AN ABSTRACT OF THE DISSERTATION OF

Kiley J. Tyler for the degree of Doctor of Philosophy in Kinesiology presented on July 27, 2016.

Title: Relations between Physical Fitness and School-Day Physical Activity Behavior in Children with Autism Spectrum Disorder.

Abstract approved:

Megan MacDonald, PhD

Background. Autism spectrum disorder (ASD) is characterized by impairments in social-communicative deficits and restricted and repetitive behaviors, interests, or activities (APA, 2013). While current estimates suggest 1 in 68 children are diagnosed with ASD, more alarming statistics indicate 1 in 50 school-aged children live with the disorder (Blumberg, Bramlett, Kogan, Schieve, & Jones, 2013). Recent empirical research indicates the amount of physical activity children between 9-17 years of age with ASD spend in physical activity is lower than typically developing peers (Tyler, MacDonald, & Menear, 2014) and sadly declines as children become older (MacDonald et al., 2011; Memari et al., 2013; Pan & Frey, 2006). While research indicates the importance of health-related physical fitness in relation to the physical activity behavior of children without disabilities (Chen, Welk, & Jones, 2014; Welk et al., 1999) research has yet to confirm this in children with ASD. In an effort to improve levels of physical activity behavior in children with ASD research would benefit from examining the relationship between health-related physical fitness and the amount of physical activity children with ASD spend in school-day physical activity. Whereas the majority of physical activity research reflects daily average levels of physical activity, this study is unique in that it investigated the children's physical activity in the context of the school-day. This was in hopes to support the need for school-based physical activity provisions specific to children with ASD (Pan et al., 2015). **Purpose.** Therefore, the purpose of this investigation was to examine relations between muscular strength and aerobic capacity and the amount of physical activity a sample of children, between 9-17 years of age diagnosed with ASD, accumulated in school. It was hypothesized that both aerobic capacity and muscular strength would have a significant positive association with the amount of school-day physical activity children with ASD accrued. **Methods.** Children with ASD between the 9-17 years of age (*N* = 48, M = 40, F = 8) participated in this cross-sectional descriptive study. Data analysis consisted of a multiple regression, which was used to understand the relationship between the amount of school-day physical activity accumulated (i.e., steps per minute accumulated over 4 days of wear time) and components of health-related physical fitness including aerobic capacity (i.e., distance in meters walked in 6 minutes), and muscular strength (i.e., upper body isometric strength measured through grip strength) and in children between 9-17 years of age diagnosed with ASD.

Results. Results indicated that the combination of age, gender, aerobic capacity and muscular strength explained 4.83 % of school-day physical activity, $R = 13.68$. Although a Pearson correlation demonstrated a non-significant relationship between aerobic capacity and school-day physical activity, the multiple regression analysis revealed a significant relationship between aerobic capacity and time spent in school-day physical activity *($B = 0.00$, $p = 0.02$)*. Other variables (i.e. age, gender and muscular strength) in the model did not demonstrate a significant relationship to school-day physical activity.

Conclusion. The health-related physical fitness components of aerobic capacity were found to be significantly associated with the amount of physical activity accumulated by children with ASD during school. While more research is needed in the examination of relations between school-day physical activity and health-related physical fitness in school-age children (i.e. 9-17 years of age) with ASD, this study provides an initial step forward in the identification of key physical activity determinants relevant to children diagnosed with ASD.

Relations between Physical Fitness and School-Day Physical Activity Behavior in Children with Autism Spectrum Disorder

By
Kiley J. Tyler

A DISSERTATION

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APPROVED:

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Kiley J. Tyler, Author

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1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social-communicative skills and restricted or repetitive behaviors and interests (American Psychiatric Association [APA], 2013). Current estimates indicate 1 in 68 children are diagnosed with ASD and that boys are 5 times more likely to be diagnosed when compared to girls (Center of Disease Control and Prevention [CDC], 2014). A recent national report indicated 1 in 50 school-aged children are diagnosed with ASD (Blumberg et al., 2013). The increased prevalence of school-aged children with ASD has prompted attention towards recognizing common behaviors distinctive to school-aged children with ASD so that appropriate supports can be identified and provided (Kuhlthau et al., 2010). Common behavioral characteristics of school-aged children with ASD include difficulties in understanding the feelings of others, lack of eye contact and verbal communication, presentation of stereotypical behaviors such as hand-flapping and spinning, low levels of motor skill performance and low levels of physical activity (Bandini et al., 2013; Lloyd, MacDonald, & Lord, 2013; Lord & Jones, 2010; MacDonald et al., 2011; Pan et al., 2014; 2015; 2016; Tyler et al., 2014). While prior research has thoroughly examined behavioral characteristics such as difficulties with communication and social-based behaviors in school-aged children with ASD (both diagnostic specific indicators of ASD), less attention has been spent investigating the characteristics associated with the physical inactivity of school-aged children with ASD.

Physical Activity

Physical activity is *any bodily movement produced by skeletal muscle resulting in a substantial increase over resting energy expenditure* (Casperson, Powell, & Christensen, 1985; Corbin et al., 2000; Shephard & Bouchard, 1994). Physical activity behavior is a multidimensional construct that serves as an umbrella term encompassing five sub-categories of physical activity: exercise, sport, leisure activities, dance and ‘others’ (Corbin et al., 2000). Physical activity can be described or identified by four primary dimensions including frequency, intensity, mode, and duration (Casperson et al., 1985; Corbin et al., 2000; Sallis & Saelens, 2000) which serve as a means of identifying and describing a person’s engagement in physical activity (Corbin et al., 2000).

It is well established that participation in physical activity provides numerous physical and psychosocial health-related benefits in school-aged children (Lange et al., 2010; Ortega et al., 2008). Physical health-related benefits include reduced risk for chronic conditions such as diabetes, high blood pressure, high cholesterol, cancer and obesity (Buchner, 2010; Jansen & LeBlanc, 2010; Johnson, 2009; Ortega, 2008). While the psychosocial benefits of engaging in physical activity for school-aged children range in nature, benefits often consist of improved social skills, academic performance, and on-task behaviors in school-aged children with ASD (Lange et al., 2010; Sorensen & Zarrett, 2014; Sowa & Muelenbroek, 2012). Ruiz et al. (2014) suggested that positive physical activity habits early in life are crucial for the current and future health of children. Although recent research has begun to describe the physical activity patterns of school-aged children with ASD more work is needed (MacDonald et al., 2011; Pan et al., 2015; Tyler et al., 2014). In respect to the physical activity patterns of typically developing children, research has indicated that by participating in 60 minutes of moderate to vigorous physical activity per day substantial health benefits can be attained (Physical Activity Guidelines Advisory Committee [PAGAC], 2008).

Children with ASD spend less time engaging in physical activity behavior when compared to peers without disabilities (Borremans, Rintala, & McCubbin, 2010; Tyler et al., 2014; Pan et al., 2016). While approximately 60- 73% of typically developing children meet the current physical activity recommendation of attaining at least 60 minutes of moderate to vigorous physical activity per day (PAGAC, 2008), only 37- 47% of children with ASD meet this recommendation (Pan et al, 2015; 2016). Research also indicates that physical activity participation in children between 9-17 years of age, with ASD, decreases with age (MacDonald et al., 2011). Improved understanding of the reduced levels of physical activity in children with ASD has prompted attention to support improving the physical activity behavior of children with ASD (Johnson, 2009; Srinvivasan, Pescateloo, & Bhat, 2014). Thus, identifying malleable factors associated with physical activity behavior in children with ASD could serve as an important first step to understand potential ways to improve physical activity behavior for this group. One such factor related to physical activity in school-age children is health-related physical fitness (Chen, Welk,

& Jones, 2014; Ortega et al., 2008; Welk, 1999).

Health-Related Physical Fitness

Health-related physical fitness (HRPF) has been established as a marker of physical health in children and adolescents with and without disabilities (Caspersen et al., 1985; Johnson, 2009; Ortega et al., 2008; Pate, 1988; Winnick & Short, 2005). Physical fitness consists of a set of attributes, which relate to a person's ability to engage or perform in physical activity (Corbin et al., 2000; U.S. Department of Health and Human Services; 1996). Representing a multidimensional and hierarchical construct, physical fitness encompasses two primary and independent facets: HRPF (i.e. body composition, aerobic fitness, flexibility, and muscular fitness) and skill-related physical fitness (i.e. agility, balance, coordination, power, speed and reaction time) (Corbin et al., 2000; Morrow et al., 2013; Ortega et al, 2008; Ruiz et al., 2014; Winnick & Short, 2005). While both HRPF and skill-related physical fitness components have been shown to contribute to the physical activity behavior of children with and without disabilities exploration pertaining to the relationship between HRPF and physical activity in children with disabilities is needed.

HRPF can function as a malleable, individual-level contributor to physical activity participation (Downs et al., 2013; Chen et al., 2014; Welk, 1999). Findings indicate that aerobic capacity, one component of HRPF can enable or hinder the physical activity of children without disabilities (Chen et al., 2014; Welk, 1999). In a study investigating the physical activity of children without disabilities (N = 1,103), findings indicated that good aerobic capacity was associated with increased likelihood of engaging in physical activity (Chen et al., 2014). In a similar study the physical activity of children between 9-18 years of age diagnosed with either ASD or Down syndrome (N = 71), was investigated through the provision of an adapted bicycle- training program. Findings indicated that when children who learned to ride a two-wheeled bicycle independently were compared to those who did not learn to ride, muscular leg strength and percentage of body fat appeared to be differential factors in the amount of bicycle riding the child engaged in (MacDonald et al., 2012). In combination, these studies suggest HRPF factors such as muscular strength, and aerobic capacity may be key determinants for children to engage in physical activity, including children with ASD (MacDonald et al., 2012). Further analysis examining how the HRPF components aerobic capacity and muscular strength relate to the amount of physical activity children with

ASD engage in was recently examined in a single study concerning Taiwanese adolescent males with ASD (Pan et al., 2016). While the study suggested that HRPF components relate to the physical activity of children diagnosed with ASD, exploration of this relationship in context to a specific physical activity environment reflecting a larger age range is warranted.

While 95% of U.S. children are enrolled in school, research indicates that the school environment is crucial in promoting and providing physical activity to children with and without disabilities (Centers for Disease Control and Prevention [CDC], 2013; Pate et al., 2006). Provided that children between 9-17 years of age spend a significant portion of their day at school (Pate et al., 2006), the analysis of school-day physical activity is crucial to examining relations between HRPF and physical activity. While an ample amount of research indicating the need for school-based physical activity provisions for children with ASD exist (Pan et al., 2015), the context in which physical activity has been investigated at large, reflects daily average levels of physical activity across multiple environments. For example, Pan (2016) used daily average physical activity levels of male Taiwanese adolescent students diagnosed with (N = 35) and without ASD *(N = 35)* to study physical activity behavior. Findings indicated that HRPF demonstrated a significant, low to moderate correlation with the amount of moderate-to-vigorous physical activity (MVPA) engaged in (Pan et al., 2016). More specifically, aerobic capacity and muscular strength had low to moderate correlations with physical activity behavior. However, findings indicated that when physical activity was represented as percent time spent in MVPA, the relationship with muscular strength demonstrated significance, while the previous association found with aerobic capacity was found not to be significant (Pan et al., 2016). These findings suggest that HRPF could serve as a malleable factor relating to the physical activity behavior of children with ASD. Although it is widely understood that schools play a crucial role in the provision of daily physical activity and in the establishment of healthy physical activity habits (Pate et al., 2006), the physical activity of children with ASD has yet to be investigated specific to the school-day environment. Research would benefit from examing relations between HRPF and school-day physical activity in children with ASD. Therefore, the purpose of this study was to examine how muscular strength and aerobic capacity related to the amount of accumulated school-day physical activity in a sample of children with ASD between 9-17 years of age. Based on previous associations between

HRPF in typically developing children and in children diagnosed with ASD it was hypothesized that both aerobic capacity and muscular strength would have a significant positive association with the amount of school-day physical activity children with ASD accumulated.

2 Methods

Participants

Approval from the Institutional Review Board at Oregon State University was obtained for this study. Children diagnosed with ASD (*n* = 48) between the 9-17 years of age were recruited to participate from public and private non-profit schools and community programs in the greater urban Chicagoland area. Each participant had a previous diagnosis of ASD and was between 9-17 years of age. Parent/caregiver consent was obtained prior to child assent and any data collection procedures. In plain language, the procedures and information about the study were explained through the assent process to each participant, allowing for questions to be asked and answered. During this discussion, the participant was also informed, at an appropriate developmental level, that participation in the study was voluntary and that study participation could be withdrawn at any time. Finally, during the assent process, each child was asked to confirm participation in the study. Positive assent was indicated by either the participant signing their name or an ‘x’ on the IRB-approved assent form, verbally agreeing to participate, and/or through engagement with the materials used for assessment (e.g., toys, puzzles, or through conversation with the examiner).

Measurements

Aerobic Fitness Assessment. The Six Minute Walk Test (6MWT) is a valid and reliable means of assessment for children with disabilities (Elmahagoub et al., 2012). This test was used to assess the aerobic capacity of each participant individually. The 6MWT measures the distance a child walks for a total of 6 minutes over a 20-meter indoor visually-marked track. The tract was measured and marked by the study staff at each location on a hard, flat surface. The goal of the assessment was for the child to cover the most distance possible, in 6 minutes, by walking between/along the indoor visually-marked track. The child was allowed to self-pace and rest as needed. Before the assessment began, each child was provided with an initial developmentally-appropriate verbal explanation of the assessment, a visual demonstration and an opportunity to practice walking along the track. An example of the initial verbal explanation of the aerobic assessment is as follows:

"Hello (child's name), my name is (examiner's name), and today we are going to see how many times you can walk from this cone to that cone (each child was visually shown where and which cone) in 6 minutes' time. Six minutes is how long it takes to (each child was then provided a familiar example of something, by the attending community, school, or parental caregiver, in their day that took 6 minutes' time to complete). The goal (child's name) is to walk as fast as you can so you can cover as much distance as possible during the 6 minutes. Would you like to try it out? (If the child did not agree to participate, the community, school, or parental caregiver would then attempt to explain it to them. If then agreed to participate, the child participant would then begin their practice trial. However, if they did not agree to participate in the activity the assessment was omitted from the study procedures for that child and coded in the data accordingly). Great, lets get started!" (or) "No problem, we can move on to something else, how about..?"

Study staff and the parent/school-based caregiver provided continual verbal motivation while also serving as a pacing partner for the child over the course of the 6 minutes.

Strength Assessment. Upper body isometric strength (muscular strength) was measured using grip strength, which consisted of assessing maximum handgrip using a Jamar handgrip dynamometer with an adjustable grip (Milliken et al., 2008). Each participant's upper body muscular strength was measured in kilograms (kg) with the Jamar handgrip dynamometer and was based on the participant's maximum grip of the instrument using the dominant hand (Winnick & Short, 2005). Before the administration of the assessment, the examiner and parent/school-based caregiver provided a developmentally-appropriate verbal and visual explanation of the assessment while a practice trial was also provided. Each child was assessed individually at the approved testing site (e.g., safe, accessible, and familiar therapy/movement room in the school) by the examiner. The child stood upright on both feet and gripped the dynamometer in the dominant hand. The grip strength trial (1of 3 total trials) began when the child's arm of the hand holding the dynamometer was bent at 90 degrees of flexion and began squeezing the instrument. While continually gripping the dynamometer instrument with maximum force, the child straightened the arm to full elbow extension upon completion of the trial. At the end of each trial, the examiner recorded the amount of force in kilograms. The entire action was performed within a 3- to 5-second interval and was performed a total of three times with a 30-60 second break in between trials. Three separate trials were then averaged and used to indicate upper body isometric strength (Winnick & Short, 2005). Handgrip strength is a valid measure of upper body muscular strength in children (Milliken et al., 2008) and in children with disabilities (Winnick & Short, 2005).

School-Day Physical Activity Assessment. The Omron HJ-720ITC pocket pedometer (Omron Healthcare, Bannockburn, Illinois) was used as the primary measure of school-day physical activity to determine the overall time each child spent being active during school hours. The Omron HJ-720ITC is a user-friendly device (1 7/8' [w] x 2 7/8' [h] x 5/8' [d]) in dimension and weighs 1 ¼ oz. with the battery included). It can store up to 41 days' worth of step-count material and has a battery life of approximately 6 months. The Omron Health Management Software accompanies the pedometer and was used as a means of accessing steps taken by the user in a data, graph, and text format, which detailing how many steps were accumulated per hour of wear time (HealthCare, 2007).

Each child participant wore the monitor over the course of 4 school days for all hours of the school day (about 5.5 hours/day) for all activities except swimming and showering/bathing. The 4-day timeframe used for this study is common and used in other studies (e.g. Kim & Yun, 2009; Tudor-Locke et al., 2006),The monitor was worn on the right hip using a clip attached to the participant's waistband or around the waist using an elastic belt. School staff assisted each child participant in putting on the pedometer upon arrival to school and taking off the pedometer before the child left school, ensuring each child wore the pedometer for all hours of the school-day (i.e. 5.5 hours of wear-time), and that wear time reflected 4 consecutive school-days which coincided with the information documented on the child's physical activity log. The physical activity log was a simple word document filled out by each designated school staff person assigned to each child participant indicating when the pedometer was placed on the child and when it was removed. This provided the minutes/hours of pedometer wear-time. The pedometer is a valid and reliable means of assessing physical activity in school-age children with (Kim & Yun, 2009; Pan et al., 2015) and without disabilities (Eston et al., 1998; Tudor-Locke et al., 2006).

Procedures

Following the consent/assent process, each parent/caregiver of the child participant completed the demographic questionnaire. Standard information was completed within this demographic form, which included but was not limited to diagnosis of ASD, birthdate, medications used, age of parents when child was born, and parental level of education. The examiner met the child participant in an accessible 'therapy/movement room' located in one of the previously approved school or community-based recruitment sites. Each assessment session was held with the continual accompaniment of the parent/caregiver or school staff (i.e., school administrator, classroom teacher, and/or each child participant's personal school-aide), was conducted during school hours (typically 9am-3pm) and lasted approximately 45 minutes in length (approximately 15 minutes to review and confirm correct record of previously filled out consent/assent forms, approximately 15 minutes for physical fitness assessments, 15 minutes for the administration of pedometers). Generally, the participants partook in assessments in the following order: an upper body strength assessment, an aerobic capacity assessment, and the explanation and demonstration of the primary measure of physical activity, the pedometer. Each child participant was weighed with a scale so the participant's weight could be entered into the pedometer (e.g., 135 lbs.), along with the participant's stride length (i.e., the distance covered in meters by 10 steps) to ensure correct calibration of the unit before it was used. The pedometer, the primary physical activity measure, was then given to each child participant with the support of the personal school-aide; similar in nature to previous studies that measured the physical activity of children with and without ASD (e.g. Kim & Yun, 2009; Tudor-Locke et al., 2006).

Data Reduction

School-day physical activity behavior was collected using a primary objective measurement of physical activity in the form of a pedometer. The pedometer measured the number of steps accumulated during school hours over 4 consecutive school days and thus, used to reflect school-day physical activity.

School-day physical activity was then reduced to steps-per-minute (SPM), to represent the number of steps each child accumulated throughout the school day. Common in the measurement of school-day physical activity in children with ASD (Pan et al., 2014) the following sequential method was used: (1) obtain the number of steps accumulated per hour by downloading the pedometer data into the Omron Software system (e.g., 9am-10am, 1 hour of wear time, 823 steps), (2) sum the number of minutes the child wore the pedometer (e.g., 5.5 hours = 330 minutes of wear time for day 1 of 4), (3) divide the sum of steps for a day by the number of minutes monitored that day (i.e., 2410 steps/330 minutes), (4) the average daily (SPM) was calculated by averaging the daily SPM values (e.g.., # steps/day divided by #

minutes worn/day). Therefore, the average of each child participant's daily SPM served as the dependent variable throughout data analysis.

The health-related physical fitness (HRPF) components of muscular strength and aerobic capacity were reduced into continuous raw scores and served as independent variables in the final analysis. Muscular strength was measured in kilograms (kg) using a handheld dynamometer. Three trials represented three separate values of maximum handgrip force. All three values were then summed and averaged to represent the continuous raw score of muscular strength (Winnick & Short, 2014). Aerobic capacity was measured in meters through the use of the 6MWT. Meters walked was reduced to feet for data analysis. Thus, the continuous raw score of total feet walked in 6 minutes served as the continuous raw score for aerobic capacity.

Single Means Substitution was used to resolve missing values in each of the continuous primary variables of interest which included, number of steps accumulated in school-day physical activity, muscular strength, and aerobic capacity (Howell, 2010). The values used to substitute each missing value were derived from the mean of each variable (e.g., mean strength in kilograms), based on age (represented categorically) and by gender. The age groups as seen in Figure 1 were decided based on a categorical representation of age and gender; (9-11 years of age), (12-14 years of age), and (15-17 years of age) as used in a study pertaining to the physical activity of children with ASD conducted by Pan & Frey (2006).

Data Analysis

The relationship between the HRPF components, muscular strength and aerobic capacity, and the number of steps accumulated in school-day physical activity was examined using a series of analyses. A pearson product moment correlation was then conducted to examine initial relations of physical activity, muscular strength, aerobic capacity, age and gender. In addition, a multiple regression was used to further understand relations between both aerobic capacity and muscular strength with school-day physical activity. The test of eight assumptions was conducted (Laerd, 2015). The use of the Durbin-Watson statistical analysis verified the independence of observations. By visually analyzing a scatterplot representation of the data and partial regression plots a linear relationship between the DV and IV were found to exist. The homoscedasticity of residuals was found to be met through the analysis of a studentized residual and unstandardized predicted values plot. Multicollinearity was tested through the inspection of the Tolerance/VIF values while outliers, leverage, and influential points were inspected using casewise diagnostics, the studentized deleted residuals and Cook's Distance. A histogram with a superimposed normal curve was generated and residuals were found to be normally distributed. Data was analyzed using SPSS-21 for MAC.

3 Results

Children with ASD between 9-17 years of age (N = 48, M = 40, F = 8) participated in this cross-sectional descriptive study. Descriptive demographic information can be found in Table 1. Descriptive outcome information about dependent and independent variables can be found in Table 2.

Assumptions of linearity and independence of residuals were met through the examination of full and partial regression plots and through the verification of a Durbin-Watson statistic value of 1.776. Using the plot of studentized residuals versus unstandardized predicted values, homoscedasticity of the sample was confirmed, while the lack of multicollinearity was established by predictor tolerance values greater than a 0.1. Leverage values and those with a Cook's distance above 1 were not found in the remaining data. The assumption of normality was also met through the assessment of a histogram with a superimposed normal curve (Laerd, 2015), thus resulting in the final valid and reliable analysis of (N = 48; M = 40, F = 8) children between 9-17 years of age diagnosed with ASD.

Results derived from the correlation analysis indicated that aerobic capacity *($r = -0.37$, $p = 0.00$)* and muscular strength *($r = -0.53$, $p = 0.00$)* significantly decreased with age. However, muscular strength and aerobic capacity were correlated with the amount of school-day physical activity (Table 3).

The results of the multiple regression analysis revealed that the combination of age, gender, aerobic capacity and muscular strength explained 4.83 % of school-day physical activity, R = 13.68. The multiple regression analysis revealed a significant relationship between aerobic capacity and school-day physical activity *($b = 0.003$, $p = 0.02$)* existed when all other variables were considered. None of the other variables included in the multiple regression were significantly related to school-day physical activity (Table 4).

4 Tables & Figures

Table 1

Participant Demographics

Variable	N	M ± SD	%
Age (years)	48	13.1 ± 2.1	
Gender			
Male	40		83.3
Female	8		16.7
Maternal Education			
College	32		76.2
No College	16		23.8
Ethnicity			
Caucasian	29		60.4
Other	19		39.6
Other Disabilities			
Yes	25		63.3
No	23		36.7
Medication			
Yes	30		62.5
No	18		37.5
Income Bracket			
≥ $80,000/year	13		51.7
≤ $80,000/year	15		48.3
Missing values	20		

Note. M = Mean; SD = Standard Deviation. % = valid percent of participants included in analysis.

Table 2

Health-Related Physical Fitness and School-Day Physical Activity Participant Measures

School-aged children with ASD (N = 48; M = 40; F = 8)

Variable	M ± SD/Frequency	Min-Max
Strength (kg)	14.3 ± 7.56	1.6 – 34.0
Aerobic (ft)	1448.4 ± 438.36	500.0 – 2612.5
Total SPM	11.7 ± 3.81	3.9 – 24.0

Note. M = Mean; SD = Standard Deviation.

Table 3

Correlations for Health-Related Physical Fitness and School-day Physical Activity

Variables	Gender	Age	Strength	Aerobic	Phy. Activity
Gender		-0.15	-0.12	-0.23	-0.02
Age			-0.53**	-0.37**	-0.17
Strength				0.41**	-0.04
Aerobic					0.25

***. Correlation is significant at the 0.01 level (2-tailed).*

Table 4

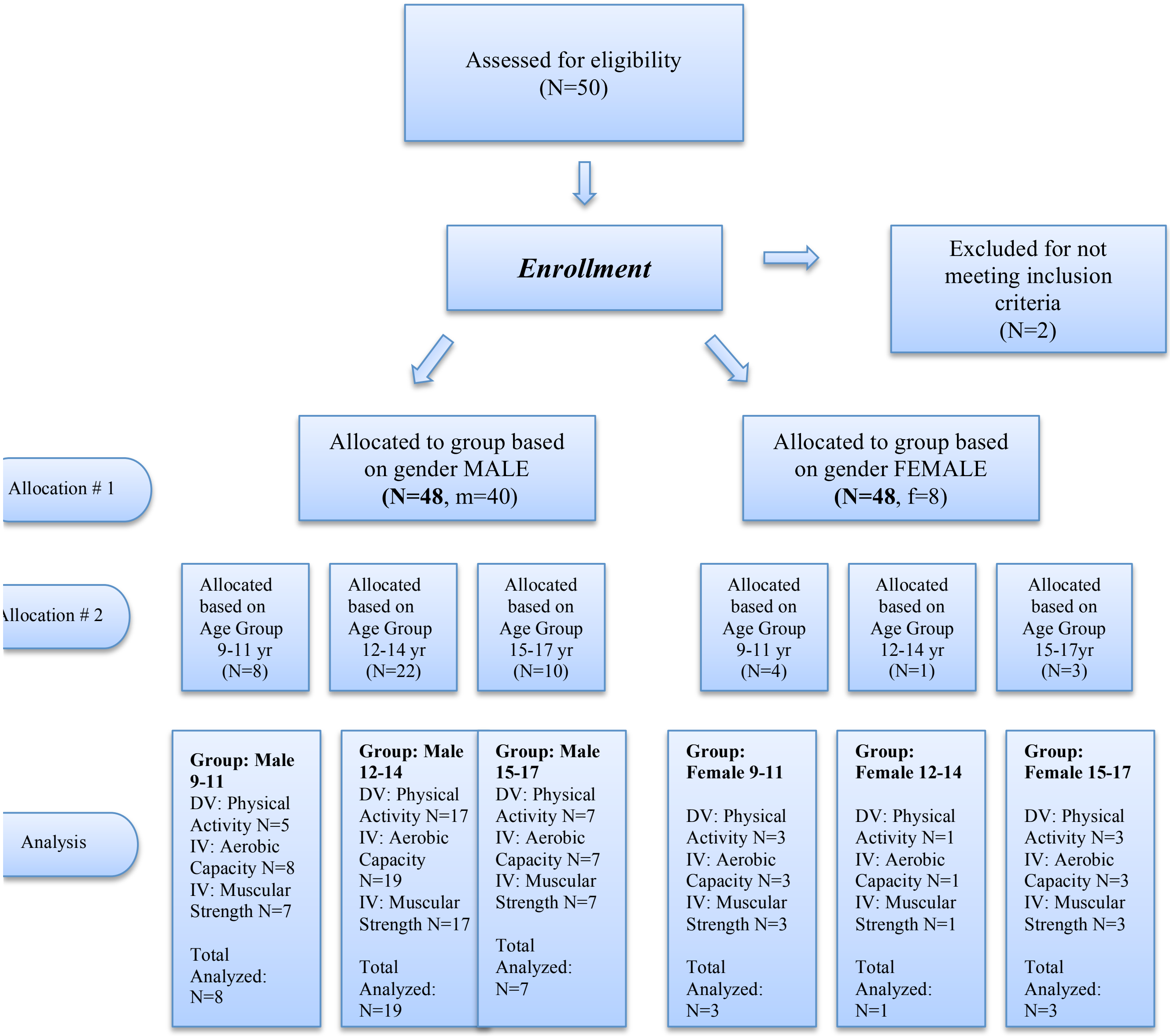
Multiple Regression of School-day Physical Activity Behavior (SPM)

Predictor Variable	*b*	*Significance*
Age (yr)	-0.50	0.08
Gender	0.11	0.93
Strength (kg)	-0.01	0.83
Aerobic (ft.)	0.00	0.02*

Note. *B* = unstandardized coefficient. *$p < 0.05$.

Figure 1

Missing values of IV and DV by age and gender



Note. *Missing values were resolved through Single Mean Substitution (Howell, 2010), derived by using the variable means of child's age in years (represented categorically) and gender (male and female).*

5 Discussion

This investigation was the first study to examine aerobic capacity and muscular strength in relation to school-day physical activity in children ages 9-17 years with ASD. While aerobic capacity was significantly and positively associated with the amount of steps children with ASD accumulated during the school day when age, gender and muscular strength were accounted for, muscular strength was not significantly related to school-day physical activity. Thus, the potential contribution of children aerobic capacity could have implications to improve school-day physical activity behavior.

Previous studies that examined relations between aerobic capacity and daily, average physical activity in children without disabilities found that aerobic capacity was an important factor in the amount of physical activity engaged in (Chen et al., 2014; Welk, 1999). It was found within this previous work that aerobic capacity could enable physical activity and that low levels of aerobic capacity decreased a child's likelihood of engaging in physical activity (Chen et al., 2014). Yet, it was unclear, whether or not children with disabilities were included within the study parameters. While other studies pertaining to children without disabilities, indicated that a weak to moderate association between aerobic capacity and physical activity existed (Kristensen et al., 2010), our study was the first to address this question in children with ASD as it pertained to school-day physical activity and considering other important variables (e..g, age, gender, muscular strength).

Surprisingly muscular strength was not associated with school-day physical activity accumulated by our sample of children with ASD. In another study, conducted by Pan et al., (2016), both muscular strength and aerobic capacity were significantly positively associated with the overall time adolescent males with ASD spent in physical activity. Yet, when physical activity was reduced to percent time spent in MVPA, versus overall being physical activity (e.g. light intensity), relations with aerobic capacity become non-significant while relations with muscular strength continued to demonstrate significance (Pan et al., 2016). Thus, muscular strength appeared to be the most significant HRPF componment, while our study indicated that aerobic capacity was the most salient HRPF component when compared to school-day physical activity accumulation. Although Pan's findings differed from the results of our study, variability may be due to several factors. One factor of importance is the means in which physical activity was measured. While both studies measured physical activity objectively, our study utilized pedometers while Pan et al., (2016) used accelerometers. Accelerometers measure physical activity across multiple dimensions of human movement. Given the irregular and sporadic nature of physical activity behavior in children, especially in children with ASD (e.g. jumping, climbing, and cycling, stereotypical behavior, etc.) the robust measure of physical activity via the accelerometer may have captured physical activity that was not captured with a pedometer.

Other factors that may have influenced the variability of results across studies, encompassing both children with and without disabilities, was the measure of physical activity in the school-day environment. In our study child participants wore the pedometers only during school hours. This was different from the common approach of measuring physical activity behavior in children over the course of an entire day (e.g. wearing the pedometers from when they wake-up till they go to sleep). Although our study provided physical activity measurement in a controlled environment, more physical activity behavior is known to occur beyond the school (e.g. home, park, soccer practice, etc.) Participant cohort characteristics, may be another contributing factor to differential findings, such as sample size, the presence of children with and without disabilities (e.g. diagnosis of ASD) and the wide age variability of participants across various study cohorts. Given the lack of published literature examining relations between HRPF and physical activity behavior in children with ASD, this study contributes to an existing gap in the literature and acknowledges relations between aspects of HRPF, namely aerobic capacity and the school-day physical activity behavior of children with ASD. This study also presents a unique approach to measuring physical activity in a specific environment such as the school, where children spend most of their day (Pate et al., 2006). The relevance examining HRPF in relation the school-day environment could potentially lend to the need for school-based physical activity provisions for children with ASD, and the focus of improving aerobic capacity to address school-day physical activity improvement.

Limitations notwithstanding, this study included a small sample size limiting the generalizability of the results. It was assumed that participants offered their maximum effort during the assessment process, yet, there was no measure to ensure this, so it is possible that some of the results were not representative of maximal effort. It was also assumed that each parent/caregiver were truthful and accurate when filling out the demographic form. Given the overall constraint for time, the severity of ASD and the level of gross and fine motor skill performance were not collected, potentially posing an additional limitation to this study. Provided the use of the pedometer to measure the amount of physical activity child participants engaged in across the school-day, reactivity (Bassett & Dinesh, 2010), and external and internal school-based factors (e.g. school-day schedule, district and school-level resources such as the contribution recess, physical education and/or classroom activity breaks) (Pan et al., 2015) could have posed an additional limitation.

6 Conclusion

Our findings from this investigation indicated that aerobic capacity was significantly associated with the school-day physical activity in children between 9-17 years of age, with ASD when age, gender and muscular strength were accounted for. While this study serves as one of the first to examine relations between HRPF components and physical activity in children with ASD, it is unique in that it specifies an environmental context, the school day, in which physical activity was measured. Research indicates children with ASD are in need of school-based physical activity resources (Pan et al., 2015). Concurrently, as are ideas and support staff to integrate resources and to ultimately improve physical activity behavior in all children with disabilities at the school level (Jenkinson et al., 2014). While more research is needed investigating relations between HRPF and the amount of school-day physical activity attained by children with ASD, this study provides an initial first step.

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APPENDIX

Appendix

Literature Review

Autism spectrum disorder. Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social-communicative skills and restricted or repetitive behaviors and interests (American Psychiatric Association [APA], 2013). ASD was first described 1943 in Leo Kanner's publication titled *Autistic disturbances of affective contact,* (Kanner, 1943) and in Hans Asperger's 1944 description of behavior patterns observed in boys (Asperger, 1944). However, a formal diagnostic criterion for ASD did not emerge until the publication of the Diagnostic and Statistic Manual of Mental Disorders, Third Edition in 1980 (APA, 1980). Common behavioral characteristics of ASD vary in nature and severity across the lifespan. In young children with ASD characteristics may consist of; abnormal eye gazing, lack of eye contact and adverse response to human engagement, abnormal tone or pitch while babbling, and feeding issues. As children with ASD age, behaviors can present in various forms including discomfort initiating and sustaining conversations, interest in repetitive movements, sounds, and/or sensory-based objects such as textures. Behaviors may also present as difficulty or awkwardness in posture, gait, and the performance of motor skills. ASD has undergone several transformations stimulated by an increase of knowledge about the disability.

Current estimates indicate 1 in 68 children are diagnosed with ASD and that boys are 5 times more likely to be diagnosed with ASD when compared to girls (Center of Disease Control and Prevention [CDC], 2014). In a recent national report of school-aged children findings indicated 1 in 50 were diagnosed with ASD (Blumberg et al., 2013). The rising prevalence of ASD is complex and while it is not yet known why rates are increasing at such an aggressive pace, the contrasting prevalence rates between school-aged children (e.g., 9-17 years of age) and children of all ages (e.g., 4-17 years of age) suggest the school environment provides ample opportunity to intervene. Given the robust social characteristics of the school environment, the school serves as an advantageous environment for interventions for school-aged children with ASD.

Discussions regarding the increasing prevalence have concentrated on shifts in the conceptualization of ASD (Lord, 2010), the rise in public awareness surrounding ASD, and improved diagnostic criteria and assessments (Rice et al., 2012). A recent review indicated the rising prevalence of ASD is partly influenced by the environment (i.e., prenatal and neonatal care [Schieve et al., 2014]), culture variations of social characteristics, and the varying research methodologies available for use (Matson & Kozlowski, 2011). Although genetic underpinnings have been clearly acknowledged, the specific cause(s) of ASD have yet to be confirmed. With increased awareness and attention, ASD has become more identifiable (Constantino & Charman, 2016). Although a child can be diagnosed as early as 2 years of age, current efforts are being made to administer ASD evaluations in children even younger (Christensen et al., 2016). The focus on early screening, diagnosis, and behavior-based intervention strategies directed toward children with ASD have more recently become a priority among government agencies, healthcare professionals, and educators alike. In support of early intervention, that which constitutes the provision of treatment before 3 years of age, initiatives such as *'Learn the signs. Act Early'* developed by the Centers for Disease Control and Prevention was launched in 2005. The purpose of this campaign, among others, was to raise awareness, educate, and provide tools for the early diagnosis of ASD (CDC, 2016). Thus, early intervention has been indicated as a priority in respect to identification and ultimately in respect to intervention. Unfortunately, less attention has gone towards identifying characteristics and interventions for school-aged children with ASD.

Co-occurring behaviors commonly found in school-aged children and adults diagnosed with ASD include aggression (Matson & Cervantes, 2014), anxiety, depression and obsessive-compulsive disorder (Mattila et al., 2010), impaired fine and gross motor skills (Lloyd, MacDonald, & Lord, 2013; Matson et al., 2011; Provost, Lopez, & Heimerl, 2007; Staples & Reid, 2010), intellectual disability, challenges with adaptive behavior (Matson et al., 2011; Rice, 2012), high levels of obesity (Curtin et al., 2010; Phillips et al., 2014), and poor physical activity behaviors (Bandini et al., 2013; MacDonald et al., 2011; Tyler et al., 2014). While motor proficiency of children with ASD has received recent attention (Lloyd et al., 2013; Lloyd et al., 2011; Pan, Tsai, & Chu, 2009; Staples et al., 2010), physical activity behavior has not.

Physical activity behavior in school-aged children with ASD. Physical activity is *any bodily movement produced by skeletal muscle resulting in a substantial increase over resting energy expenditure*

(Casperson, Powell, & Christensen, 1985; Shephard & Bouchard, 1994). Physical activity behavior is a multidimensional construct that serves as an umbrella term encompassing five sub-categories of physical activity: exercise, sport, leisure activities, dance and others (Corbin et al., 2000). Physical activity can be identified by four primary domains; frequency, intensity, mode, and duration (Casperson et al., 1985; Sallis & Saelens, 2000). These primary domains serve as a means of identifying and describing a person's engagement in physical activity.

When it comes to the physical activity behavior of children with ASD, disparities exist compared to peers without disabilities (Tyler et al., 2014). Approximately 60- 73% of typically developing children meet the current recommended physical activity guidelines of at least 60 minutes of moderate to vigorous physical activity a day (Physical Activity Guidelines Advisory Committee [PAGAC], 2008), while less than half of children with ASD meet this recommendation, about 37-47% (Pan et al, 2015; 2016). Research also indicates that physical activity participation in school-aged children with ASD significantly declines as children grow older (MacDonald et al., 2011). Understanding how to support the physical activity disparities of school-aged children with ASD is a topic of discussion (Johnson, 2009; Srinvivasan, Pescateloo, & Bhat, 2014).

Physical activity promotion. Although the environment plays a role in respect to promoting physical activity behavior, less attention has been devoted to individual level characteristics such as health-related physical fitness (Belton, O'Brien, Meegan, Woods, & Issartel, 2014; Downs et al., 2013). A variety of theoretical frameworks have been used to promote the physical activity behavior of children (Arim, Findlay, & Kohen, 2012; Bauman et al., 2002; Brown et al., 2013; Sallis, Prochaska, & Taylor, 2000; Shields et al., 2012; Welk & Schaben, 2004). Commonalities amid these various theoretical frameworks include the use of a social-ecological perspective (Bronfenbrenner, 1979). One such model, which encompasses the social-ecological perspective, is the Youth Physical Activity Promotion (YPAP) model (Welk, 1999). The YPAP identifies modifiable factors that enable or hinder physical activity behavior in children by taking into account their developmental, psychological, and behavioral characteristics (Downs et al., 2013; Welk, 1999). The YPAP model accounts for the unique individual and environmental level factors that help shape physical activity behavior in children (Belton et al., 2014; Downs et al., 2013;

Heitzler et al., 2010; Welk, 1999; Wenthe, Janz, & Levy, 2009; Welk, 1999). The YPAP embraces a multi-theoretical approach by incorporating perspectives from the Social-Cognitive Theory (Bandura 1986; 2004), the Theory of Planned Behavior (Ajzen, 1991; Ajzen & Madden, 1986), and the Theory of Reasoned Action (Fishbein, 1979). Individual and environmental variables are organized into a social-ecological framework, a recommended means of examining mechanisms of physical activity behavior (Ravesloot et al., 2011; Sallis & Owen, 2000; Glanz, Rimmer, & Viswanatha, 2008), via the Precede-Proceed Health Promotion Planning Model (Green & Kreuter, 1991). The YPAP employs the Precede-Proceed Health Promotion Planning Model by applying a three-tiered organizational framework; (1) utilizing a primary influential variable of a behavior such as physical fitness (2), classifying influential variables (based on the importance and potential for change) into factors that either predispose, enable or reinforce the behavior in question and by (3), providing directional pathways for the promotion or analysis in question (Welk, 1999). Within this study, the YPAP framework has been adopted to identify evidence-based, modifiable individual level factors that may enable school-day physical activity behavior in school-aged children with ASD. Enabling factors refer to variables that facilitate or allow the child to be physically active, and thus conclude health-related physical fitness (HRPF) components such as aerobic capacity qualify as such (Chen, Welk, & Jones, 2014; Welk, 1999).

The majority of physical activity research, using the YPAP framework, pertains to identifying environmental level factors, such as the positive enabling effects of family or parent (Downs et al., 2013; Silva, Lott, Mota, & Welk, 2014; Rowe et al., 2007; Wenthe et al., 2009) and peer support (Downs et al., 2013; Heitzler et al., 2010; Silva et al., 2014; Rowe et al., 2007) in promoting the physical activity behavior of children. What little research we have pertaining to relations between environmental level factors and the physical activity behavior of children with ASD (Obrusnikova & Cavalier, 2011; Pan et al., 2011), has helped construct interventions for improved physical activity behavior in school-aged children with ASD; such as the use of peer-mediated support in community-based exercise programs, (Obrusnikova & Cavalier, 2011; Pan, 2011; Stanish & Temple, 2012). In a study investigating the time children with ASD spend being physically active, findings indicated a structured, goal-directed environment and progressive instructional approach, in addition to a motivating pool environment, enabled children with ASD to engage in physically activity through swimming (Pan, 2011). The exploration of environmental factors (i.e., social, cultural, physical, and/or institutional factors directly or indirectly influencing the individual's behavior) for the purpose of identifying modifiable factors that can be used as a point of intervention has been shown valuable in improving the physical activity behavior of children with ASD.

Unfortunately, the reality of poor physical activity levels and the lack of physical activity promotional opportunities still exists for children with ASD (Matson & Konst, 2014; Mire et al., 2015). Less attention has focused on underlying individual level factors that influence the physical activity behavior of school-aged children with ASD (MacDonald et al., 2012; Pan et al., 2016; Sorensen & Zarrett, 2014). Identifying malleable individual level factors is an important first step towards addressing this concern. One such individual level factor is HRPF.

Health-related physical fitness. HRPF is recognized as a marker of health in children (Caspersen et al., 1985; Ortega et al., 2008; Pate, 1988; Winnick & Short, 2005), defined as a set of attributes, which allow a person to engage or perform in physical activity (Corbin et al., 2000; U.S. Department of Health and Human Services; 1996). HRPF consists of the following components: body composition (i.e. refers to the relative amount/percentage of bone, fat and muscle), aerobic fitness (aerobic capacity, power and endurance), flexibility (i.e. the ability to move a joint through complete range of motion), and muscular fitness (muscular strength and muscular endurance) (Morrow et al., 2013; Ortega et al, 2008; Ruiz et al., 2014; Winnick & Short, 2005). While it is known that engagement in habitual physical activity has an important effect on the attributes of HRPF in children (Ortega et al., 2008), what is less known is the existence of relations between HRPF and the amount of physical activity children between 9-17 years of age diagnosed with ASD accumulate during the time they spend at school.

Identifying components of HRPF related to physical activity behavior in children with ASD may help identify malleable factors that can ultimately be used to improve physical activity in school-aged children with ASD (Downs et al., 2013; Heitzler et al., 2010; Silva et al., 2014; Rowe et al., 2007). In a recent descriptive cross-sectional study children with ASD exhibited similar levels of body composition, flexibility, and aerobic capacity when compared to typically developing peer study participants (Tyler et al., 2014). Yet, in the same study, children with ASD were found to spend significantly less time in physical activity, while simultaneously presenting significantly lower levels of muscular strength (Tyler et al., 2014). In two similar investigations, findings revealed significant physical fitness deficits in all domains of HRPF (i.e. muscular strength, aerobic capacity and flexibility) in children with ASD compared to those without ASD (Borremans et al., 2010; Pan et al., 2014). Although some work has been done in this area inconsistencies exist, thus, further work is needed.

HRPF can function as a malleable, individual-level contributor to time spent in physical activity behavior; findings indicate that aerobic capacity can enable time spent in the physical activity of school-aged children (Chen et al., 2014; Welk, 1999). In a study investigating the time school-aged children without disabilities (*N* = 1,103) spent in physical activity, findings indicated that low levels of aerobic capacity decreased the likelihood of the time school-aged children spent engaging in physical activity (Chen et al., 2014). In a similar study investigating the physical activity behavior of school-aged children diagnosed with ASD and Down Syndrome (*N* = 71), through the provision of an adapted bicycle- training program, findings indicated that when children who learned to ride a two-wheeled bicycle independently were compared to those who did not learn to ride, muscular leg strength and height appeared to be differential factors (MacDonald et al., 2012). Thus suggesting, that while aerobic capacity has demonstrated importance in the physical activity of children without disabilities; muscular strength may be key in relation to the physical activity of children with ASD. A more recent study conducted by Pan et al. (2016), indicated that both aerobic capacity and muscular strength displayed a significantly positive association with the time adolescent males spent in physical activity. A study examining the relationship between physical activity behavior (i.e. intensity and duration) and HRPF (i.e., muscular strength, flexibility, cardiovascular fitness, and body mass index) in male Taiwanese adolescents with (*N* = 35) and without ASD *(N = 35)* was recently conducted (Pan et al., 2016). Study findings indicated a significant, low to moderate correlation between physical activity (i.e. counts per minute based on accelerometery) and individually measured HRPF components; aerobic capacity ($r = 0.34$, $p < 0.05$) and muscular strength ($r = 0.48$, $p < 0.01$) (Pan et al., 2016). However, findings also indicated that when physical activity was represented as percent time spent in MVPA, the relationship with muscular strength *($r = 0.42$, $p = 0.01$)* continued to demonstrate significance, while aerobic capacity *($r = 0.27$, $p = 0.12$)* did not (Pan et al., 2016). While these findings suggest that HRPF might potentially serve as a malleable factor on the physical activity behavior of school-aged children with ASD, further research is warranted. It is important first to explore relations between HRPF and physical activity in U.S. students, in the context of U.S. the time they spend at school. Thus, examining relations between aerobic capacity and muscular strength and the amount of physical activity children, between 9-17 years of age diagnosed with ASD, accumulate during their time spent at school is a an initial step towards understanding physical activity behavior in children with ASD as a whole.

In summary, while research has acknowledged the increasing prevalence of school-aged children diagnosed with ASD, attention pertaining to existing physical activity disparities is warranted. Less than half of school-aged children with ASD meet the recommended 60 minutes of MVPA/day (Pan et al., 2015). One successful avenue of providing physical activity promotional opportunities for children diagnosed with ASD is through the school, given that they spend the majority of their day at school however, more support is needed (Jenkinson et al., 2014; Matson & Konst, 2014; Mire et al., 2015). Research has demonstrated the importance of malleable environmental level factors (e.g. peer-mediated support, adapted sport equipment, inclusive lesson content) in improving the physical activity of school-aged children with ASD (Obrusnikova & Cavalier, 2011; Pan, 2011; Stanish & Temple, 2012). However, low levels of physical activity in school-aged children with ASD persist (Pan et al., 2015). In support of improved physical activity levels for children diagnosed with ASD the exploration of individual level factors, such as HRPF is considered (MacDonald et al., 2012; Pan et al., 2016; Sorensen & Zarrett, 2014). Previous studies concerning children without disabilities indicate that HRPF components such as aerobic capacity enable time spent in physical activity (Chen et al., 2014). However, less attention pertaining to relations between HRPF and time spent in physical activity has been provided to children between 9-17 years of age, diagnosed with ASD (Pan et al., 2016). Thus, the exploration of the HRPF components (i.e. aerobic capacity and muscular strength) in relation to the amount of physical activity children (i.e. 9-17 years of age) with ASD, accumulate during school is purposed as an initial first step in support of improved physical activity levels in children with ASD.

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Pedometer Reduction Table

Study ID	Date	Weekday	Start	End	Wear (hr)	Wear (min)	Steps/HR	Total Steps	Daily Avg. Steps	SPM/Day
	11-Apr	MONDAY	9:32am	2:36pm	5	300	279+1115+307+ 1080+379+538	3698		12.32666667
	12-Apr	TUESDAY	9:07am	2:29pm	5.5	330	680+145+529+6 94+91+61	2200		6.666666667
	13-Apr	WEDNESDAY	8:50am	1:27pm	4.5	270	591+881+1289+ 445+263	3469		12.84814815
	14-Apr	THURSDAY	8:44am	2:30pm	5.5	330	702+734+1023+ 847+218+234	3758		11.38787879
6								**13125**	**3281.25**	**10.80734007**

Missing Value Table

	MALE			FEMALE		
AGE GROUPS	**9-11 yr**	**12-14 yr**	**15-17 yr**	**9-11 yr**	**12-14 yr**	**15-17 yr**
STRGN	7 valid/1 miss	17 valid 6 miss	7 valid 3 miss	3 valid 0 miss	1 valid 0 miss	3 valid 1 miss
6MWT	8 valid/0 miss	19 valid 4 miss	7 valid 3 miss	3 valid 0 miss	1 valid 0 miss	3 valid 1 miss
PA (spm)	5 valid/3 miss	17 valid 6 miss	7 valid 3 miss	3 valid 0 miss	1 valid 0 miss	3 valid 1 miss
Total Missing	**N=8**	**N=23**	**N=10**	**N=4**	**N=1**	**N=3**

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CONSENT FORM

Project Title:	Relations between physical fitness and physical activity behavior in school-age children with Autism Spectrum Disorder
Principal Investigator:	Megan MacDonald
Student Researcher(s):	Kiley Tyler
Co-Investigator(s):	N/A
Sponsor:	Unfunded

1. WHAT IS THE PURPOSE OF THIS FORM?

This form contains information you will need to help you decide whether to be in this research study or not. Please read the form carefully and ask the study team member(s) questions about anything that is not clear.

2. WHY IS THIS RESEARCH STUDY BEING DONE?

The purpose of this study is to examine the association between physical fitness (strength and aerobic capacity) and physical activity behavior (intensity, duration and mode) in school-age children with ASD.

This study is for the completion of a dissertation.

Up to (N = 300) may be invited to take part in this study.

3. WHY AM I BEING INVITED TO TAKE PART IN THIS STUDY?

You and your child are being invited to take part in this study because you have indicated that you have a child diagnosed with Autism Spectrum Disorder between the ages of 9- 17 years old.

4. WHAT WILL HAPPEN IF I TAKE PART IN THIS RESEARCH STUDY?

Your participation in this research study is completely voluntary and you and your child can withdraw at any time. By participating in this study you be asked to fill out a demographic questionnaire and confirm that your child has been diagnosed with ASD and is between the ages of 9-17 years. You child will be asked to participate in the following assessments;

Storage and Future use of data or samples:
Information collected for this study is confidential and only members of the research team will have access to identifiable information. It is possible that the information that you and your child provide could be helpful for our future research. With your permission we would like to keep your information to use in the future for studies concerning such topics as children or physical activity.

______You may store information about me and my child for use in future studies.
Initials

______ You may not store information about me and my child for use in future studies.
Initials

Future contact: We may contact you in the future for another similar study. You may ask us to stop contacting you at any time.

Study Results: It is expected that results from this study will be shared at conferences and through scientific journals.

5. WHAT ARE THE RISKS AND POSSIBLE DISCOMFORTS OF THIS STUDY?

This study is expected to have no more than minimal risk to the participants. No more risks than typical scratches or bruises that children may experience in traditional play. Most of the assessments in this study have been standardized and are commonly administered to children.

6. WHAT HAPPENS IF I AM INJURED?

Oregon State University has no program to pay for research-related injuries. If you think that you have been injured as a result of being in this study, please contact your medical insurance provider and notify the research team of any injuries.

7. WHAT ARE THE BENEFITS OF THIS STUDY?

We do not know if you will benefit from being in this study.

8. WILL I BE PAID FOR BEING IN THIS STUDY?

You will not be paid for being in this research study.

9. WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

The only potential cost to you is the cost of traveling to the assessment site.

10. WHO WILL SEE THE INFORMATION I GIVE?

The information you provide during this research study will be kept confidential to the extent permitted by law. Research records will be stored securely and only researchers will have access to the records. Research records, including recordings and other identifiable data, will be kept indefinitely. Federal regulatory agencies and the Oregon State University Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. Some of these records could contain information that personally identifies you.

To help ensure confidentiality, we will keep any identifiable information about you and your child in a locked room in a locked file cabinet. Documents with your name or your child's name will be kept in a secured file (electronic documents) or locked in a file cabinet.

To further assure confidentiality you and your child will be assigned an identification number (ID number), which will be linked to the information that we get from you. Note this form will be kept separate from all other data collected.

Under Oregon law, all OSU employees are considered to be mandatory reporters. The researchers on this study are OSU employees and are required to report to the appropriate authorities any information concerning child abuse or neglect. The researchers may also report threats of harm to self or to others.

11. WHAT OTHER CHOICES DO I HAVE IF I DO NOT TAKE PART IN THIS STUDY?

Participation in this study is voluntary. If you decide to participate, you are free to withdraw at any time without penalty. You will not be treated differently if you decide to stop taking part in the study. If you choose to withdraw from this project before it ends, the researchers may keep information collected about you and this information may be included in study reports.

12. WHO DO I CONTACT IF I HAVE QUESTIONS?

If you have any questions about this research project, please contact: Megan MacDonald at 541-737-3273 or megan.macdonald@oregonstate.edu or Kiley Tyler 630-408-2444 or Kiley.Tyler@oregonstate.edu

If you have questions about your rights or welfare as a participant, please contact the Oregon State University Institutional Review Board (IRB) Office, at (541) 737-8008 or by email at IRB@oregonstate.edu

13. ASSENT STATEMENT

This research study has been explained to my child in my presence in language my child can understand. He/she has been encouraged to ask questions about the study now and at any time in the future.

14. WHAT DOES MY SIGNATURE ON THIS CONSENT FORM MEAN?

Your signature indicates that this study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Do not sign after the expiration date: 01/11/2017

Child participant's Name (printed): ____

Caregiver's phone number and email address (printed):

____

____ ___________________________________
(Signature Parent/Guardian/ Legally Authorized Representative) (Date)

______________________________________ ___________________________________
(Signature of Person Obtaining Consent) (Date)

College of Public Health and Human Sciences
School of Biological and Population Health Sciences
Oregon State University, 101 Milam Hall, Corvallis Oregon 97331
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ASSENT FORM

Project Title: Relations between physical fitness and physical activity behavior in school-age children with Autism Spectrum Disorder
Principal Investigator: Megan MacDonald
Student Researcher(s): Kiley Tyler
Co-Investigator(s): N/A
Sponsor: Unfunded

We are asking you whether you want to be in a research study. Research is a way to test new ideas and learn new things. You do not have to be in the study if you do not want to. You can say Yes or No. If you say yes now, you can change your mind later.

Ask questions if there is something that you do not understand. After all of your questions have been answered, you can decide if you want to be in this study or not.

This study is about the physical activity behavior of children like you.

We are asking you if you want to be in this study because you are between the ages of 9-17 years old.

If you take part in this study, we will ask you to come the assessment room and do some different activities with us. For example we will ask you to do some activities that you often do in Physical Education. For example, we will ask you to run and walk and show us how strong you are. We will also ask you to wear an activity monitor for four days. An activity monitor is a small computer, about the size of a stamp, and it tells us how often you are doing activities like walking and playing sports. We will also give you a special belt to wear the activity monitor with.

Some things that might happen to you if you are in this study are you could fall and get scratched or bruised. Like the scratches or bruises that you might get from physical education, like if you fall running. But, just like in physical education you'll be able to keep participating, so you can get up and keep running.

We will write a report when the study is over, but we will not use your name in the report.