time is it Mr. Wolf" it's "what time is it Mr. Pokemon" or whatever the case may be. – *Darren, PE teacher*

Carrie also expressed how she used the interests of the participants to her benefit:

> Some of them are motivated my music, yeah, you just really have to, they are all unique individuals. So you have to figure out what it is that is going to work for them. Like I had one little boy who loved to count. He loved to count! So anything I would do with counting, he would do, so then if I'm counting "let's do 10 jumps" then he was motivated to jump. So it's yeah, I think it's really, really individual. – *Carrie, dance*

Although instructors of physical activity programs for TD children may incorporate interests of the children into their classes, it was recognized that instructors of physical activity programs for children with ASD might do so to a greater extent.

The primary caregivers also expressed challenges to physical activity for their families, which was not specific to their children's diagnoses. James and Heather both indicated that the differing interests between family members made physical activity as a family unit difficult. Heather expressed that since her children had differing interests, she and her husband had to divide and conquer to satisfy both children.

> Skating too, Tessa loves to skate, Jack not at all. So if my husband is here, he will take Tessa to skating, then I'll stay with Jack. But now Jack is old enough so he doesn't have to, have to have any supervision. But when they were younger, yeah my husband had to take Tessa to the skating. – *Heather Smith, caregiver*

James also indicated there were different interests between family members:

> Different interests, different, between parents and kids there's different interests obviously. Between the two girls there's different interests… So finding something that would accommodate both and be interesting to both is tricky. – *James Williams, caregiver*

It was clear in the quote above that James believed that raising two children with ASD had clear similarities to raising TD children. Most importantly, the interests of his children were not a result of their diagnoses.

From the children's perspectives and regardless of their level of abilities, Jack advocated for having time between extra-curricular activities and school.

> …. Lets say right after school, I kinda want to have a little bit of a break in between then just to kind of like the hustle of "oh my gosh I have to be in curling in like 15 minutes and I'm not even, and I just got out of school". And you have to go back home and, like my home is really far compared to the curling place so it's kind of stressful – *Jack Smith, child ASD*

Another component most children indicated made it hard for them to participate in physical activity was their interest in the activity. For example, Amanda, a sibling, disliked yoga and did not want to participate in yoga: "… I don't really like it… But it doesn't make me tired, it just makes me frustrated because I don't really like yoga." Additionally, sibling Maddy expressed that although some difficulties associated with physical activity participation were because of her younger brother's diagnosis of ASD, more often challenges were a result of the typical family dynamic in her house.

> "….I guess sometimes it's [Ryan] having autism, but then it's also just like, I don't know. Because there's times where it's like [Ryan] is calm and then [Drew] is getting goofy. And then he'll set [Ryan] off which makes it worse because when [Ryan] is set off that's when like the autism comes in play and like he's acting like, it's hard for him to settle down after. So like, on occasion it's because of the autism, but I also think it's just because they're silly with each other" – *Maddy Murphy, sibling*

The participants indicated that although they faced challenges with physical activity participation these challenges were not related solely to ASD. Rather, many challenges associated with physical activity involvement were similar for TD children (e.g., uninterested in the class activities) and children with ASD.

2.7.2 The nature of ASD: programming and family challenges

Many participants indicated that the disability had unique influences on the family in relation to physical activity involvement. The first subtheme, "So how do we modify that activity" addressed the programming challenges, associated with having participants with ASD, while the second subtheme, "It can be fantastic and then it can just be like a total nightmare" addressed the experiences of physical activity as a family unit.

"So how do we modify that activity?"

Due to the nature of ASD, participants expressed challenges to physical activity programming for children with ASD. Creating opportunities to be physically active posed different challenges than for a TD population. The presence of support persons to assist in classes, beyond the instructor, was reported to be an integral part of any physical activity program for children with ASD. All instructors, except Amy, who presently does not have the ability to have one-on-one volunteers present during her yoga class, indicated that the volunteers for their programs were essential components to making the physical activity classes run smoothly.

> Challenges for me, I would say just being comfortable with the [education assistant, (EA)] that's with me, depending on who I have. I have one EA that is, that I worked with for 3 years and when she comes to the gym I, my, stress level is low. When she doesn't come my stress level goes up because some of the other ones aren't as capable of helping out and knowing the kids as well. – *Darren, PE teacher*

Christina expressed similar sentiments about the importance of the volunteers:

> … It's very important that we have the volunteers. So like when we have weeks where 5 volunteers cancel, me and [Erin] are pulling our hair out because we know the class is going to be so tough. And, keep in mind that if that child is so used to working with that volunteer, and then that volunteer isn't there and we have somebody new, and let's just say that they don't connect, because that happens, it's a nightmare. So that child is out of sorts, the volunteer isn't enjoying themselves and then [Erin] and I have to take time away from us teaching and

> monitoring the class to try and diffuse whatever situation is going on. So I would say that [program M] would **not** be possible without our volunteers. –*Christina, fitness*

Aside from the presence of volunteers, Alexis suggested that building quality relationships with the children was also an essential component to programming. It was also evident that Alexis believed that the intrinsic personality characteristics of the volunteers and instructors were integral to the success of her fitness programs.

> Probably, I mean other than the coaches; we have really amazing relationships with all of our people, especially the kids. Adrian… he, the relationships he builds with the boys, like we put boys with boys and girls with girls for mentorship. And friendship building and you know, to be comfortable. Because there could be some other personal issues that come up too, so we want to make sure everyone is taken care of and treated fairly and again we build that relationship. **–** *Alexis, fitness*

Patricia agreed with the importance of building rapport and knowing the children in the class, in addition to having the ability to adapt the course of the programming on a day-to-day basis.

> And some days, like we have a rule here where, all coaches have to have a plan, a skating skills plan every day. And our thing is, you may have that on paper, but the likelihood, you'll probably throw it out the window because it depends on the child. One day you're not going to get anywhere on that program that you wrote, and some days if the child is really good, then you know "oh I can push them a little bit more today" so you can take advantage of their happy day and do something else new! – *Patricia, skating*

Similarly, other instructors indicated that flexibility was vital to ASD programming. In contrast to programs for TD children, instructors of physical activity programs for children with ASD indicated that although they may have a plan for the class, more than likely they would not complete all of the activities planned. For example, Darren said:

> …I think the other thing is, just being very, very flexible. You gotta be flexible with these kids… some days you got to go with the flow. Don't make things black

> and white. Some people like to make things black and white but with kids with ASD you gotta have a lot of grey in you… if you are going to push the limits you have to, you have to be able to gauge that and is it worth your while and are they going to, how upset are they getting? So I mean that's all part of it too with them. *– Darren, PE teacher*

Amy echoed the importance of being flexible as an instructor:

> …So I typically would do my lesson plans ahead of time. And sometimes I keep with my whole plan, sometimes it's just the kids are scattered and you have to be quick on your feet and you're moving on to the next activity. *–Amy, yoga*

In addition, instructors suggested that little successes were important when running a class for children with ASD. For example, Christina stated:

> So for myself I think that, I try to keep my expectations low, because sometimes like at the beginning I had really high expectations of being able to see that they've physically changed and stuff, but once I kind of accepted that the class is going to be very disorganized, the class, instead of doing 20 push-ups they might only do one, and to be happy with that. To be happy with all that they give because as long as they are giving effort I think that I need to be happy. So really, not having expectations is probably the best thing. *–Christina, fitness*

Carrie shared similar experiences:

> …Then overcoming that challenge was just really recognizing small, small achievements are huge achievements, right? …As an instructor, if they all were listening and participating for one activity in a 45 minute dance class, that's success. So just sort of setting those smaller goals. *– Carrie, dance*

The caregivers also indicated that the intrinsic personality characteristics of the instructors or volunteers for a program make a world of difference for their children with ASD. They mentioned qualities like understanding, encouraging, and knowledge of how to effectively instruct children with ASD were essential characteristics of strong leaders. Erica suggested:

> Additional support, an understanding of maybe how to present instructions, so if he needs the one-to-one explanation, or just visual cues and markers, things like that. To break down whatever the goal or activity is for him. For sure that's the difference between I think him being able to do it and also allowing for breaks to be allowed to leave is huge for him as well. *–Erica White, caregiver*

James added that instructors of physical activity programs have to have the knowledge and training to be able to deal with various situations that may arise with children with ASD. He stated: "As long as…the coordinators understand and know how to deal with [behaviours of children with ASD]". It was evident that James felt instructors played a key role in his children's success in a physical activity program.

Karen spoke about the accessibility of programs and presence of accommodations inherent within programs. Karen's definition of accessibility referred to the availability of programs that would be suitable for her child with ASD, and the ability to find these programs to be able to enrol her child. She stated that:

> You have to know where to look, and we've gotten help about how to look…. for example, if we signed him up for karate, which we aren't planning to do because we want [Drew] to have his own thing, but they say "oh sure, we've had kids with autism" but there's not, we would have to hire someone to be in there if he needed a helper. Like there's not a lot of awareness. *–Karen Murphy, caregiver*

Erica also mentioned issues of additional support and program accessibility:

> So that makes a huge difference having additional support. And I know there's a lot of programs where they get the one-to-one, but they fill up really quick and so if, so if you, you don't, if it doesn't work into your schedule, then it also makes it hard because there's so few of them. So I think accessibility to it, and size of it makes a big difference. *–Erica White, caregiver*

Erica indicated that the number of children in the program, and the support of the instructors and volunteers were important aspects of an ideal program for her child with ASD. Her frustration was evident with knowing where to find programs with these features to best suit her child with ASD's needs. Finally, Maddy expressed that her brother Ryan did not need to be able to participate in the same activities as everyone else necessarily. Rather, physical activity programs for her brother with ASD may need to

hone in on his strengths. Her words stress the importance of differences between children and accepting children for their differences.

> … He doesn't have to be able to exercise the exact same as everyone else, because everyone else has different issues too and maybe someone's great at baseball but they can't dance, and he can dance! So just stay open minded for that too! – *Maddy Murphy, sibling*

Overall, participants indicated that certain aspects of physical activity programming were essential for program successes for children with ASD. Modifications may be necessary to address program inadequacies in order to improve programming for children with ASD.

"It can be fantastic and then it can just be like a total nightmare"

Family members reported that having a child with ASD influenced relationships within the family unit. Some, but not all of the family challenges were related to physical activity. The challenges with family physical activity, as expressed by the participants in this study, were unique to families in the current study that had children with ASD. For example, Amanda felt that her brother received different treatment from instructors and volunteers at the physical activity program they participated in together. She stated that he was allowed to leave the gymnasium frequently during the class and go "on walks" with his one-on-one volunteer, and therefore was not always participating with her in the physical activity program. She questioned why she did not receive the same concessions or allowances as her brother.

More specific to physical activity as a family, Heather verbalized the challenges her family faced when it came to the rigid interests of her son with ASD.

> It can be stressful at times because he has very rigid thinking. So sometimes we have to do whatever he wants to do or whatever way he wants to do. But then I

> think he's old enough so sometimes I tell him "it's not all about you". – *Heather Smith, caregiver*

James echoed these thoughts in regards to his younger daughter with ASD.

> And again, it kind of circles back to Jessica's own agenda…. Where she'll have an idea of what she wants to do. And whether that's an indoor activity or an outdoor activity, there will be something that she wants to do and we'll end up doing that just because fighting her to do something that we want her to do isn't always productive, I guess is the way to put it. – *James Williams, caregiver*

James and Heather verbalized explicitly that having children with ASD affected their physical activity patterns as a family unit; however, Erica and Karen stated how their children with ASD affected family relationships. These challenges were not always specific to physical activity, but could be translated into a physical activity context. For example, Erica said:

> …. It puts strain that's for sure…you have less patience to deal with your other children, or to deal with other people. And you end up sometimes becoming more closed off just because you're kind of almost burnt out at times and you want less to deal with…but there are some other extreme other opposites of the fact there are some incredible things that having a kid on the spectrum does, because you're experiencing uh some of their gifts in such an extreme way, but it is all over the board. It can be fantastic and then it can just be like a total nightmare. – *Erica White, caregiver*

Similarly Karen spoke about how Ryan's ASD diagnosis affected his relationship with his younger brother Drew:

> For [Drew], I don't know what his personality would be for good, and I wouldn't say for bad, but just it is so much shaped. His natural temperament from when he was a baby was super easy going…but he's gotten a lot more sensitive, and if someone raises their voice at him, he'd think you were screaming at him… But then he's also more compassionate, I think because of [Ryan]. More protective of people, and he has his own, I think it's really good that he has his own group of friends, I think that's really important to form his own personality. – *Karen Murphy, caregiver*

Many participants indicated the influence children with ASD have on family dynamics, both in a familial and physical activity context. The challenges that were

expressed were unique to children with ASD and participants in this study, and may not be experienced by families with solely TD children.

2.8 Summary

The purpose of the current study was to obtain various perspectives on physical activity for children with ASD. Further, the aim was to investigate how families and physical activity programming influence the physical activity patterns of children with ASD. The first research question, investigating how physical activity influences children with ASD, was addressed by obtaining the different perspectives of physical activity and physical activity programming in this chapter. Interviews with four different participant groups (children with ASD, siblings, primary caregivers, and physical activity program instructors) provided insight into the influences families and physical activity programming have on the physical activity patterns of children with ASD, and also how having a child with ASD may affect the family unit's physical activity patterns.

The principal researcher's experience with children with ASD provided a unique approach to the research. The principal researcher has volunteered with a physical activity program for children with disabilities, including ASD, for the past two years. In this physical activity program, the principal researcher worked one-on-one with a child with ASD, allowing the researcher to observe first-hand the physical activity patterns of a child with ASD. Additionally, the researcher was able to observe the challenges associated with physical activity participation for a child with ASD, and also utilize various techniques to encourage and modify the activity for the child to participate. Overall, this experience allowed the principal researcher to see first-hand how physical

activity programming for children with ASD works, and understand the changes that would need to be made to accommodate for a child with ASD's unique needs.

Overall, the results obtained from Chapter 2 of the current research indicated that although there are certain antecedents and outcomes to participation in physical activity, these all were not completely different than what a TD population would experience (for example: various interests between family members, lack of time, etc.). However, there were some unique challenges faced by children with ASD and their families in this study (for example: rigid agendas, strain on family relationships, etc.). Chapter 2 also provided suggestions from the perspective of the parent, and the physical activity instructors, on ways to improve physical activity programming to best serve the unique needs of children with ASD.

Table 2.1: Summary of themes and subthemes.

Theme	Subtheme
Physical activity, regardless of ability	• "Now it's easy to see the effects" • "To fill the gap" • "It's no different than anyone else"
The nature of ASD: programming and family challenges	• "So how do we modify that activity" • "It can be fantastic and then it can just be like a total nightmare"

CHAPTER 3: MOTOR SKILL PROFICIENCY AND PHYSICAL ACTIVITY

3.1 Research Design

The purpose of Chapter 3 was to describe the motor skill proficiency and physical activity patterns of children with ASD. To investigate whether physical activity affects children with ASD and to describe physical activity participation and motor skill proficiency for children with ASD (and their siblings), pedometers and motor skill testing methods were utilized. Motor skill testing session for children with ASD and their siblings was comprised of three motor tasks and was completed within one day. The children with ASD wore pedometers for the entirety of seven consecutive days.

3.2 Research Tools and Methods

3.2.1 Motor Skill Proficiency

To investigate the motor skill proficiencies of the children with ASD and their siblings, three motor tasks were chosen. Chapter 3 of the current research was a descriptive study to investigate motor skill proficiency in this population. In addition, information obtained from the background questionnaires and interviews in Part C was used to provide context on demographics and physical activity involvement for the motor testing. One motor testing session was conducted with each child during the study period, with each child completing all tasks within one day (see Appendix B). No standardized testing method was chosen for this study due to poor test-retest reliability of certain standardized tests for children with motor difficulties (Venetsanou et al., 2011). However, based on previous literature and modified for this population, three separate measures were chosen to be part of a testing session: a balance task, an aiming and catching task, and a visual-motor integration iPad application task. Field notes were also

recorded during each task to indicate motor behaviours that may have not been captured through the data collected for each task.

Previous standardized testing has determined that children with ASD have the greatest motor deficits in balance and ball skills (McPhillips et al., 2014). In addition, visual-motor integration creates significant problems for children with ASD as well as deficits in motor skill proficiency (Ament et al., 2014; Miller et al., 2014). Thus, with the use of tablet technology, a visual-motor integration task can help identify these motor deficits by measuring target acquisition accuracy (Baker et al., 2015). Therefore, for this pilot motor testing, the three tasks that were chosen provided the most comprehensive results regarding physical activity patterns on the motor skill proficiency of children with ASD. Furthermore, these three motor tasks determined whether participation in a physical activity program affected fundamental motor skills like catching and balance and/or more complex integration motor skills.

Static Balance. Adapted from the NIH Toolbox, participants were asked to complete a static standing balance task. A Nintendo Wii balance board was utilized to measure the centre of pressure for each participant. The children were positioned an arms-length away from an object hanging on the wall at eye level and asked to focus their attention on this object. The researcher instructed the children to stand with their feet shoulder width apart and their arms at their sides. Children were asked to hold four poses for a total of 30 seconds each and their score was based on the amount of postural sway measured by the Wii balance board. The shortened time period from the suggested 50 seconds helped diffuse any issues the children with ASD may have had that would have affected their results (i.e., repetitive motor movements, decreased interest). The four

poses included: eyes open on a solid surface, eyes closed on a solid surface, eyes open on a foam pad, and eyes closed on a foam pad (NIH Toolbox, 2014). The use of the Wii balance board, an inexpensive and portable alternative to laboratory grade force plates, has been shown to be valid and reliable in measuring centre of pressure (Clark et al., 2010).

Aiming and Catching Task. The ball skill task was adapted from the MABC-2, requiring the children to complete a trial of both aiming/throwing, and catching (Henderson, Sugden, & Barnett, 2007). Each trial consisted of ten attempts at completing the task as best as possible, and the scores were averaged. For the aiming task, children were asked to stand two meters away from a target on the floor and toss a beanbag to the target on the floor. The distance from the beanbag, to the centre of the target was measured for all ten attempts. For the catching task, children were asked to catch a beanbag thrown to them ten times, from a distance of two metres. The researcher recorded the number of successful catches using both hands, without trapping the beanbag against the body. Despite the lack of research on validity and reliability of the MABC-2, it appears to be clinically useful in assessing children and adolescents with suspected motor impairments, but should not be utilized as the sole method for diagnosing motor deficiencies (Brown & Lalor, 2009).

Visual-Motor Integration Task. An iPad application was utilized to measure visual-motor integration in the children with ASD. The iPad application was designed with a black background, grey circular home button, and yellow 'targets'. The children were asked to rest their index fingers on the home button, located at the bottom of the screen in the middle. A short period of predetermined time elapsed (500ms, 1000ms, or

1500ms), and then the target appeared at a random location anywhere on the screen along the horizontal and vertical axes of the tablet screen in the direction away from the home button (Baker et al., 2015). When participants' fingers were removed from the home button, the target disappeared. Participants were instructed to touch where they remembered the target had been. The accuracy of the target acquisition was graded based on the distance of the children's fingers in relation to the target radius. Children were asked to complete 20 trials, following five practice trials, each lasting about two seconds, and scores were recorded for statistical analyses (Baker et al., 2015). This task has been previously utilized with participants with ASD, however, as it has been newly developed, little information is known about the reliability and validity of this testing method.

3.2.2 Objective Physical Activity Measurement

To objectively measure physical activity of the children with ASD, the children were asked to wear pedometers for seven consecutive days, including five week days and two weekend days (see Appendix B). The children were asked to wear the pedometers from the time they woke up in the morning, to the time they went to sleep in the evening (except for water activities). The self-report physical activity journals supplemented the information obtained from the pedometers. Each family member reported physical activity participation, duration, participants involved in the activity, location, and perceived exhaustion for each activity for the same seven days the children with ASD wore the pedometers (see Appendix F for journals).

Pedometers. Children with ASD were asked to wear pedometers for seven consecutive days, the same week the self-reported physical activity journals were completed (see Appendix B). The primary caregivers were asked to assist the children in

putting on and taking off the pedometers each day. The primary researcher also ensured the pedometers were set to zero at the beginning of the week, and the primary caregivers or children with ASD were asked to record the number of steps at the end of each day. Upon completion of seven full days of wearing the pedometers, the researcher obtained the self-report physical activity journals with the steps for each day recorded.

3.3 Data Treatment

For each motor task, the individual scores from the motor testing session were compared between the children with ASD and their sibling. The data from the children with ASD were also compared to each other. In the single case where the child with ASD did not have sibling data for comparison, the participant was compared to the other participants with ASD. In addition, the data obtained from the pedometers provided information about the physical activity patterns of the children with ASD. These data were analyzed in conjunction with all other data that were collected.

Aiming and Catching. The distance from each beanbag to the centre of the target in the aiming task was recorded. Absolute error was calculated by adding together each recorded distance from the beanbag to the centre of the target, and subsequently dividing the sum of the distances by the number of trials (n= 10). For the catching task, the number of successful catches was reported.

Static Balance. The centre of pressure (CoP) values over the 30 seconds each participant was on the Wii balance board in each condition were calculated in both the medial/lateral and anterior/posterior directions. The CoP values were calculated based on the mass in each quadrant of the Wii balance board over the entire trial. Before calculating the area of the ellipse, it was determined if there was any point in time in

which 90% of the total mass did not register on the Wii balance board. This was then compared to the researcher's field notes that had been completed during testing to determine if the participant had stepped off of the Wii balance board. In cases where the children stepped off of the Wii balance board their data was omitted. Children only stepped off of the Wii balance board in the foam eyes closed condition. Next, the area of the ellipse was calculated based on the CoP values in each direction. Finally, the values used for analysis were 95% of the area of the ellipse to eliminate any outliers. In order to depict these results in graphic form, each CoP value was subtracted from the average CoP in the respective direction. The CoP in the medial/lateral direction was then plotted against the CoP in the anterior/posterior direction to produce a representation of the postural sway during each condition.

Visual-Motor Integration. The reaction times and accuracy values from each trial were obtained once the task was completed. For each participant, an average reaction time and an average accuracy value was calculated based on 20 trials. The accuracy value was based on 125% of the radius of the target, and each trial was graded on a point system. A value of 1.0 was a direct hit on the target, a value of 0.5 was a non-direct hit within 125% of the target radius, and a value of 0 was a non-direct hit not within 125% of the radius (Baker et al., 2015).

3.4 Motor Testing Results

The data obtained from each motor task were used to calculate descriptive statistics of the motor skills of the participants. No statistical analyses were performed on any task due to the small sample size and the difficulty children had completing certain tasks. Each task was descriptively compared between sibling dyads, and between all

children with ASD. The sibling dyads were compared because first order relatives of children with ASD may manifest similar characteristics to their siblings with ASD termed Broader Autism Phenotype (Ozonoff et al., 2014). Additionally, the TD siblings were assumed to be the best comparison to the children with ASD, as they would have engaged in similar sedentary and physical activities as a family. The TD siblings were not compared as it was beyond the scope of this study. Where there was no sibling data for comparison, that participant was only compared to the other participants with ASD. All tables and figures appear at the end of Chapter 3. Pseudonyms were not used in Chapter 3 to protect participant anonymity, instead participants were randomized and referred to in family pairs (Family A, B, C, D).

3.4.1 Static Balance

Four of the five balance poses were analyzed. The poses included: solid surface eyes open, solid surface eyes closed, foam surface eyes open, and repeated solid surface eyes open. Due to the difficult nature of the fourth pose, foam surface eyes closed, it was not included in the analyses. Five of the participants were unable to remain on the Wii balance board for the entire foam surface eyes closed condition. The area of the ellipse surrounding the variability in the centre of pressure (COP), or postural sway, for each participant was calculated, and 95% of the area of the ellipse was reported to eliminate outliers. Refer to Table 3.1 for these area values for participants during each balance condition. The larger the 95% ellipse area, the more compromised the balance and the greater the postural sway. In Family A, the child with ASD and the sibling had similar balance values in each pose. The postural sway for the child with ASD and sibling in Family A over the 30-second trial period was depicted in Figure 3.3. Each of the four

balance conditions were included in Figure 3.3 including: solid surface eyes open, solid surface eyes closed, foam surface eyes open, and repeated solid surface eyes open. For both children in Family A, the 95% ellipse area was low in the control trial (solid surface eyes open). When visual input was removed (solid surface eyes closed), these values increased. Next, when visual input was made available again, but somatosensory input was compromised (foam surface eyes open), the 95% ellipse area increased even more. When asked to repeat the initial balance pose (repeated solid surface eyes open), the child with ASD in Family A returned close to where his/her balance originally was in the control trial, however the sibling's (Family A) balance did not and instead was comparable to his/her solid surface eyes closed trial.

The postural sway over each 30-second trial for the child with ASD and sibling in Family B are depicted in Figure 3.4. The child with ASD's balance compared to the sibling revealed that his/her overall balance was more compromised (see Table 3.1 for summary of 95% ellipse area for each condition). In the solid surface eyes open condition, the child with ASD and the sibling in Family B have similar 95% ellipse areas. However, when visual input was removed (solid surface eyes closed), the 95% ellipse area for the child with ASD increased and the sibling's 95% ellipse area also increased, but to a lesser degree. When visual input was restored, but somatosensory input was compromised (foam surface eyes open), both the child with ASD and the sibling had smaller 95% ellipse areas compared to when visual input was unavailable, but worse than the control trial. Finally, when asked to repeat the first condition (repeated solid surface eyes open), both children's (Family B) 95% ellipse areas did not return to baseline and instead were comparable to their second trials, solid surface eyes closed.

The child in Family C did not have any sibling data for comparison. However, compared to every other participant with ASD in this study, his/her balance was the best (see Table 3.1 for summary of 95% ellipse areas). During the control trial, solid surface eyes open, his/her 95% ellipse area was low. When visual input was removed (solid surface eyes closed), the 95% ellipse area increased. When visual input was restored, but somatosensory input was removed (foam surface eyes open), the child with ASD's (Family C) balance remained similar to the previous condition. Finally, when he/she repeated the control condition stance for a second time, (repeated solid surface eyes open), his/her balance did not return to baseline.

The child with ASD in Family D, compared to his/her younger sibling had more compromised balance in all conditions (see Table 3.1 for summary of 95% ellipse areas in each condition). Their postural sway over each 30-second trial was depicted in Figure 3.5. When visual input was removed, the child with ASD's 95% ellipse area decreased, while the sibling's 95% ellipse area increased. Interestingly, when visual input was then restored and somatosensory input was compromised, the child with ASD's 95% ellipse area increased again. The sibling's 95% ellipse area also increased when somatosensory input was compromised. For the final trial, repeated solid surface eyes open, both the child with ASD and the sibling in Family D had lower 95% ellipse areas, with the child with ASD's being much lower than his/her control trial, and the sibling's being larger than his/her control trial.

Overall, comparing the means of each condition for the children with ASD to the TD siblings, on average the children with ASD performed poorer on every task with a larger standard deviation around the mean (see Table 3.1 and Figure 3.1). A visual

representation of the balance results for the children with ASD can be found in Figure 3.2. Additionally, the largest ellipse area was seen in the foam surface eyes open condition, when somatosensory input was manipulated. When only looking at the children with ASD, the children with ASD from Family A and C performed the best in every condition, while the child with ASD from Family D performed the worst in every condition.

3.4.2 Aiming and Catching

The absolute error was calculated for each participant for the aiming task. For the catching task, the number of successful catches was recorded along with descriptive notes on the catching dynamics.

All the children with ASD had lower absolute error values (mean=23.95cm) compared to their TD siblings (mean=35.20cm; see Table 3.2 for summary of absolute errors). Both children in Family A, and Family B had similar absolute errors between sibling pairs; however, the siblings with ASD had lower absolute errors. Notably, the child with ASD in Family D had an absolute error that was significantly lower than his/her sibling. The child with ASD in Family C, as compared to the other participants with ASD had a similar absolute error, which was smaller than all the TD siblings.

The results for the catching task were variable between sibling dyads (see Table 3.2 for summary of catching average); however, the differences between each sibling in the dyad were not noticeable. The sibling in Family A caught one more than the child with ASD, the child with ASD in Family B caught one more than his/her sibling, and the child with ASD in Family D caught three more than his/her sibling. In Family C, the child with ASD's catching average was comparable to the other participants with ASD.

3.4.3 Visual-Motor Integration Task

The visual-motor accuracy and reaction time were calculated for each participant. The visual-motor accuracy was based on a point system, where 1.0 was a direct touch on the target. The reaction time was calculated from the time participants fingers were moved from the resting position to the time their fingers touched the target. Overall, the children with ASD have slower reaction times than their TD siblings (see Table 3.3 for summary of accuracy and reaction times).

When comparing sibling dyads, the child with ASD in Family A was less accurate and had a slower reaction time than his/her sibling. The child in Family B was more accurate than his/her sibling, but had a slower reaction time. In Family D, the child with ASD was less accurate and had a slower reaction time than his/her sibling. The child with ASD in Family C, when compared to the other participants with ASD had a faster reaction time, and his/her accuracy was comparable to each participant with ASD.

3.5 Objectively Measured Physical Activity Results

At the end of each day the children with ASD or the primary caregivers recorded the number of steps the children with ASD obtained. The average number of steps per day and standard deviation was then calculated based on the seven-day period for each child with ASD (see Table 3.4 for summary of values). After assessment of the self-report physical activity journals for each child with ASD, there appeared to be no trends to report in regards to the number of steps each child with ASD obtained in relation to the activity participation or the day of the week.

On average, the child with ASD in Family A obtained 5991 steps per day. The maximum number of steps during one day was on a Sunday (n= 12888 steps). The child

with ASD in Family B took an average of 6148 steps per day. The number of steps he/she achieved each day was variable, with the maximum number of steps (n=10995 steps), being reached on a Tuesday. The child with ASD in Family C on average took 5872 steps per day. Once again, his/her steps per day were variable, walking a maximum number of steps (n=11848 steps) on a Wednesday. Finally, the child with ASD in Family D achieved the highest average daily step count, 10644 per day. The maximum number of steps in one day for this child with ASD (n= 16230 steps) was obtained on a Wednesday. Interestingly, the days in which the participants obtained the most steps did not appear to coincide with their physical activity participation as self-reported in their physical activity journals.

3.6 Summary

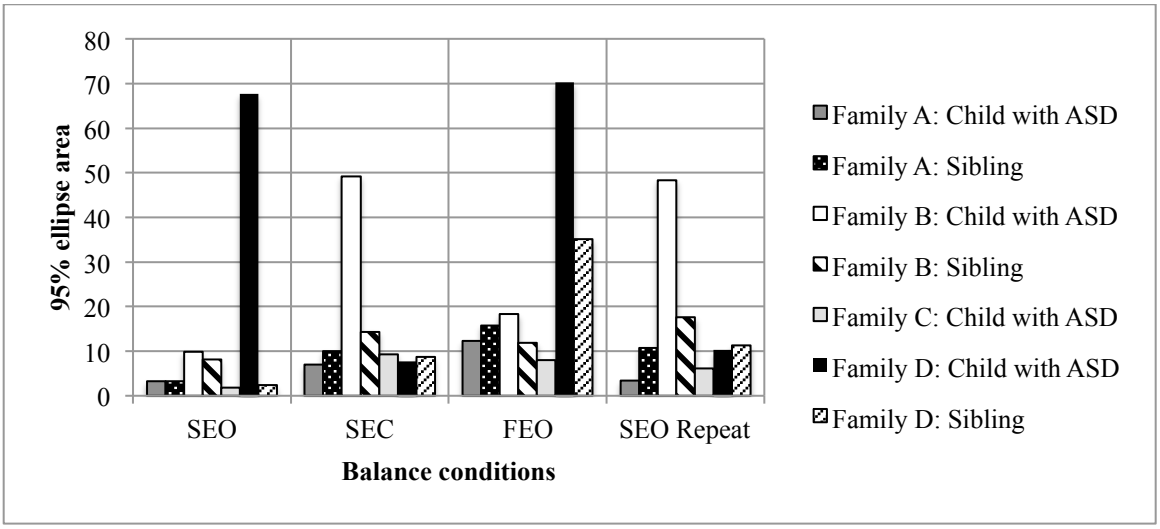
The purpose of Chapter 3 of the current research was to describe the motor skill proficiency of children with ASD and their TD siblings, and to objectively quantify the children with ASD's physical activity patterns. Between each sibling dyad, there were variable results, but the general trends indicated the TD siblings performed better than the children with ASD on most motor tasks. However, in the aiming task, the children with ASD performed better than their TD sibling, which could be due to the nature of the task (fine motor skills versus gross motor skills) or the age of the participants (children with ASD were older than the TD siblings), which will be discussed in Chapter 4. Additionally, the number of steps obtained by the children with ASD each day will be discussed in Chapter 4, along with the comparison of the objective measure of physical activity to the motor skill results.

Table 3.1: Descriptive balance results for four balance conditions

Participant	Balance: SEO_1 (cm^2)	Balance: SEC (cm^2)	Balance: FEO (cm^2)	Balance: SEO_2 (cm^2)
Family A: Child with ASD	3.27	7.05	12.32	3.37
Family A: Sibling	3.22	10.02	15.76	10.75
Family B: Child with ASD	9.90	49.22	18.31	48.35
Family B: Sibling	8.10	14.35	11.88	17.56
Family C: Child with ASD	1.84	9.33	8.02	6.06
Family D: Child with ASD	67.64	7.77	70.20	10.30
Family D: Sibling	2.40	8.67	35.07	11.34
Mean (all participants)	13.77	15.20	24.51	15.39
Standard Deviation (all)	23.95	15.19	21.96	15.20
Mean (children with ASD)	20.66	18.34	27.21	17.02
Standard Deviation (ASD)	31.52	20.61	28.97	21.08
Mean (siblings)	4.57	11.02	20.90	13.22
Standard Deviation (siblings)	3.08	2.97	12.42	3.77

Note: Numbers reported are 95% ellipse areas over 30-second trials for each condition. Conditions include: solid surface eyes open (SEO_1), solid surface eyes closed (SEC), foam surface eyes open (FEO), solid surface eyes open repeated (SEO_2). Children with ASD (grey shading) are paired in below chart with their TD sibling (no shading). Means and standard deviations for all participants, only the children with ASD, and only the TD siblings are shown below.

Figure 3.1: Visual representation of balance task for each child.



Note: Children with ASD are shown as solid bars, and their TD siblings are the adjacent patterned bars.

Figure 3.2: Visual representation of balance task for the children with ASD.

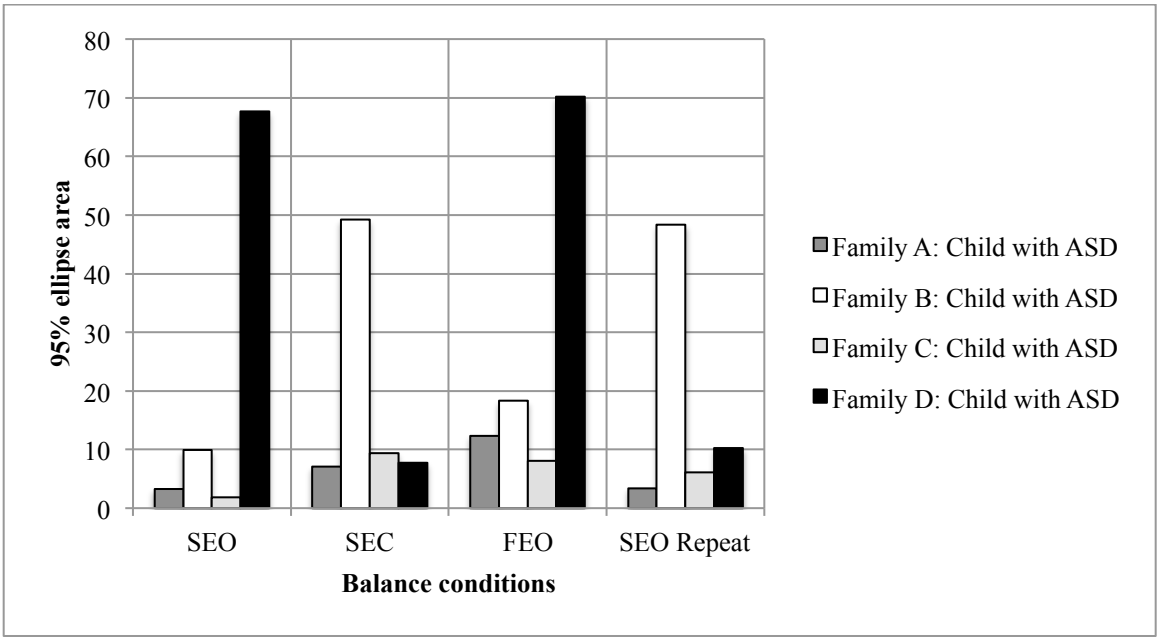
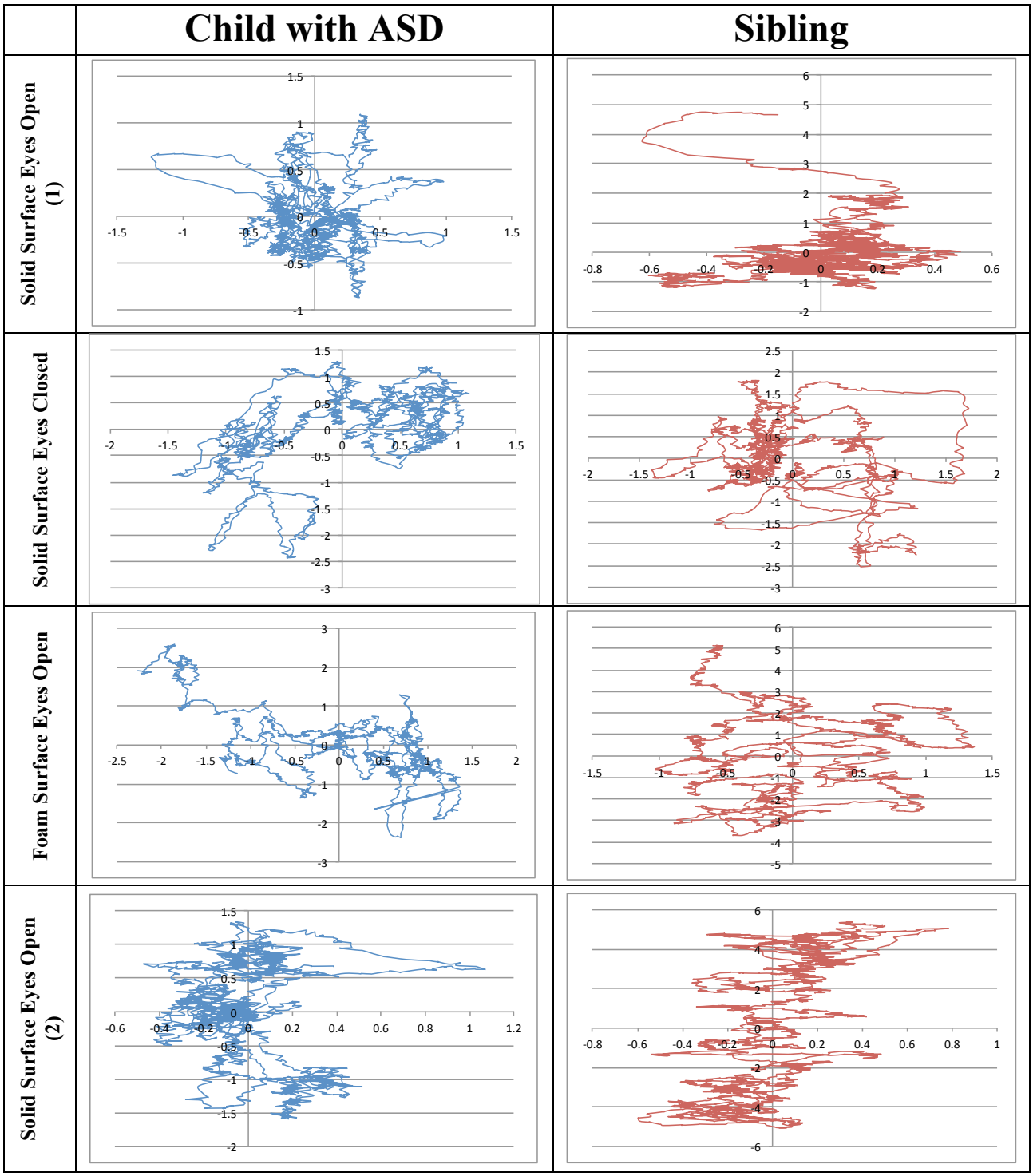
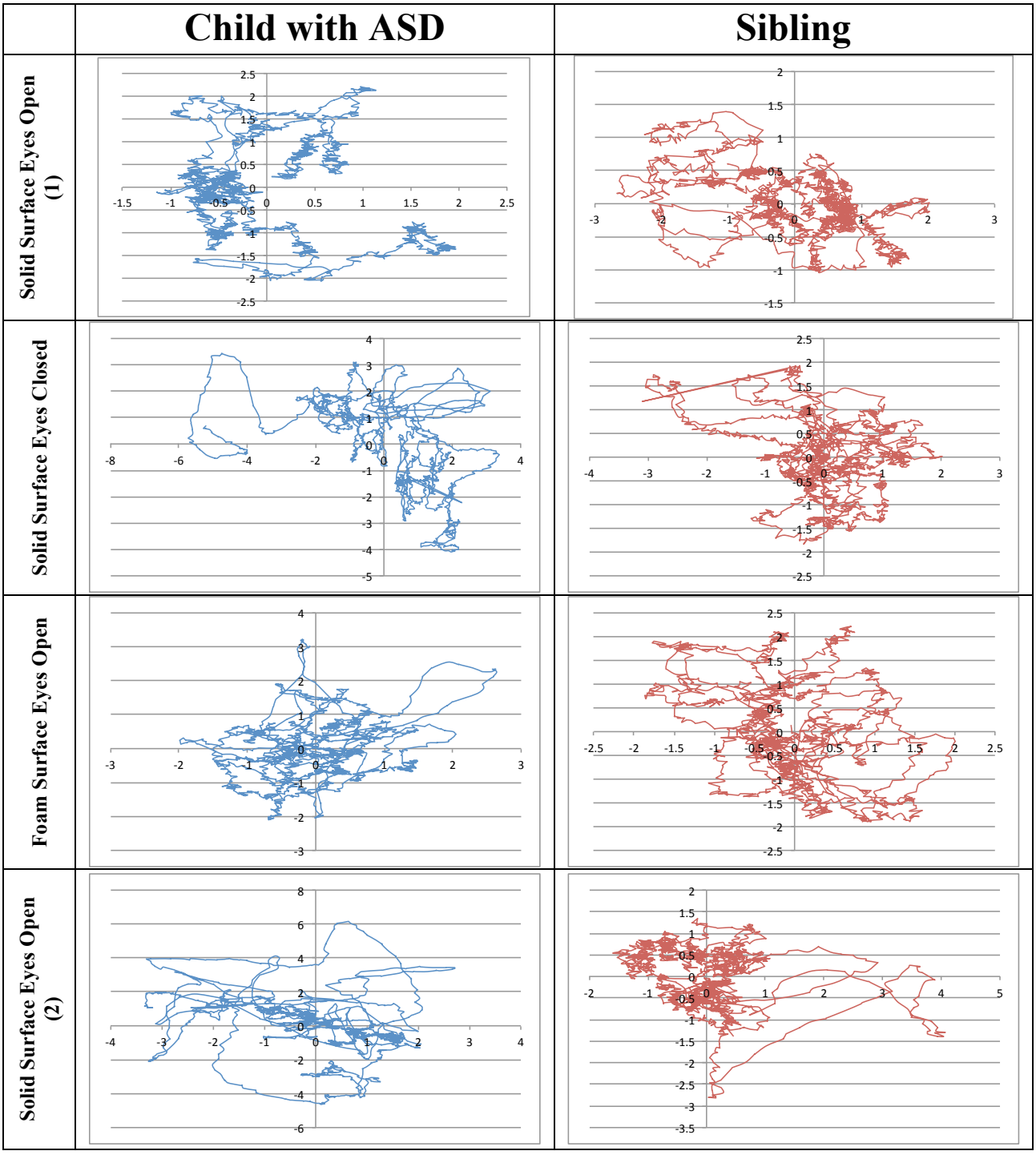


Figure 3.3: Comparison of centre of pressure (CoP) in Family A between the child with ASD and his/her sibling for four balance conditions.



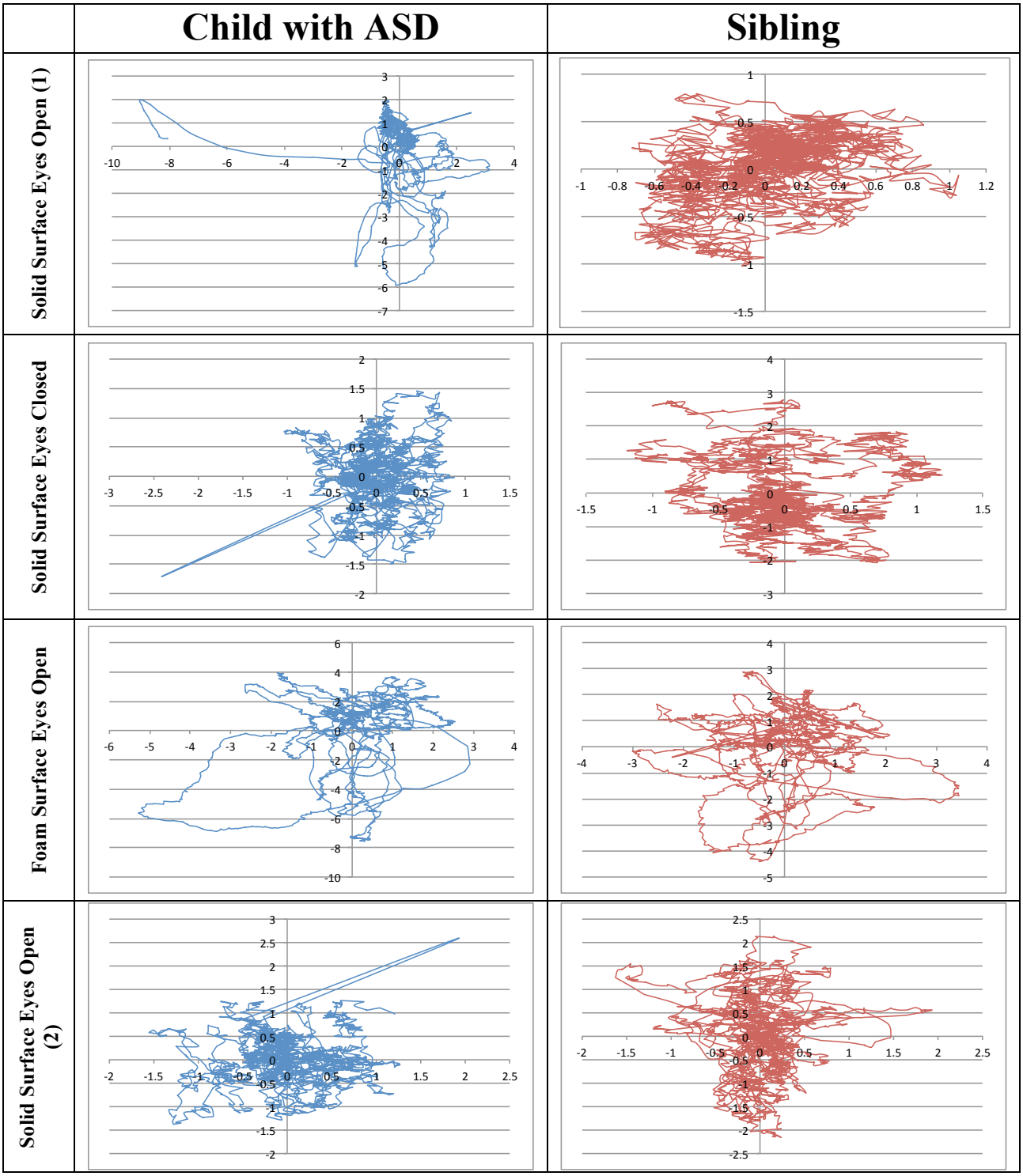
Note: Depiction of CoP in the medial/lateral (x-axis) and anterior/posterior (y-axis) directions plotted around zero, representing the centre of the Wii balance board.

Figure 3.4: Comparison of centre of pressure (CoP) in Family B between the child with ASD his/her sibling for four balance conditions.



Note: Depiction of CoP in the medial/lateral (x-axis) and anterior/posterior (y-axis) directions plotted around zero, representing the centre of the Wii balance board.

Figure 3.5: Comparison of centre of pressure (CoP) in Family D between the child with ASD and his/her sibling for four balance conditions.



Note: Depiction of CoP in the medial/lateral (x-axis) and anterior/posterior (y-axis) directions plotted around zero, representing the centre of the Wii balance board.

Table 3.2: Aiming absolute error and catching average for ten trials for each task

Participant	Aiming Absolute Error (cm)	Catching Average
Family A: Child with ASD	23.0	9
Family A: Sibling	27.4	10
Family B: Child with ASD	25.0	10
Family B: Sibling	26.7	9
Family C: Child with ASD	24.9	9
Family D: Child with ASD	22.9	8
Family D: Sibling	51.5	5

Note: Children with ASD (grey shading) are paired in below chart with their TD sibling (no shading).

Table 3.3: Visual-motor accuracy and visual-motor reaction time

Participant	Visual-Motor Accuracy	Visual-Motor Reaction Time (ms)
Family A: Child with ASD	0.78	1046.65
Family A: Sibling	0.93	812.60
Family B: Child with ASD	0.80	1603.45
Family B: Sibling	0.70	1147.45
Family C: Child with ASD	0.88	620.25
Family D: Child with ASD	0.90	1763.15
Family D: Sibling	1.00	1281.50

Note: Children with ASD (grey shading) are paired in below chart with their TD sibling (no shading). For visual-motor accuracy, 1 indicated the most accurate.

Table 3.4: Pedometer data of children with ASD over seven days.

Child with ASD	Mean steps per day	Standard deviation
Family A: Child with ASD	5991	3886.42
Family B: Child with ASD	6148	3319.09
Family C: Child with ASD	5872	3504.25
Family D: Child with ASD	10644	3878.53

CHAPTER 4: DISCUSSION

This study provided insight on physical activity for children with ASD from the perspectives of caregivers, physical activity leaders, siblings and children with ASD, in addition to describing the physical activity patterns and motor skill proficiencies of four children with ASD. Both chapters will be discussed in turn separately, followed by a general discussion of the entirety of the study.

4.1 Perspectives of Physical Activity

4.1.1 Physical activity, regardless of ability

Throughout the first subtheme, "Now it's easy to see the effects", it appeared that perspectives of physical activity were different, depending on the participant group. For example, all instructors indicated the positive effects resulting from physical activity participation. On the other hand, the primary caregivers confirmed that positive effects accrued but were aware of the negative effects that physical activity may provoke in their children with ASD. That said, caregivers also mentioned that once their children were able to overcome various hurdles associated with physical activity involvement, the negatives lessened and the positives prevailed. The disconnect between the perceptions of the instructors and the primary caregivers may be the result of the timing of the development of the effects. Physical activity program instructors arguably would only see the children with ASD during the physical activity class, while the primary caregivers would see their children with ASD before and after the physical activity classes. Therefore, the outcomes associated with participation in physical activity may differ based on perspective. Additionally, Obrusnikova and Cavalier (2011) found that parents and peers were considered factors that were perceived as both facilitators and barriers to

physical activity participation. This could account for the negative effects parents had seen, if the children saw the parent's support and encouragement as a barrier instead of a facilitator to physical activity (Obrusnikova & Cavalier, 2011).

The second subtheme, "To fill the gap", revealed certain intrinsic characteristics associated with ASD that hindered their abilities to engage in physical activity. The intrinsic abilities were social, psychological, and physical in nature and undoubtedly limited participation or completion of certain aspects associated with various physical activities. In the TD population Barnett et al. (2009) determined that having greater motor skill competency as children may increase self-esteem resulting in greater enjoyment and participation in physical activities in adolescence. As such, since motor skill competency is often compromised in children with ASD, as displayed in the current study, children may not reap the same enjoyment or participate as fully. Physical educators, instructors and caregivers for children with ASD should provide activities to improve motor skill competency with the intent of improving overall enjoyment and participation in physical activity.

Finally, the last subtheme, "It's no different than anyone else", explored the difficulties with physical activity for individuals with ASD, difficulties that were also applicable to TD populations. The main difficulty individuals expressed with regards to physical activity were varying interests. Both instructors and primary caregivers indicated that the various interests made participation in physical activity as a group difficult. However, this trend is not exclusive to children with ASD. For example, a study investigating barriers to physical activity as a family for a TD population found that interest of the activity was a barrier, echoing the findings from the present study with

children with ASD (Thompson et al., 2010). Another difficulty expressed in the TD population was the availability of time due to a busy schedule, which was also a barrier discovered in the current study for children with ASD (Thompson et al., 2010). As such, the varying interests of the children in a physical activity program, regardless of ability or diagnosis, should be taken into consideration. This also translates to family physical activity, where trying to satisfy the varying interests of all children, parents may need to divide and conquer, regardless of abilities.

4.1.2 The nature of ASD: programming and family challenges

The first subtheme, "So how do we modify that activity", demonstrated that physical activity programs for children with ASD must be modified in order to best provide physical activity to children with ASD. Each of the instructors discussed how they modified their programs to best suit the children with ASD. The primary caregivers echoed these sentiments and provided their suggestions for modifying programs to best serve their children with ASD. Modifications described the changes to class content, instructional methods, and environmental factors for children with ASD. Both the instructors and the primary caregivers stressed the importance of rapport being established between the children, volunteers, and instructors. The better the relationships between all the parties, the more the instructors were able to understand how to instruct children with ASD to be physically active. In terms of the structure of the program, instructors expressed the importance of being flexible in order that they may accommodate a myriad of issues that may derail the intended program of the day (e.g., rigidity of children, negative behaviours, etc.). The program instructors also mentioned that small accomplishments needed to be celebrated to encourage the children with ASD

to continue participation in physical activity. These findings resemble that of Pan (2011), as he determined that for individuals with ASD, there were environmental factors (i.e., instructors, content, location, etc.) that affected their physical activity participation. These findings consolidate the importance of the flexibility and instructional abilities of the instructors and volunteers as expressed by the participants in the current study. Parents also discussed the availability of programs that are suitable for their children with ASD. Although they agreed many programs are available, programs with proper training to instruct their children with ASD fill up quickly and may not be financially accessible. Pan and Frey (2006) also determined that the delivery and accessibility of physical activity for children with ASD has been seen as a barrier, which align with the findings of the current study. These aspects of physical activity programming (instructor flexibility, rapport between children and instructors, and accessibility) should be taken into consideration when planning a physical activity class for children with ASD.

The second subtheme, "It can be fantastic and then it can just be like a total nightmare", revolved around the challenges families with children with ASD encounter. Primary caregivers expressed that in order to prevent a scene or bad behaviour from occurring, families would often have to participate in the activity that the children with ASD wanted, even though other family members may have not wanted to do so. Often, events such as these affected family relationships. Although the strain experienced by family members was not solely related to physical activity involvement, it definitely spoke to the functioning of the family and whether or not they could participate in physical activity together. The development of fitness clubs that offered a myriad of activities that families could engage in, some of which were tailored to the needs to

children with ASD, would promote physical activity involvement for all members of families with children with disabilities. The notion that certain challenges with physical activity for children with ASD affected family relationships was a seemingly novel finding.

4.2 Motor Skill Proficiency and Physical Activity

4.2.1 Motor Skill Proficiency

Aiming and Catching. Contrary to previous literature that suggested children with ASD performed poorer on ball skill tasks than TD children (McPhillips et al., 2014), when the children with ASD were compared to their TD siblings in the current study, all of the children with ASD had lower absolute errors than their younger siblings. One reason for the more accurate performance by children with ASD compared to their siblings may be the result of age. There is potential that since all the children with ASD were older than their siblings, that the children with ASD had been exposed to similar tasks (in physical education class, and extra-curricular activities) for longer than their siblings, allowing the children with ASD to develop their ball skills. Such a notion has previously been supported in a study that determined that motor deficits in children with ASD became less prevalent with age (Ming et al., 2007). Another contributing factor to the more accurate ball skill performance by the children with ASD was the lessened motor ability gap between the children with ASD and their siblings due to potential Broader Autism Phenotype (Ozonoff et al., 2014). Although no primary caregivers indicated a Broader Autism Phenotype diagnosis for any of the siblings, if such a condition were present, the deficits between the children with ASD and their TD siblings would not be as wide. These findings suggest that perhaps the ASD diagnosis did not

affect their motor skill performance. Further research is needed to determine if, when children with ASD are compared to older TD siblings instead, the older siblings will perform better than the younger sibling, regardless of diagnosis. Further research should also take into consideration the diagnosis of the children along the spectrum of ASD, as much the current literature focuses on high functioning children with ASD only. This also indicates a need for the development of better motor testing methods to accurately test children along the ASD spectrum.

Balance task. First, due to the difficult nature of the foam eyes closed condition, the condition was removed from the analysis. Given that that only two children were able to complete the foam eyes closed condition indicates that this measure may not be ideal for children with ASD, and further modifications need to be made to provide a meaningful measure of balance skills in children with ASD. When looking at two of the three sibling dyads, the children with ASD had poorer balance than the TD siblings. In the one instance where the child with ASD had better balance than their TD sibling, it was important to note that the child with ASD (14 years old) was the oldest participant in the study. As mentioned previously, age may have been a factor in performance here as well. This was also supported by previous research that found that the motor deficits in children with ASD (for example: hypotonia and motor apraxia) became less prevalent as children with ASD aged, indicating that motor skills may improve over time (Ming et al., 2007).

Next, there appeared to be an improvement in some participants from the first solid surface eyes open trial to the second. It is possible that this might have been due to a learning effect. There were, however some participants that had poorer balance during the

repeated solid surface eyes open condition than the first solid surface eyes open condition, which may be partially attributed to fatigue. The findings from the balance task have been found in both TD populations, and children with ASD. Previous research has found that children with ASD had more difficulty maintaining balance when visual or somatosensory input was manipulated (Molloy, Dietrich, & Bhattacharya, 2003). Further, it has previously been found that children with ASD relied most heavily on visual cues (Molloy et al., 2003). This was not the case for one of the participants in the current study, as his/her balance improved when visual stimulation was removed, which warrants further research in the area of balance skills.

Visual-motor integration task. The results from the visual-motor integration task showed that all of the children with ASD had slower reaction times than their TD siblings. The accuracy measurement showed that in two of the three sibling pairs, the TD siblings were more accurate while in one of the sibling dyads the child with ASD was more accurate. Interestingly, this finding did not align with the findings from the aiming and catching task, regardless of the similarities. Both tasks' underlying measure was visual-motor integration, but it appeared that the children with ASD performed better than their TD siblings in the aiming and catching task, but poorer than their TD siblings in the tablet task. It is possible that that the nature of the task, gross motor versus fine motor skills, may have influenced the performance of the participants. In the current study, the aiming and catching and balance tasks were considered gross motor skills, while the visual-motor integration task was measuring fine motor skills. Ming and colleagues (2007) determined that since fine motor impairments are not recognized easily, children with ASD that have fine motor delays may not be identified and receive

treatment. As such, children with ASD may be more developed in their gross motor skills than their fine motor skills. Further, there is potential that the visual-motor integration findings from the aiming and catching task were more applicable to a physical activity context than the tablet task. If the goal of motor testing was to quantify motor abilities in children with ASD to aid in improving physical activity patterns, theoretically the aiming and catching task was a better measure of visual-motor integration.

4.2.2 Objectively Measured Physical Activity

After wearing a pedometer for seven consecutive days, the children with ASD obtained on average 7164 steps per day. When compared to a previous worldwide literature review on TD children, the children with ASD obtained substantially fewer steps per day than what is recommended by many researchers (Tudor-Locke et al., 2011). This review found that elementary school aged children should be obtaining between 11000 to 15000 steps per day, depending on gender (Tudor-Locke et al., 2011). Further, in the current study none of the participants' average daily step counts reached the lowest suggested step count provided in the aforementioned worldwide study on TD children.

On the contrary to the current study's findings, it has been previously found that children with ASD are capable of achieving the same physical activity levels as the TD population (Tyler et al., 2014). Also, it has been suggested that the movements children with ASD may engage in frequently (i.e., roaming, pacing, repetitive behaviours) may not be captured by a questionnaire (Bandini et al., 2013), but these movements may be captured by an objective measure of physical activity. Previous literature indicates that perhaps the disparity between the suggested step counts per day, and the current sample of children with ASD, may not be attributed to the diagnosis of ASD. If children with

ASD are capable of participating in the recommended amount of physical activity, and the pedometer registered steps for these repetitive movements not captured on a questionnaire, this in theory should be an accurate representation of their daily step count. It is conceivable that the difference between the step-counts in the current study and previous research is a result of other factors like sedentary behaviours and availability of structured and unstructured physical activity opportunities affecting both TD and ASD populations. This indicated that barriers to physical activity for children with ASD might not be so different than the barriers experienced by the TD population. However, the data obtained from the pedometers in this study may not have been completely accurate. There were multiple variables that may have skewed the step counts obtained. For example the principal researcher cannot ensure the children with ASD were compliant with wearing the pedometers for the entirety of each day. Further, the children were able to see the number of steps they had obtained, which may have influenced their activity patterns. Additionally, not all physical activities registered on the pedometer (i.e., biking and swimming).

Interestingly, Pan (2009) suggested that physical activity for children with ASD was affected more by social and environmental constraints rather than the impairment itself. On the contrary, Polfuss et al. (2016) indicated that parent's of children with ASD suggested certain characteristics of their children (i.e., lack of coordination and social abilities) affected their participation in structured sports. Additionally, McCoy and colleagues (2016) found no differences between children with ASD and TD children in terms of sedentary behaviours (e.g., screen time and computer usage). However, Polfuss et al. (2016) highlighted parent's concerns with limiting screen time for their children

with ASD when it was perceived as a mechanism to learn social skills and communication. Further research is warranted on these aforementioned conflicting findings between children with ASD and the TD population in both physical activity and sedentary behaviour contexts. Therefore, the question remains, should children with ASD be expected to obtain similar step counts to TD populations, or should these step counts be modified for children with ASD to reflect their unique challenges to physical activity?

4.3 General Discussion

Many of the participants in this study expressed perceptions that participation in physical activity improved physical skills in children with ASD, including motor skills. Unfortunately, the current study did not conduct motor testing with the children at more than one time. Thus, improvements in motor skills through participation in physical activity cannot be concluded from this study. Although previous research has determined that childhood motor skills predicted physical activity participation in TD adolescents (Barnett et al., 2009), future studies are warranted in comparing the perceptions of physical activity participation for children with ASD with an objective measure of motor skill proficiency. Furthermore, changes to motor skill testing for children with ASD need to be considered to best represent the qualitative observations indicated by the participants during the interviews. For example, motor deficits found in children with ASD are commonly visual-motor integration difficulties (Ament et al., 2014; Molloy et al., 2003). This suggests that motor testing may need to be based on integration tasks, rather than compartmentalizing the motor skills and sensory inputs when testing.

Interestingly, the objective measure of physical activity utilized in this study (pedometers), indicated that the more steps a participant took did not relate to motor skill

proficiency or the perceptions of physical activity provided by the family. The child with ASD that obtained the most steps during the seven-day period they were asked to wear the pedometer performed the poorest on all of the motor tasks compared to the other children with ASD. This finding suggests that motor skill ability did not impede the objectively measured physical activity, but instead may affect other aspects of physical activity (i.e., available programming, social interactions, structured sports or activities, etc.). Additionally, many of the caregivers and children indicated that as a family, most of their physical activity occurred on the weekends. However, based on the pedometer data from the current study, the majority of the steps taken by the children with ASD were during the week. This could support the importance of physical education and school based physical activity opportunities. It was also important to consider that some of the family physical activities mentioned were activities that may not be recorded through a pedometer (i.e., bicycling and swimming).

4.4 Limitations

The results obtained from the current study may only be applicable to a narrow demographic range. As such, the experiences of physical activity programming for children with ASD expressed in this study are representative of geographic areas that have available programming. Additionally, this study only investigated certain physical activity programs. It was acknowledged that there are many other available physical activity programs that exist for children with ASD that may show benefits, or have different challenges. Therefore, the research findings are not applicable to every physical activity program for children with ASD, but they likely translate to other activities. The exclusion of lower functioning children with ASD may also be taken as a limitation. Due

to the nature of the tasks the children with ASD were asked to complete as part of this study (i.e., interviews and motor testing) the children with ASD were all high functioning. To investigate lower functioning children with ASD, a modified study would be necessary. The pedometers used in this study to objectively measure physical activity also did not capture all of the physical activities indicated in the physical activity questionnaires and interviews. Thus, the number of steps obtained from the pedometers did not provide a comprehensive view of the physical activity patterns of the children with ASD. Finally, as previously noted, the motor testing methods for children with ASD utilized in this study proved to be difficult for the participants. Therefore, the data obtained from the motor testing may not be representative of the motor skill proficiency of the participants in this study.

4.5 Implications

The current study provided some major implications for physical activity and motor skill testing for children with ASD. First, the various perspectives obtained from the primary caregivers, children, and instructors in this study may help to improve current physical activity programs. These perspectives on physical activity programs were applicable programs specifically for individuals with ASD. However, this may be extrapolated to the TD population, as a theme that emerged from the interviews with participants indicated that aspects of physical activity for children with ASD might not be different than the TD population. The various perspectives of physical activity programs for children with ASD are useful for policy makers, instructors, and families when developing physical activity programs, and trying to find physical activity programs that will work for their children with ASD. This study also illuminated the need for further

research into motor skill testing for children with ASD. Currently, the standardized motor skill testing methods are not without fault, and even when using modified testing methods as done in this study, there were still difficulties for the participants. Thus, the development of a reliable and valid measure of motor skill proficiency for this population is crucial in quantifying motor skills and providing ways to help improve the motor skills for children with ASD.

In conclusion, this study provided a representation of the perspectives of physical activity for children with ASD. The descriptive motor testing and pedometer data supplemented the information obtained from the interviews and questionnaires completed by the participants. Overall, this study presented potential improvements to physical activity programming for children with ASD, and described the physical activity patterns of children with ASD and their families.

4.6 Recommendations

Currently, there does not appear to be motor testing methods that provide representative results of motor skill proficiency of children with ASD. Perhaps the next steps in developing a better measure of motor skill proficiency for children with ASD should start with observational methods. For example, if physical activity instructors were educated on fundamental motor skills, they may be able to provide an observational account of the children with ASD's motor skill proficiency during physical activity programming. Furthermore, the instructors would be able to provide a longitudinal account of motor skill changes of the children with ASD throughout their participation in physical activity programs.

Multiple suggestions to improve community-based physical activity programming for individuals with ASD also surfaced from the research. Physical activity instructors in the community should take into consideration the population of individuals that the programs services. Regardless of the level of ability, instructors should speak to parents and participants to gain an understanding of how to best create a program for the unique needs of participants. For example, the modifications to a physical activity program for individuals with physical disabilities would not necessarily be the same as the modifications needed for individuals with developmental disabilities. Using parents, as proxies for their children with disabilities, will provide insight on how to effectively instruct their children. Additionally, formal training to instruct individuals with a range of abilities would be instrumental in providing successful programs. Instructors are encouraged to complete their own research, and speak with other physical activity program instructors that may experience similar challenges and successes. Exchanging perspectives and experiences will aid in the development of successful programming.

Although creating a physical activity program for physical education teachers would be similar to the recommendations provided above, there are unique challenges within the school system. Administrators need to consider the modifications children with different abilities may need for physical education classes. Currently, modifications are typically available for children in other areas of elementary and secondary school, but it appears that physical education does not service children with disabilities to the same extent. Specifically, children with ASD may struggle to participate in physical education in a gymnasium with multiple other children due to physical, sensory, and social challenges. However, the challenges children with ASD may experience in physical

education class should not discount the importance of physical activity participation in school for each child. The school system needs to consider the implementation of unique physical education classes for children with different needs, making necessary modifications to allow children with disabilities to succeed in physical education. As stated clearly by an instructor in the current study, “I believe every instructor in every program should open their doors to every single ability and be willing on a moment’s notice to accommodate and modify that program to ensure that everyone fits in.”

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APPENDIX A
Ethics Approvals and Modifications

July 27, 2016

Dear Kristen Wright

REB # 5010
Project, "Moving and Improving: Investigating Physical Activity for Children with Autism Spectrum Disorder (ASD)"
REB Clearance Issued:July 27, 2016
REB Expiry / End Date: May 01, 2017
The Research Ethics Board of Wilfrid Laurier University has reviewed the above proposal and determined that the proposal is ethically sound. If the research plan and methods should change in a way that may bring into question the project's adherence to acceptable ethical norms, please submit a "Request for Ethics Clearance of a Revision or Modification" form for approval before the changes are put into place. This form can also be used to extend protocols past their expiry date, except in cases where the project is more than two years old. Those projects require a new REB application.

Please note that you are responsible for obtaining any further approvals that might be required to complete your project.

Laurier REB approval will automatically expire when one's employment ends at Laurier.

If any participants in your research project have a negative experience (either physical, psychological or emotional) you are required to submit an "Adverse Events Form" within 24 hours of the event.

You must complete the online "Annual/Final Progress Report on Human Research Projects" form annually and upon completion of the project. ROMEO will automatically keeps track of these annual reports for you. When you have a report due within 30 days (and/or an overdue report) it will be listed under the 'My Reminders' quick link on your ROMEO home screen; the number in brackets next to 'My Reminders' will tell you how many

reports need to be submitted. Protocols with overdue annual reports will be marked as expired. Further the REB has been requested to notify Research Finance when an REB protocol, tied to a funding account has been marked as expired. In such cases Research Finance will immediately freeze the release of your funding.

All the best for the successful completion of your project.

(Useful links: ROMEO Login Screen ; ROMEO Quick Reference Guide ; REB webpage)

Yours sincerely,

Robert Basso, PhD
Chair, University Research Ethics Board
Wilfrid Laurier University

July 29, 2016

Dear Kristen,

REB # 5010
Project, "Moving and Improving: Investigating Physical Activity for Children with Autism Spectrum Disorder (ASD)"
REB Clearance Issued:July 27, 2016
Expiry / End Date: May 01, 2017

I have reviewed the changes (Change in age range of participants - 5-25 years old) to the above proposal and determined that they are ethically sound.

If the research plan and methods should change in a way that may bring into question the project's adherence to acceptable ethical norms, please contact me as soon as possible and before the changes are put in place.

(This letter has been issued on behalf of Dr. R. Basso, by Paul Barnard, Research Compliance Officer.)

(Useful links: ROMEO Login Screen ; ROMEO Quick Reference Guide ; REB webpage)

Yours sincerely,

Robert Basso, PhD
Chair, University Research Ethics Board
Wilfrid Laurier University

January 31, 2017

Dear Kristen,

REB # 5010
Project, "Moving and Improving: Investigating Physical Activity for Children with Autism Spectrum Disorder (ASD)"
REB Clearance Issued:July 27, 2016
Expiry / End Date: May 01, 2017

I have reviewed the changes (Recruitment e-mail script) to the above proposal and determined that they are ethically sound.

Note: As a part of this approval, please include the following statement in the recruitment e-mail "This project has been reviewed and approved by the University Research Ethics Board, REB #5010"

If the research plan and methods should change in a way that may bring into question the project's adherence to acceptable ethical norms, please contact me as soon as possible and before the changes are put in place.

(This letter has been issued on behalf of Dr. R. Basso, by Courtney Lunt, Research Compliance Officer.)

(Useful links: ROMEO Login Screen ; ROMEO Quick Reference Guide ; REB webpage)

Yours sincerely,

Robert Basso, PhD
Chair, University Research Ethics Board
Wilfrid Laurier University

April 04, 2017

Dear Kristen,

REB # 5010
Project, "Moving and Improving: Investigating Physical Activity for Children with Autism Spectrum Disorder (ASD)"
REB Clearance Issued:July 27, 2016
Expiry / End Date: August 01, 2017

I have reviewed the changes (Extend end date until August 1, 2017) to the above proposal and determined that they are ethically sound.

If the research plan and methods should change in a way that may bring into question the project's adherence to acceptable ethical norms, please contact me as soon as possible and before the changes are put in place.

(This letter has been issued on behalf of Dr. R. Basso, by Courtney Lunt, Research Compliance Officer.)

(Useful links: ROMEO Login Screen ; ROMEO Quick Reference Guide ; REB webpage)

Yours sincerely,

Robert Basso, PhD
Chair, University Research Ethics Board
Wilfrid Laurier University

APPENDIX B
Schedule of Study Period

Task completed	Date (length of time)
Interviews	September 2016 – March 2017
Motor testing session	September 2016 – February 2017
Pedometer data collection	September 2016 – February 2017 (1 week)
Self-report physical activity journal	September 2016 – February 2017 (1 week, same week as pedometers)
Data Analysis	March – April 2017

APPENDIX C
Background Questionnaires

Background Questionnaire: Physical Activity Participation in Children with ASD
Primary Caregiver Background Questionnaire

Thank you for agreeing to participate in this study. This questionnaire aims to obtain background information to provide the researcher with context prior to the interview. The questions on this questionnaire will include demographic information, information about your child with ASD, and the physical activity patterns of yourself, your family, and your child with ASD. All personal information provided on this questionnaire will be kept confidential. You are reminded that your participation is completely voluntary. You may choose to refrain from answering any questions with which you feel uncomfortable. Please fill out the following information to the best of your ability.

Background Information

1. What is your relationship with the child? _____

2. Date of birth (MM/YYYY) _____

3. Highest level of education completed:
   - ☐ Elementary school
   - ☐ High school
   - ☐ College
   - ☐ University
   - ☐ Post-graduate degree
   - ☐ Other (please specify): _____

4. What is your marital status?
   - ☐ Single
   - ☐ Married
   - ☐ Common law
   - ☐ Divorced
   - ☐ Separated
   - ☐ Widowed
   - ☐ Other (please specify): _____

5. What is your occupation?
   - ☐ Full time (please list): _____
   - ☐ Part time (please list): _____
   - ☐ On leave (please specify): _____
   - ☐ Unemployed
   - ☐ Retired
   - ☐ Other (please specify): _____

6. Please provide the following information about any children you may have:

	Gender	Date of birth (MM/YYYY)	Health conditions	Activity participation in the past 12 months?
Child with ASD				
Child 2				
Child 3				
Child 4				
Child 5				

Information about your child with ASD

7. How old was your child when diagnosed with ASD? _____

8. What signs and symptoms of ASD does your child currently display? Please list.

_____
_____
_____
_____
_____
_____

9. Does your child have any secondary health concerns?
   - ☐ No
   - ☐ Yes

   If yes, please specify:

_____
_____
_____

10. Does your child with ASD receive any treatment and/or therapies specific to his/her ASD?
    - ☐ No
    - ☐ Yes

    If yes, please list:

_____
_____
_____

11. Has your child with ASD participated in recreational physical activities in the past 12 months?
    - ☐ Yes
    - ☐ No

    If yes, please list below and provide a short description:

_____
_____
_____
_____
_____
_____

12. Does your child attend regular physical education classes at school?
    - ☐ No
    - ☐ Yes

    If yes, please specify how many days per week, and for how long:

_____

13. Do you notice any changes in your child after he/she participates in physical activity? Please check how the following changes may impact your child with ASD.

	Positive	Negative	Both	No effect
Physical abilities				
Social abilities				
Cognitive abilities				
Psychological health				
Symptoms associated with ASD				
Other (please specify):				

14. Does your child's participation in physical activity affect you personally?
    - ☐ No
    - ☐ Yes

    If yes, please explain:

_____
_____
_____
_____
_____
_____

Thank you for taking the time to complete this questionnaire!

Background Questionnaire: Physical Activity Participation in Children with ASD
Physical Activity Instructors

Thank you for agreeing to participate in this study. This questionnaire aims to obtain background information to provide the researcher with context prior to the interview. The questions on this questionnaire will include demographic information and information about the physical education program. All personal information provided on this questionnaire will be kept confidential. You are reminded that your participation is completely voluntary. You may choose to refrain from answering any questions with which you feel uncomfortable. Please fill out the following information to the best of your ability.

1. What is your gender? _____

2. Date of birth (MM/YYYY): _____

3. What physical activity program(s) are you currently involved with for children with ASD?
   _____
   _____

4. What physical activity program(s) have you previously been involved with for children with ASD?
   _____
   _____

5. How long have you been working with children with ASD? _____

6. How long have you been involved in the physical activity classes for children with ASD? _____

7. How frequently are you present for the physical activity class?
   - ☐ Every day
   - ☐ Occasionally (please specify): _____
   - ☐ Never

8. During class, do you participate in the physical activities with the children?
   - ☐ Yes
   - ☐ No
   - ☐ N/A

9. Do you encounter any difficulties during the physical activity class with children with ASD?
   - ☐ No
   - ☐ Yes

   If yes, please check all that apply:
   - ☐ Paying attention to the instructor
   - ☐ Social interactions with peers
   - ☐ Participating in physical activity for the length of the class
   - ☐ Other (please list):

_____
_____
_____
_____

10. In general, do you notice any changes in the children with ASD after attending the physical activity class?
    - ☐ No
    - ☐ Yes

    If yes, in the table below please check how the following changes may impact children with ASD (check all boxes that apply).

	Positive	Negative	Both	No effect	Short term?	Long term?
Physical abilities						
Social abilities						
Cognitive abilities						
Psychological health						
Signs and symptoms associated with ASD						
Behaviour						
Other (please specify):						

Thank you for taking the time to complete this questionnaire

APPENDIX D
Interview Guides
Interview Questions: *Primary Caregiver*

Before we get started, I would like to thank you for your participation in this study. Please feel free to ask questions or make comments at any time during this interview. Also, I want to remind you that your participation is completely voluntary. You may refrain from answering any questions with which you feel uncomfortable, and you may choose to end the interview at any time. I will be recording the interview on an audio recorder. If you feel uncomfortable or would like a break, please let me know and we can stop recording.

Background Information

1. How would you describe yourself to a stranger?
    - Family
    - Occupation
    - Hobbies and interests
    - How do you think others would describe you?

2. Please tell me about your child with ASD.
    - Diagnosis
    - Current signs and symptoms
    - Co-morbidities
    - Does ASD affect your child in any specific way? Probe from background questionnaire.
        - Physical
        - Social
        - Psychological
        - Academically
    - Does he/she experience difficulties in daily life?

Family System

3. What does a typical day look like for your family?
    - Morning
    - Evening
    - Weekends

4. How do you think others would describe your family?

5. What are the dynamics of your family?
    - Members
    - Your specific roles and responsibilities?
        - What about with respect to your child with ASD?
    - Other family member's roles and responsibilities?
        - What about with respect to the child with ASD?

6. Can you share with me your caregiving tasks?
    - Child with ASD specifically
    - Your spouse's tasks?

7. Tell me about the relationships within your family unit.
    - Yourself and the child with ASD
    - Other children and the child with ASD
    - Your partner and the child with ASD
    - Yourself and your partner

Physical Education

8. Can you share with me your thoughts on the physical education programs your children are currently involved in?
    - Do they share what they have learned?
    - Likes and dislikes
    - Influenced family or child?

9. Can you share with my why your child with ASD is enrolled in this specific physical education program?
    - Motivation for enrolling
    - School decision

10. Do you think physical education has any effect on your child with ASD?
    - Use background questionnaire to probe.
    - Positive or negative?
    - Physical
    - Social
    - Psychological
    - When? Before, during, after?

11. Do you think physical education has any effect on your TD children?
    - Positive or negative?
    - Physical
    - Social
    - Psychological
    - When? Before, during, after?

12. What would you describe as the "ideal" physical education program for your child with ASD?
    - Activities
    - Time
    - Inclusive vs. segregated?
    - Compared to current physical education program

13. What would you describe as the "ideal" physical education program for your TD children?
    - Activities
    - Time
    - Different from child with ASD?

Physical Activity

14. Can you share with me your views on physical activity for your children?
    - Physical education
    - Community programs
    - TD vs. ASD
    - Duration, frequency, and participation

15. Do you participate in any type of physical activity?
    - Probe from background questionnaire
    - Are there factors that affect your ability to participate in physical activity?
        - Children
        - Time
        - Interest

16. Do you participate in any activities as a family?
    - Evenings
    - Weekends
    - Physical activities?

17. In terms of physical activity as a family unit, what are some:
    - Barriers
        - Programs
        - Time
        - Family dynamics
        - Interests
        - ASD symptoms
            - Do you think that having a child with ASD affects your physical activity patterns?
    - Facilitators
        - Use same probes as above

18. Is your child with ASD currently enrolled in any physical activity programs outside of school?
    - What are these activitites?
    - Community based vs. school based
    - Peers with ASD or TD?
    - Siblings
    - Family

19. Are your TD children currently enrolled in any physical activity programs outside of school?
    - What are these activities?
    - Community vs. school
    - Peers
    - Siblings
    - Family

20. Do you think physical activity has any effect on your child with ASD?
    - Use background questionnaire to probe.
    - Positive or negative?
    - Physical
    - Social
    - Psychological
    - When? Before, during, after?

21. Do you think physical activity has any effect on your TD children?
    - Positive or negative?
    - Physical
    - Social
    - Psychological
    - When? Before, during, after?

22. Once again, can you share with me your view on physical activity for your children?
    - Physical education
    - Community programs
    - Duration, frequency, and participation

Final questions

23. Given all that we've discussed, can you think of one word to sum up your experience with physical activity as a family unit?
    - What about physical activity for your child with ASD?
    - Do you have any advice for other parents?

24. Is there anything else you would like to add?

25. Do you have any questions for me?

Interview Questions: *Sibling*

Before we get started, I would like to thank you for your participation in this study. Please feel free to ask questions or make comments at any time during this interview. Also, I want to remind you that your participation is completely voluntary. You may refrain from answering any questions with which you feel uncomfortable, and you may choose to end the interview at any time. I will be recording the interview on an audio recorder. If you feel uncomfortable or would like a break, please let me know and we can stop recording.

Background Information

1. Tell me about yourself.
    - Interests
    - Hobbies
    - Interesting facts
    - Family

Family System

2. Can you tell me about your family?
    - Siblings
    - Parents
    - Relationships with family members

3. Can you describe what it is like having a sibling with ASD?

4. Do you participate in any activities with your family?
    - Parents
    - Siblings
    - Physical activities

Physical Activity

5. How would you describe the term "physical activity"?
    - Do you enjoy being physically active?

6. Do you participate in any physical activities outside of school?
    - Sports
    - Clubs
    - Family
    - Siblings

7. Do you participate in gym class at school?
    - Likes
    - Dislikes
    - Activities

8. Does anything help you be physically active?
    - Family (parents or siblings)
    - Friends
    - Activities you enjoy

9. Does anything make it hard for you to be physically active?
    - Family (time, attention, transportation, etc.)
    - Siblings
    - Friends
    - Activities you dislike

Final Questions

10. Given all that we have discussed, can you think of one word that would sum up your experience of being physically active with your sibling with ASD?

11. Do you have any advice for other siblings like you?

12. Is there anything else you would like to add about your experience with physical activity?
    - Family influence

13. Do you have any questions for me?

Interview Questions: *Child with ASD*

Before we get started, I would like to thank you for your participation in this study. Please feel free to ask questions or make comments at any time during this interview. Also, I want to remind you that your participation is completely voluntary. You may refrain from answering any questions with which you feel uncomfortable, and you may choose to end the interview at any time. I will be recording the interview on an audio recorder. If you feel uncomfortable or would like a break, please let me know and we can stop recording.

Background Information

1. Can you tell me about yourself?
    - Interests
    - Hobbies
    - Interesting facts

Family System

2. Do you do any fun things with your family?
    - Parents
    - Siblings
    - Activities that make you breathe hard or make your heart beat faster?

Physical Education

3. Tell me about your gym class at school.
    - Activities
    - Enjoyment
    - Parts you dislike
    - What have you learned?
    - Do you share with your family?

4. Does anything make it hard for you to be active in gym class at school?
    - Peers
    - Family
    - Activities

5. Does anything help you be active in gym class at school?
    - Peers
    - Family
    - Activities

Physical Activity

6. What do you think physical activity means?

7. Do you think it is good to be physically active?
    - Why?

8. Do you like physical activity?
    - Running around
    - Playing sports
    - Gym class
    - How does it make you feel?

9. Do you play any sports or do any activities outside of school?
    - Please list them
    - Friends
    - Siblings

10. Does anything make it hard for you to be active outside of school?
    - Peers
    - Family
    - Activities

11. Does anything help you be active outside of school?
    - Peers
    - Family
    - Activities

Final questions

12. Is there anything else you would like to tell me about gym class or sports and activities?

13. Do you have any questions for me?

Interview Questions: ***Physical Activity Instructors***

Before we get started, I would like to thank you for your participation in this study. Please feel free to ask questions or make comments at any time during this interview. Also, I want to remind you that your participation is completely voluntary. You may refrain from answering any questions with which you feel uncomfortable, and you may choose to end the interview at any time. I will be recording the interview on an audio recorder. If you feel uncomfortable or would like a break, please let me know and we can stop recording.

Background Information

1. Tell me about your position as an instructor?
    - Why are you part of the program?
    - Children with ASD
    - Physical activity
    - Expectations
    - How do you think others would describe what you do?

2. Please tell me about your experiences with children with ASD.
    - Length of time
    - Programs

3. Please tell me about your experiences with physical activity programming.
    - Knowledge of physical activity
    - Benefits
    - Children with ASD

Physical Activity

4. Why did this physical activity program start?
    - Intent of program
    - Personal experience
    - Administration
    - Need from the community?

5. Describe a typical physical activity class with children with ASD
    - Planning a class
    - Children's favourite part and why?
    - What types of activities are involved?
    - Volunteers
        - What is their role?
    - Challenges

6. During classes, what do you find helps get the children with ASD to be physically active?
    - Structure
    - Routine
    - Activities
    - Encouragement

7. What effects do you think physical activity has on the children with ASD?
    - Positive or negative?
    - During class, after class, etc.
    - Why do you think you saw these? Why not?

8. Since the start of this physical activity program with children with ASD, have there been improvements in the children with ASD?
    - Behavioural
    - Participation
    - Physical fitness
    - Social skills

9. What would you describe as an "ideal" physical activity program for children with ASD?
    - Activities
    - Time
    - Inclusive vs. integrated?
    - Compared to current physical activity program

Final questions

10. What are your future goals for physical activity programs for children with ASD?
    - Changes to program
    - Needs

11. What would you want other instructors to know about this program?
    - Parents?

12. Given all that we've discussed, can you think of one word that would sum up your experience with physical activity programming for children with ASD?

13. Is there anything else you would like to add?

14. Do you have any questions for me?

APPENDIX E
Physical Activity Questionnaires
Modified Activity Questionnaire for Adolescents

1. How many times in the past 14 days have you done at least 20 minutes of exercise hard enough to make you breathe heavily and make your heart beat fast? (Hard exercise includes, for example, playing basketball, jogging, or fast bicycling; include time in physical education class)
   - ☐ None
   - ☐ 1 to 2 days
   - ☐ 3 to 5 days
   - ☐ 6 to 8 days
   - ☐ 9 or more days

2. How many times in the past 14 days have you done at least 20 minutes of light exercise that was not enough to make you breathe heavily and make your heart beat fast? (Light exercise includes playing basketball, walking or slow bicycling; include time in physical education class)
   - ☐ None
   - ☐ 1 to 2 days
   - ☐ 3 to 5 days
   - ☐ 6 to 8 days
   - ☐ 9 or more days

3. During a normal week how many hours a day do you watch television and videos, or play computer or video games before or after school?
   - ☐ None
   - ☐ 1 hour or less
   - ☐ 2 to 3 hours
   - ☐ 4 to 5 hours
   - ☐ 6 or more hours

4. During the past 12 months, how many team or individual sports or activities did you participate in on a competitive level, such as varsity or junior varsity sports, intramurals, or out-of-school programs?
   - ☐ None
   - ☐ 1 activity
   - ☐ 2 activities
   - ☐ 3 activities
   - ☐ 4 or more activities

   What activities do you compete in?

   _____
   _____
   _____

5. Check all activities that you did at least 10 times in the **PAST YEAR.** Do no include time spent in school physical education classes. Make sure you include all sport teams that you participated in during the last year.

☐ Aerobics ☐ Band/Drill Team ☐ Baseball ☐ Basketball ☐ Bicycling ☐ Bowling ☐ Cheerleading ☐ Dance Class ☐ Football ☐ Garden/Yard Work	☐ Gymnastics ☐ Hiking ☐ Ice Skating ☐ Roller Skating ☐ Running for Exercise ☐ Skateboarding ☐ Snow Skiing ☐ Soccer ☐ Softball ☐ Street Hockey	☐ Swimming ☐ Tennis ☐ Volleyball ☐ Water Skiing ☐ Weight Training (Competitive) ☐ Wrestling ☐ Others: _____ _____ _____

List each activity that you checked above in the "Activity" box below.
Check the months you did each activity and then estimate the mount of time spent in each activity.

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Months per Year	Days per Week	Minutes per Day

CARDIA Physical Activity History

Now I'll be asking you about some specific activities and the amount of time you spend doing each. Only include the time spent actually doing the activity. For example, sitting by the pool does not count as time swimming; sitting in a chair lift does not count as time skiing.
First I'll ask you about vigorous activities. Vigorous activities increase your heart rate or make you sweat when doing them or make you breathe hard or raise your body temperature. If you do an activity but not vigorously, please include it later when I ask you about other non-strenuous sports.

1. The first vigorous activity is running or jogging. Did you run or jog in the past 12 months for at least one hour total time in any month? For instance, you might have done three 20-minute sessions in the month. (VIGOROUS BACKPACKING, HIKING, MOUNTAIN CLIMBING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____

2. Did you do vigorous racquet sports in the past 12 months for at least one hour total time in any month? (TENNIS, BADMINTON, PADDLE BALL, RACQUETBALL, HANDBALL, SQUASH)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____

3. Did you bicycle faster than 10 miles an hour or exercise hard on an exercise bicycle (in the past 12 months for at least one hour total time in any month)? (ROWING MACHINE)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____

4. Did you swim in the past 12 months for at least one hour total time in any month? (SNORKELING, SCUBA DIVING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____

5. Did you do a vigorous exercise class or vigorous dancing (in the past 12 months for at least one hour total time in any month)? (JAZZERCISE, JANE FONDA-TYPE WORKOUT, AEROBIC DANCING, BALLET)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____

6. Did you do a vigorous job activity such as lifting, carrying, or digging in the past 12 months for at least one hour total time in any month? (LOADING TRUCKS, STACKING LUMBER)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____
- (How many of these months/In this month) did you do this activity for at least 5 hours a week? _____

7. Did you do home or leisure activity such as snow shoveling, moving heavy objects, or weight lifting (in the past 12 months for at least one hour total time in any month)? (SHOVELING SAND OR GRAVEL, NAUTILUS WORKOUT, MOVING FURNITURE)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____

8. Did you do other strenuous sports such as basketball, football, skating, or skiing in the past 12 months for at least one hour total time in any month? (MARTIAL

ARTS, SOCCER, RUGBY, LAND OR WATER SKIING, ICE OR ROLLER SKATING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____

9. Did you do non-strenuous sports such as softball, shooting baskets, volleyball, ping pong, leisurely jogging, swimming or biking which we haven't included before (in the past 12 months for at least one hour total time in any month)? (HORSEBACK RIDING, FISHING FROM BANK OR BOAT, ARCHERY, NONVIGOROUS ROWING OR SAILING, NONVIGOROUS BIKING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____

10. Did you take walks or hikes or walk to work in the past 12 months for at least one hour total time in any month? (STREAM FISHING, HUNTING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____
- (How many of these months/In this month) did you do this activity for at least 4 hours a week? _____

11. Did you bowl or play golf (in the past 12 months for at least one hour total time in any month)?

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
  - ☐ Always use motorized cart
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____
  - ☐ Always use motorized cart

Now, I'd like to ask you about more leisurely activities.

12. Did you do home exercises or calisthenics in the past 12 months for at least one hour total time in any month? (NONVIGOROUS EXERCISE OR ROWING MACHINE)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 1 hour a week? _____
- (How many of these months/In this month) did you do this activity for at least 3 hours a week? _____

13. Did you do home maintenance and gardening, including carpentry, painting, raking or mowing (in the past 12 months for at least one hour total time in any month)? (HANGING WALLPAPER, WEEDING, GARDENING)

☐ Yes
- How many months did you do this activity? _____

☐ No
- (How many of these months/In this month) did you do this activity for at least 2 hours a week? _____
- (How many of these months/In this month) did you do this activity for at least 5 hours a week? _____

14. List sports or other activities not elsewhere classified SPORT:

_____

_____

15. Have you already counted this in any other category?

☐ Yes (if yes, do not record here)

☐ No

16. How many months? _____
- Average hrs. in those months? _____

APPENDIX F
Self-Report Physical Activity Journal
Please complete Monday through Sunday

Participant Name: _____
Date: _____

Name of Physical Activity	**Duration** (minutes)	**Participants in Activity** (Indicate who this activity was done with, or if it was done alone)	**Location of Activity** (School, home, community)	**Intensity of Exercise** (Scale of 0-10; 0=not intense, 10=very, very intense)

APPENDIX G
Addressing Research Questions by Methodologies and Participants

Data Collection Method	Research Question		
	#1: How does physical activity influence children with ASD?	#2: Are there any measurable motor skill improvements through participation physical activity for children with ASD?	#3: How do families influence physical activity patterns in children with ASD?
Motor testing		Children with ASD	Siblings
Pedometers	Children with ASD	Children with ASD	Children with ASD
Background questionnaires	Instructors		Primary caregivers
Interviews (and member checks)	Children with ASD, instructors, primary caregivers		Children with ASD, primary caregivers, siblings
Field notes	Principal researcher	Principal researcher	Principal researcher
Journals	Principal researcher		
Physical activity questionnaires			Children with ASD, primary caregivers, siblings
Self-report physical activity journals			Children with ASD, primary caregivers, siblings