Exploring the Relationship Between Physical Activity and Symptom Severity in Adolescents with Autism Spectrum Disorder

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Exploring the Relationship Between Physical Activity and Symptom Severity in Adolescents with Autism Spectrum Disorder

An Honors College Thesis
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Abstract

Objective

While the beneficial effects of exercise on physical and mental well-being, as well as the symptoms of Autism Spectrum Disorder (ASD), are well known, there is a gap in literature on the effect of physical activity (PA) on the psycho-social symptoms of ASD. The purpose of this study is to examine the relationship between physical activity and symptom severity in adolescents with ASD.

Method

Participants who have children with ASD between the ages of 6 and 18 were solicited through the Vermont Family Network. The measures we used in this study were the Autism Spectrum Rating Scale (ASRS), the CPAQ (Children’s Physical Activity Questionnaire), and a demographics form that had an additional segment asking parents to rank various PA barriers their children might encounter. A simple correlational analyses was run between the ASRS and CPAQ results.

Results

Three families participated in the study. Family members reported their children encountering both physical and social barriers to PA; of the barriers reported, difficulty with team sport interaction, an inability to self-monitor, and limited motor functioning were reported to be most inhibitory to the child’s participation in PA. Subjects were reported to average about 4 hours of leisure-time PA per week, with only 20 minutes of sport-related activity. Strong associations were seen between number of minutes spent in leisure-time PA and both the severity and treatment scales of the ASRS; individuals who were rated with an above average presence of ASD symptoms (i.e. Social/Communication, Unusual Behaviors, Self-Regulation) were also reported to partake in a low volume of PA.
Conclusion

While this was a small pilot study, the findings do indicate general inverse associations between time spent in leisure-time PA and both the severity and treatment scales of the ASRS. If these trends were seen on a larger scale, implications could lead to prescribing PA as a means of complimenting traditional management of ASD. Future studies should examine larger, more heterogeneous samples to establish significance within these trends.
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Introduction

Autism Spectrum Disorder (ASD) is a neuropsychiatric disorder characterized by abnormal social communication and interaction as well as repetitive behavior patterns (American Psychiatric Association, 2013). ASD is becoming increasingly prevalent, and therefore, of increasing interest in the field of research. In 2000, 1 in 150 children were diagnosed with ASD while in 2012, 1 in 68 children were diagnosed – a rate that has more than doubled over the span of only 12 years (Centers for Disease Control and Prevention, 2016).

Children with ASD appear to be less physically active than typically-developing peers (Healy, Haegele, Grenier, & Garcia, 2017; Pan & Frey, 2006; Stanish, Curtin, Must, Phillips, Maslin, & Bandini, 2017). In particular, children with ASD have been found to become significantly less active after elementary school age (Pan & Frey, 2006). There is a gap in research as to whether this drop in activity level is due to a lack of available programming, financial barriers, behavioral inhibitors, or other factors (Jones et. al, 2017). While not proven to be directly associated with this decrease in activity, many children diagnosed with ASD are also at an increased risk for being overweight. In a sample of children with ASD, 42% were either overweight or obese (Lawson & Foster, 2016).

In general, studies have shown a positive association between physical activity (PA) and well-being in a range of healthy and clinical populations (Paluska & Schwenk, 2000; Penedo & Dahn, 2005). PA has been shown to play a role in preventing heart disease, lowering blood pressure and cholesterol, decreasing the incidence of Type II Diabetes, and assisting in lowering rates of obesity (American Heart Association, 2013; Ely et al., 2017). However, little research exists examining these associations in individuals with ASD (Jones et al., 2017). Parents of children with ASD also report a concern for their children’s well-being (Lee, Harrington, Louie,
& Newschaffer, 2008). In addition, PA has been shown to help reduce the onset of both depression and anxiety (American Psychiatric Association, 2013; Landers & Arent, 2001), two mental health diseases that individuals with ASD are prone to experience (Buck et al., 2014). Further research, however is needed on the specific association between PA and symptom severity in individuals with Autism Spectrum Disorder (Chen et al., 2016; Jones et. al, 2017).

Finally, some studies have shown that PA helps reduce the occurrence of repetitive behaviors in individuals with ASD; some of these studies suggest that the decrease in repetitive, self-stimulatory behaviors could lead to improved social interactions, yet this area of research remains incomplete at this time (Anderson-Hanley, Tureck, & Schneiderman, 2011; Bass, Duchowny, Llabre, 2009). Responding to this gap in research, the purpose of this study is to examine the relationship between physical activity and symptom severity in youth with ASD.
Review of Literature

Physical Health Benefits of PA

Physical activity (PA) - defined as the act of doing anything that causes one to move their body and to burn calories (American Heart Association, 2013) - is widely recognized to have positive physiological health benefits (CDC, 2017; Di Pietro, Dziura, & Blair, 2004; Ely et al., 2017). It has been shown to play a role in preventing heart disease, lowering blood pressure and cholesterol, decreasing the incidence of Type II Diabetes, and playing a role in lowering rates of obesity (American Heart Association, 2013; Ely et al., 2017). Interestingly, however, the majority of the general population fails to meet the standardized PA recommendations (World Health Organization, 2010). The World Health Organization (WHO) recommends that adults engage in 150 minutes of moderate intensity aerobic PA, 75 minutes of vigorous intensity aerobic PA, or a combination of both, per week (2017). WHO also recommends that children between the ages of 5 and 17 partake in at least 60 minutes of moderate-vigorous intensity PA each day (2017). Only 20% of adolescents, a population encompassed in this study, meet these PA guidelines (WHO, 2010).

Following these PA guidelines plays a significant role in heart disease prevention (American Heart Association, 2013; Booth, Gordon, Carlson, & Hamilton, 2000; Eckel et al., 2014). Heart disease is the leading cause of death worldwide, fatally impacting 25% of the U.S. population each year (CDC, & NCHS, 2015). Even moderate amounts of exercise, however, have been associated with decreased rates of heart disease. For example, even leisure-time spent walking at a rate greater than 100 steps/minute has been shown to predict decreased cardiovascular disease mortality (Brown, Harhay, & Harhay, 2014). In addition, 40 minutes of moderate to vigorous intensity exercise 3-4 times per week has been shown to lower both blood
pressure and cholesterol (American Heart Association, 2013), two risk factors strongly correlated
to coronary heart disease (Vazquez-Benitez et al., 2015; Varghese et al., 2016).

PA, independent of weight loss, has also been shown to play a role in delaying and/or
preventing the onset of Type 2 Diabetes (Ely et al., 2017; Jeon, Lokken, Hu & Van Dam, 2007). In a longitudinal study conducted from 2004 to 2016, researchers found that for every 1.5 hours of PA, there appeared to be a 2% decrease in the incidence of diabetes (American Diabetes Association, 2017). These results are noteworthy as diabetes affects nearly 10% of the U.S. population, and a quarter of the 65 and older population (ADA, 2017). Additionally, nearly half of the adults who do have diabetes spend less than 10 minutes per week in moderate to vigorous level intensity PA (ADA, 2017), 140 minutes below the recommended WHO guidelines (WHO, 2017).

Not only is PA associated with reduced risk in developing Type 2 Diabetes and lowering blood pressure and cholesterol, it also plays a role in the prevention of obesity. With over 35% of Americans being obese, the obesity epidemic is becoming of increasing concern to health care researchers (CDC, 2017; Ogden, Carroll, Fryar, & Flegal, 2015). In children alone, the incidence of obesity in children was 17% in 2015 (Ogdenet al., 2015). In 2008, the medical cost of obesity was $147 billion (CDC, 2017), a statistic that researchers can use to emphasize cost-effectiveness of promoting PA as a management-tool for combatting obesity. Based on a review of the National Longitudinal Study of Adolescent Health, for each day that an adolescent engaged in PA, his/her likelihood for being overweight as an adult decreased by 5 percent (Menschik, Ahmed, Alexander, & Blum, 2008). This association is significant as the data from the CDC suggests that there is a 19.5% increase in obesity rates from childhood to adolescence (CDC, 2017; Ogden, Carroll, Fryar, & Flegal, 2015).
Mental Health Benefits of PA

Interestingly, PA is also widely shown to have a positive impact on mental health (MH) in both healthy and clinical populations; some of these benefits include improved self-esteem, mood enhancement, increased confidence, and lower levels of stress and anxiety (Annesi, Porter, Hill, & Goldfine, 2017; Feliciano-Hernández, Martínez-Colon, Rivera-Morales, & Ramírez-Marrero, 2017; Stubbs et al., 2017; Petzold et al., 2017). The study of PA and MH is becoming increasingly popular as awareness of MH disorders increases. MH disorders are reported to affect nearly fifty percent of the world’s population at some point during one’s lifetime (Martinsen, 2000).

PA has specifically been shown to be inversely related with both depression symptoms and the onset of major and minor depression (Feliciano-Hernández et al., 2017; Jerstad, Boutelle, Ness, & Stice, 2010). A recent study found that, through only a 6-week group exercise program, participants were able to decrease their symptoms of depression and to increase their overall physical fitness (Feliciano-Hernández et al., 2017). Of the individuals who fit the criteria of having symptoms of major depression, the majority expressed interest in participating in an exercise-based treatment program designed to improve mood and relieve depressive symptoms (Busch et al., 2016). In a study that then compared psycho-education versus PA interventions, individuals in the PA group experienced significantly higher relief of depression symptoms than did those in the psychoeducation group (Parker et al., 2016).

People with severe mental illnesses have been found to be less likely to meet PA guidelines than the healthy population (Vancampfort et al., 2017). A recent study found individuals with severe mental illnesses to be significantly more sedentary than individuals from the non-clinical general population; specifically, the study found individuals with severe mental
illnesses to be sedentary for 476.0 minutes during waking hours of the day (Vancampfort et al., 2017). Considering the established benefits of PA on physical and mental health, the lack of PA in the populations affected by mental illness is concerning.

Similar to its relationship with depression, participation in PA, at any intensity, has been shown to have an inverse relationship with anxiety symptoms (Stubbs et al., 2017). While the global rate of participation in low intensity PA is 22% in healthy populations, that rate is significantly lower - at 16% - in populations suffering from anxiety (Stubbs et al., 2017). Even within this category of individuals who engage in PA, those who more often engaged in high intensity PA versus low intensity PA were significantly less likely to suffer from anxiety symptoms (Stubbs et al., 2017). Studies have then suggested that there is a strong association between cardiac disorders and expressing symptoms of anxiety (Caldirola, Schruers, Nardi, De Berardis, Fornaro, & Perna, 2016).

PA has also been shown to have a positive effect on mood enhancement (Annesi, Porter, Hill, & Goldfine, 2017; Berger, Darby, Zhang, Owen, & Tobar, 2016) and self-esteem (Bobbio, 2009). A recent study done on university students showed that increasing PA levels for at least 2 days a week was associated with a significant decrease in negative mood (Annesi et al., 2017). Evidence supports that desirable mood enhancement occurs after only 15 minutes of preferred-intensity exercise (Berger et al., 2016). Interestingly, many of these mental health conditions and mood disorders that PA has been shown to help alleviate in the nonclinical population, are present in the population affected by ASD. A lack of literature exists, however, looking at these relationships in the ASD population.

Defining Autism Spectrum Disorder
Autism Spectrum Disorder (ASD) is a neuropsychiatric disorder characterized by abnormal social communication and interaction as well as repetitive behavior patterns (American Psychiatric Association, 2013). Thought to be associated with a genetic alteration on the X chromosome (Chung et al., 2011; Nava et al., 2012), ASD is 4.5 times more prevalent in males than it is in females (Christensen et al., 2012). As it becomes increasingly prevalent, ASD is becoming of greater interest in the field of research. In 2000, 1 in 150 children were diagnosed with ASD while in 2012, 1 in 68 children were diagnosed – a rate that has more than doubled over the span of 12 years (Centers for Disease Control and Prevention, 2016).

ASD can typically be reliably diagnosed by age 2, but is often not diagnosed until later in the child’s life. Children with ASD may express social deficits that typically-developing (TD) children do not. For example, children with ASD will often struggle to engage in conversation and appear disinterested in a conversation due to frequent avoidance of eye contact (CDC, 2016). Individuals with ASD often do not seek out social support when in distress and struggle with social reciprocity due to fixations on particular objects (Lord, Cook, Leventhal, & Amaral, 2013). Children with ASD may not point to objects of interest, look at objects others point to, or make eye contact. They may also have trouble adapting to a change in routine, may repeat words of interest, and may struggle to understand abstract concepts (CDC, 2014). Collectively, these various signs contribute to the umbrella of abnormal social behaviors seen in individuals with ASD.

Children are diagnosed with ASD on a spectrum of increasing severity – Level I “requiring support,” Level II “requiring substantial support,” and Level III “requiring very substantial support” (APA, 2013). A child diagnosed with Level I ASD may be able to express him or herself clearly, but have difficulty making friends and be slightly functionally impaired
by a disruption in his or her schedule, a child diagnosed with Level III ASD may lack an ability or interest to engage in any sort of social interaction and will be severely inhibited by a change in pattern (APA, 2013). In addition to symptoms listed above, children with ASD have been noted to have a tendency towards impulsivity and inattention, as well having issues with co-operation, assertion, and self-control (Macintosh & Dissanayake, 2006; Matson, Worley, Neal, Mahan, & Fodstad, 2010).

Considering the abnormal social behaviors associated with ASD together with the social implications of many physical activities, it is not surprising to find that children with ASD are less physically active than their typically-developing peers (Healy, Haegele, Grenier, & Garcia, 2017; Pan & Frey, 2006; Stanish, Curtin, Must, Phillips, Maslin, & Bandini, 2017). Children with ASD have been found to become significantly less active after elementary school age (Pan & Frey, 2006). There is a gap in research as to whether this drop-in activity level is due a lack of available programming, financial barriers, behavioral barriers, or other factors (Jones et al., 2017). Considering the known health conditions in the nonclinical population associated with insufficient PA, it is likely the ASD population is at risk for the same health conditions considering the lack of PA in this group.

Standard management of ASD is typically focused on a therapeutic intervention directed towards addressing the individual’s abnormal social behavior. Each case of ASD, however, varies and requires the collaboration of providers and parents to create a plan of action for the individual with ASD (National Autism Center, 2015). According to the National Standards Project, a national project that sought to use evidence-based guidelines to analyze the efficacy of interventions for ASD, there are 14 established interventions that are effective and used frequently for individuals with the ASD under the age of 22. Some of the key interventions
include cognitive behavior, parent training, social skills package etc. Interestingly, none of these interventions included any mention of physical activity (National Autism Center, 2015).

While behavioral interventions are usually used initially to manage ASD, a medical professional may also prescribe medication depending on the severity of the symptoms. The purpose of prescription medication in the case of ASD is usually to prevent self-injury or to attempt to bring an individual to the functional level that he/she could benefit from a therapeutic intervention (Myers & Johnson, 2007). The most commonly prescribed medications are serotonin reuptake inhibitors (SSRIs), stimulants, and anticonvulsants. (Myers et al., 2007). Again, however, physical activity is not mentioned in the standard protocol for management of ASD.

Recent studies have led researchers to believe, however, that PA may have the potential to lessen the occurrence of certain symptoms associated with ASD. (Tan, 2011; Pan, Tsai, & Hsieh, 2011). For example, exercise has been shown to improve the attention span of individuals with ASD (Tan, 2011). In addition, social initiation as well as interaction with both TD adults and peers also appeared to be positively associated with PA (Pan, Tsai, & Hsieh, 2011). This same effect on socialization in children with ASD was seen in a study engaging children with ASD in therapeutic horseback riding (Bass, Duchowny, Llabre, 2009). In addition, PA has been associated with a decline in the occurrence of repetitive behaviors (Anderson-Hanley, Tureck, & Schneiderman, 2011). While further research is needed to draw conclusions on the effect of PA on symptom severity in children with ASD, these preliminary studies indicate reason to further research this association.

Children diagnosed with ASD are, additionally, at an increased risk for being overweight (McCoy, Jakicic, & Gibbs, 2016). In a sample of children with ASD, 42% were either
overweight or obese (Lawson & Foster, 2016). From a similar study, results led researchers to estimate that children with ASD are at a 40% greater risk for being obese than are children without ASD (Curtin, Anderson, Must, & Bandini, 2010). Considering that children with ASD are both more prone to obesity and are less likely to be physically active, evidence based on the nonclinical population would suggest that increased PA could help lower the rate of obesity in individuals with ASD.

Regarding mental health, comorbid psychiatric conditions are incredibly prevalent in the ASD community; between 41% and 81% of individuals with ASD are estimated to have a comorbid psychiatric disorder (Buck et al., 2014; De Bruin, Ferdinand, Meester, De Nijs, & Verheij, 2007; Morgan, Roy, & Chance, 2003). Interestingly, however, the prevalence of these comorbid psychiatric disorders tends to decrease in adulthood (Lever & Geurts, 2016). Based on a collection of over 100,000 parent-reports, children with ASD were 38.9% likely to have either comorbid anxiety or depression, while TD children were only 4.2% likely to have either of these comorbid conditions (Gurney & McPheeters, 2006). Evidence of inverse relationships between PA and both depression and anxiety in the general population offer a compelling reason to further explore these relationships in ASD - a condition with a high rate of both comorbid anxiety and depression.

While PA has been shown to have a positive effect on both physical and mental health in the nonclinical population, there is a gap in literature regarding these relationships in the ASD population. Children with ASD, however, have been shown to be less active than their TD peers. Individuals with ASD have been reported to have a high occurrence of conditions/symptoms that are typically alleviated, to some extent, by PA in the nonclinical population. The purpose of this
study is to address the gap in literature addressing the relationship between ASD and symptom severity in individuals with ASD.

Method

Participants

Participants were recruited through the Vermont Family Network, an organization that supports Vermont families of children with special needs (http://www.vermontfamilynetwork.org). Specifically, families were solicited within this network who have children diagnosed with ASD between the ages of 6 and 18 years old. After expressing interest in the study, families were sent survey packets to their residential addresses (n=7).

Instruments

Data was collected via the completion of 3 forms by a family member of the child with ASD: an Autism Spectrum Rating Scale (ASRS), a Children’s Physical Activity Questionnaire (CPAQ), and demographics form. These forms took an estimated total of 16 minutes for completion: CPAQ – 10 minutes, ASRS 4 minutes, and Demographics Form – 2 minutes.

ASRS: The ASRS Parent Ratings Form (6-18) is a validated and reliable psychometric measure of severity of ASD in children ages 6-18 (ASRS, 2004; Simek & Wahlberg, 2010) This rating scale is a 71-item form measuring typical behaviors associated with ASD. From the data collected on the 71 items, the results are categorized into the Total Score, ASRS Scales, DSM-IV-TR Scale, and Treatment Scales. In this study, attention was focused on the ASRS Scales as well the ASRS Treatment Scales. The ASRS Scales (Social/Communication, Unusual Behaviors, Self-Regulation) measure the severity of symptoms associated with the clinical diagnosis of
ASD; the 8 ASRS Treatment Scales (Peer Socialization, Adult Socialization, Social/Emotional Reciprocity, Atypical Language, Stereotypy, Behavioral Rigidity, Sensory Sensitivity, and Attention) are then measures of symptoms typically targeted in treatment plans for individuals with ASD (Goldstein, & Naglieri, 2010).

These scales each have a raw score range that compares the subject to a distribution of normative samples, with the lowest end of the range representing somebody displaying a low occurrence of the respective symptom associated with ASD and the highest end of the range representing somebody with very elevated occurrence of the respective symptom associated with ASD (Goldstein, & Naglieri, 2010). The ASRS Scales are categorized as Social/Communication (Raw Score Range 0-76), Unusual Behaviors (Raw Score Range 0-96), and Self-Regulation (Raw Score Range 0-68), while the Treatment Scales are divided into Peer Socialization (Raw Score Range 0-36), Adult Socialization (Raw Score Range 0-24), Social/Emotional Reciprocity (Raw Score Range 0-52), Atypical Language (Raw Score Range 0-24), Stereotypy (Raw Score Range 0-20), Behavioral Rigidity (Raw Score Range 0-24), Sensory Sensitivity (Raw Score Range 0-24) and Attention (Raw Score Range 0-44). For each measure, as the raw score increases, the severity of the said symptom or characteristic is reported to be more prevalent (Goldstein & Naglieri, 2010). Scoring in the upper range indicates the individual demonstrates a very elevated incidence of this behavior while scoring in the lower range demonstrates a low incidence of this behavior.

**CPAQ:** The family members reported their child’s PA level by completing the CPAQ – the Children’s Physical Activity Questionnaire (Crocker, Bailey, Faulkner, Kowalski & McGrath, 1997). This questionnaire is a validated retrospective questionnaire assessing the
child’s total time spent engaged in PA over the past seven days – encompassing sports activities, leisure time activities, activities at school, and other miscellaneous daily tasks (Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012). The CPAQ has also been shown to be valid measure of moderate and vigorous PA in children (Corder et al., 2009).

**Demographics Form:** To gain a sense of the background of the child with ASD, the parent answered some basic demographic-related questions regarding his/her child. These questions were included to assess any potential confounding influences between demographics, PA level and/or symptom severity. Because the literature states that a child’s home environment and parental involvement impacts his or her PA level (Garriguet, Colley, & Bushnik, 2017; Keeney, Schneider, & Carter, 2016; Trapp et al., 2012), variables were included pertaining to the home environment as well as to the parents’ demographics. While some included variables, such as socioeconomic statuses, have previously been linked to activity limitations (Zheng & George, 2012), other variables not yet linked to PA such as parents’ education level, parents’ marital status, etc. were included as well. These variables were selected in an effort to gain a sense of the demographic heterogeneity of the sample as well as to explore any novel trends that may appear between measured variables in this study. In addition, parents were asked to rate how prevalent certain barriers to physical activity were for their children; the barriers included were barriers reported to be frequently encountered by individuals with ASD: lack of access to physical education classes, lack of extracurricular programs, cost of extracurricular programs, limited motor functioning, low motivation, difficulty self-regulating, and difficulty with team sport interaction (Menear, Neumeier, 2015; Obrusnikova, & Cavalier, 2011; Ohrberg, 2013).
Procedure

Following approval of the University of Vermont Institutional Review Board, participants were solicited with the support of the Vermont Family Network (VFN). A letter was posted on the VFN listserv of families who have children with Autism Spectrum Disorder, explaining the study and soliciting interest. Envelopes containing a pre-addressed return envelope, coded demographics form, coded CPAQ, and coded ASRS – coded to de-identify the participants – were addressed and sent to the families; addresses were then discarded to remove any chance of the study results being associated with the names of the respective participants.

Implied consent was obtained by voluntary return of the envelope, a process explained in a cover letter sent to the families with the packet of forms. Families returned their completed forms in the pre-addressed return envelopes, and the results were analyzed upon receipt of the forms.

Data Analysis

The mean and standard deviation for each variable were calculated within each data set. In addition, a simple correlational analyses was run, calculating the correlational coefficients between the 3 severity and 8 treatment scales of the ASRS to CPAQ results. An alpha level of significance was set at $p \leq 0.05$ a priori.

Results

Overall, 3 parents of the 7 who initially expressed interest returned the forms reporting on their children with ASD. The average age of the subjects ranged between 12 and 13 years old, with two being female and one being male. All subjects were reported as identifying as white,
attending public schools, and having access to early intervention services. While one subject was reported as being diagnosed with ASD Level II - requiring substantial support - the other two subjects were reported as being ASD Level I - requiring support. (See Table 1a/b)

Of the barriers reported, difficulty with team sport interaction (Mean: 3.00 ±0.00) was reported to be very hindering barrier for all three subjects. Self-monitoring (Mean: 2.67 ±0.58) as well as limited motor functioning (Mean: 2.33 ±0.58) were unanimously reported as barriers to PA for these children with ASD. Also noteworthy was that, for every participant, aside from cost of extracurricular programs, barriers of some sort were encountered. Lack of extracurricular curricular programs was reported across the range of subjects to be a barrier occasionally encountered (Mean: 2.00 (±0.00). (See Table 2)

Of the ASRS Scales – Social/Communication, Unusual Behaviors, and Self-Regulation – the subjects scored above average in Unusual Behaviors (Mean: 49.67 ±17.01) in comparison to a distribution of normative samples (Goldstein, & Naglieri, 2010). In addition, of the ASRS Treatment Scales, Stereotypy (Mean: 9.67 (±26.67), Behavioral Rigidity (Mean: 19.67 ±26.67) as well as Peer Socialization (Mean: 20.00 ±9.64) were reported to be above average for these three subjects. Social/Emotional Reciprocity (Mean: 18.33 ±26.67) and Attention (Mean: 25.00 ±26.67) were reported with average prevalence in our sample in comparison to a distribution of normative samples (Goldstein, & Naglieri, 2010). (See Table 3 a/b)

Overall, participants averaged 20 minutes of sport-related activity and about 4 hours of leisure-time activity over the course of 7 days. The participants averaged over 53 hours of sedentary activity the course of the week. Participants who demonstrated more severe symptoms of ASD demonstrated less time spent engaging in PA and increased time spent being sedentary. (See Table 4)
Strong trends were seen between both the ASRS Scales and ASRS Treatment Scales of ASD and time spent in leisure-time PA. Regarding each of the three ASRS Scales, there was a moderate inverse association between time spent in leisure activity and severity of the symptoms. In addition, nearly every subscale had a strong positive trend with sedentary activity over the last seven days, indicating that with increased time spent in sedentary activity, the presence of these subscale behaviors increased. (See Table 5a/b).

**Discussion**

PA has widely been reported to have a positive impact on overall physical and mental health (American Heart Association, 2013; Ely et al., 2017; American Psychiatric Association, 2013). Yet, individuals with ASD tend to demonstrate both a lack of PA as well as an elevated incidence of comorbid psychiatric conditions (Stanish, Curtin, Must, Phillips, Maslin, & Bandini, 2017; Buck et al., 2014). There is, however, a gap in the literature examining the impact of PA on symptom severity in individuals with ASD (Chen et al., 2016; Jones et. al, 2017). The purpose of this study was to examine the impact of PA on symptom severity in individuals with ASD.

Within this pilot study, parents consistently reported their children experiencing barriers to PA, indicating that barriers are prevalent for individuals with ASD. There is a lack of clarity in the literature as to whether the low levels of PA seen in ASD are due to internal or external barriers (Jones et. al, 2017). Because the most commonly reported barrier was difficulty with team interaction, offering alternative means of PA may be of benefit to this group, particularly considering that lack of participation in a physical education class was reported as a barrier for two of the three subjects. In addition, as limited motor functioning was a barrier for all of the
subjects as well, access to an adaptive sports or adaptive sports equipment could be of benefit to this population. In addition, the further examination of the impact of these programs is supported by the fact that each subject was reported to have faced a barrier to physical activity in the way that there was a lack of extracurricular programming. Again, further research is needed to establish a presence of certain barriers in an effort to establish the best plan of action.

The children in this study presented with the same symptoms consistently reported to be associated with ASD (American Psychiatric Association, 2013); regarding the ASRS Scales (Social/Communication, Unusual Behaviors, Self-Regulation) measuring the symptoms associated with the diagnostic criteria in ASD, the subjects ranked having anywhere from average to very elevated presence of these symptoms (Goldstein, & Naglieri, 2010). In Social/Communication, being that two subjects ranked as being average, and one being very elevated, a lack of heterogeneity was seen. Contrarily, for Unusual Behaviors, there was a variance within the data, with one subject ranking as slightly elevated, another as elevated, and the third as very elevated (Goldstein, & Naglieri, 2010). Similarly, there was a variance in the data when looking at the distribution of Self-Regulation; one subject rated as having an average prevalence of this symptom, while another was slightly elevated and the third was very elevated (Goldstein, & Naglieri, 2010).

The subjects were also reported to demonstrate Stereotypy (repetitive behaviors) something that research has preliminarily shown to be reduced with PA (Anderson-Hanley, Tureck, & Schneiderman, 2011). While two subjects rated as average in comparison to normative samples, the other ranked as above average (Goldstein, & Naglieri, 2010). Looking at Attention, the subjects were distributed in the same manner in comparison to the normative
distribution (Goldstein, & Naglieri, 2010). In general, this data indicates that these subjects demonstrate the typical symptoms seen in individuals with ASD.

The results seen in this sample do follow the current findings that individuals with ASD demonstrate a low rate of PA (Healy, Haegele, Grenier, & Garcia, 2017; Pan & Frey, 2006; Stanish, Curtin, Must, Phillips, Maslin, & Bandini, 2017). While it is recommended that youth engage in 60 minutes of moderate to vigorous intensity level PA per day (WHO, 2017), the average PA level – including both sport and leisure time PA – met each day was just over a half an hour amongst the sample. Because the subjects follow this trend seen in the literature, there is continued reason to believe that a deficiency in PA levels is consistent in individuals with ASD.

As mentioned earlier, standard management of ASD focuses on therapeutic intervention and pharmacologic intervention (Myers & Johnson, 2007; National Autism Center, 2015); a protocol has yet to be established that prescribes PA as a means of management. The data collected within this study shows trends of increased activity and decreased presence of associated ASD symptoms within the ASRS Scales and Treatment Scales. (Table 5a/b). Because of the small sample size, a p-value was not included. While the data above does not necessarily prove significance (Table 5a/b), however, this data could represent an important role of PA in the standard management of ASD if it were to be replicated on a larger scale.

If these results were replicated in a larger sample, this could indicate that PA has the potential to serve as an adjunct to both pharmacologic and therapeutic intervention in the standard of care of ASD (Myers & Johnson, 2007; National Autism Center, 2015). In particular, if the moderate inverse association between Social/Communication skills and leisure time spent doing PA were to be replicated on a larger scale, this could implicate that PA could be used as an complement to not only some of the anxiety and depression medication normalizing their social
functioning, but also some of the therapeutic interventions that are meant to address abnormal social behaviors. In addition, if the moderate inverse association seen between Self-Regulation and leisure time spent in PA could be replicated on a larger scale, research may indicate that PA has the potential to complement standard of care for ASD.

In addition, a replication of the inverse relationship between the treatment scale, Stereotypy, and leisure time spent in PA would indicate the potential to use PA as a complement to both behavioral interventions and use of serotonin reuptake inhibitors. Similarly, a replication of this same association with Attention could be used to implement PA as a means of managing attention impairment as a complement to using stimulants. If PA does indeed have the influence to alleviate some of these symptoms in ASD, approaches to ASD management could be begin to transition towards lifestyle choices as opposed to medication.

**Conclusion**

Key findings from this study indicate that there is reason to further research the relationship between PA and symptom severity in children with ASD. While this study was a small pilot study and therefore unable to conclude significance, the findings do indicate general trends that should be further examined. In particular, strong associations existed between time spent in leisure time physical activity and both the ASRS Scales as well as ASRS Treatment ratings. If these associations were found on a larger scale, implications could be the prescription of PA as a means of management for ASD.

Limitations of this study, however, include a small sample size, as well as homogeneity of the sample. Future studies should continue to examine this relationship between PA and symptom severity in individuals with ASD by gathering a larger sample size as well as increased
homogeneity within the sample. By attaining a large, representative sample of the ASD population, further research can be pursued to determine if the trends seen within this study are significant.

Overall, these study subjects were consistent within the literature in that they were engaged in a low amount of PA (Healy, Haegele, Grenier, & Garcia, 2017; Pan & Frey, 2006; Stanish, Curtin, Must, Phillips, Maslin, & Bandini, 2017). Because this pilot study showed strong associations between this time spent in leisure time PA and severity of ASD symptoms, and strong positive associations between this time spent in sedentary activity and severity of ASD symptoms, further research should continue to examine this association in a larger, more heterogeneous sample. If the inverse association between PA and presence of ASD symptoms is to be shown on a larger scale, next steps include examining the efficacy of PA as an intervention in individuals with ASD. Future research should include an intervention study examining different treatment groups. If this data were replicated in the youth population, next steps would then be to examine the association between PA and symptom severity in adults with ASD.
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Appendix

Table 1a
Demographics

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Age</th>
<th>Gender</th>
<th>DSM-5 Severity Level</th>
<th>School</th>
<th>Access to Early Intervention Services</th>
<th>Both Parents/Guardians Living in Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>13</td>
<td>Female</td>
<td>I</td>
<td>Public</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>104</td>
<td>13</td>
<td>Female</td>
<td>I</td>
<td>Public</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>107</td>
<td>12</td>
<td>Male</td>
<td>II</td>
<td>Public</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Note:
Regarding DSM-5 Severity Level- I: requires support; II: requires substantial support; III: requires very substantial support

Table 1b
Demographics

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Highest Level of Education Attained by Mother</th>
<th>Highest Level of Education Attained by Father</th>
<th>Annual Household Income ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>Bachelor’s Degree</td>
<td>Bachelor’s Degree</td>
<td>100,000+</td>
</tr>
<tr>
<td>104</td>
<td>Bachelor’s Degree</td>
<td>Bachelor’s Degree</td>
<td>100,000+</td>
</tr>
<tr>
<td>107</td>
<td>High School</td>
<td>High School</td>
<td>25,000 – 50,000</td>
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</tbody>
</table>
Table 2

Barriers to PA

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Lack of Physical Education Classes</th>
<th>Lack of Extracurricular Programs</th>
<th>Cost of Extracurricular Programs</th>
<th>Limited Motor Functioning</th>
<th>Low Motivation</th>
<th>Difficulty with Team Sport</th>
<th>Difficulty Self-Monitoring</th>
<th>Difficulty Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>104</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>107</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mean</td>
<td>2 (±1.00)</td>
<td>2.00 (±0.00)</td>
<td>1.33 (±0.58)</td>
<td>(±0.58)</td>
<td>(±0.00)</td>
<td>(±0.58)</td>
<td>3 (±0.00)</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1: No barrier; 2: Barrier occasionally encountered; 3: Barrier very hindering
Table 3a

**ASRS Raw Scores**

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Social/Communication (SC)</th>
<th>Unusual Behaviors (UB)</th>
<th>Self-Regulation (SR)</th>
<th>DSM-5 Scale (DSM)</th>
<th>Peer Socialization (PS)</th>
<th>Adult Socialization (AS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>8</td>
<td>37</td>
<td>31</td>
<td>22</td>
<td>13</td>
<td>8</td>
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<td>104</td>
<td>17</td>
<td>43</td>
<td>34</td>
<td>61</td>
<td>16</td>
<td>10</td>
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<tr>
<td>107</td>
<td>13</td>
<td>69</td>
<td>57</td>
<td>120</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>Mean</td>
<td>27.67 (±26.67)</td>
<td>(±17.01)</td>
<td>(±14.22)</td>
<td>(±49.34)</td>
<td>(±9.64)</td>
<td>(±4.73)</td>
</tr>
</tbody>
</table>

Table 3b

**ASRS Raw Scores**

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Social/Emotional Reciprocity (SER)</th>
<th>Atypical Language (AL)</th>
<th>Stereotypy (ST)</th>
<th>Behavioral Rigidity (BR)</th>
<th>Sensory Sensitivity (SS)</th>
<th>Attention (AT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>7</td>
<td>10</td>
<td>8</td>
<td>14</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>104</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>19</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>107</td>
<td>37</td>
<td>17</td>
<td>15</td>
<td>26</td>
<td>12</td>
<td>40</td>
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<tr>
<td>Mean</td>
<td>18.33 (±16.29)</td>
<td>(±3.79)</td>
<td>(±4.73)</td>
<td>(±6.03)</td>
<td>(±3.51)</td>
<td>(±13.23)</td>
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</table>
Table 4

*CPAQ Results*

<table>
<thead>
<tr>
<th>Subject #</th>
<th>Sports Activities Over Last 7 Days (total min.)</th>
<th>Leisure PA Over Last 7 Days (total min.)</th>
<th>Sedentary Activity Over Last 7 Days (total min.)</th>
<th>Sedentary Activity Over Last 7 Days (total hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>60</td>
<td>180</td>
<td>2475</td>
<td>41.25</td>
</tr>
<tr>
<td>104</td>
<td>0</td>
<td>465</td>
<td>2295</td>
<td>38.25</td>
</tr>
<tr>
<td>107</td>
<td>0</td>
<td>65</td>
<td>4845</td>
<td>80.75</td>
</tr>
<tr>
<td>Mean</td>
<td>20.00 (±34.64)</td>
<td>236.67 (±205.93)</td>
<td>3205.00 (±1423.13)</td>
<td>53.42 (±23.72)</td>
</tr>
</tbody>
</table>
Table 5a

*Correlations: CPAQ Results to ASRS T-Scores*

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leisure PA Over Last 7 Days (total min.)</td>
<td>-0.5822</td>
<td>-0.6378</td>
<td>-0.5976</td>
<td>-0.6108</td>
<td>0.6221</td>
<td>-0.6378</td>
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<tr>
<td>Sedentary Activity Over Last 7 Days (total min.)</td>
<td>0.9693</td>
<td>0.9842</td>
<td>0.9738</td>
<td>0.9774</td>
<td>0.0296</td>
<td>0.9842</td>
</tr>
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</table>

Table 5b

*Correlations: CPAQ Results to ASRS T-Scores*

<table>
<thead>
<tr>
<th>Physical Activity Measure</th>
<th>Atypical Language (AL)</th>
<th>Stereotypy (ST)</th>
<th>Behavioral Rigidity (BR)</th>
<th>Sensory Sensitivity (SS)</th>
<th>Attention (AT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leisure PA Over Last 7 Days (total min.)</td>
<td>-0.6378</td>
<td>-0.8591</td>
<td>-0.3215</td>
<td>-0.3572</td>
<td>-0.6009</td>
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<tr>
<td>Sedentary Activity Over Last 7 Days (total min.)</td>
<td>0.9842</td>
<td>0.9866</td>
<td>0.8564</td>
<td>0.8754</td>
<td>0.9747</td>
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