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ORIGINAL ARTICLE

Psychosocial Correlates of Physical Activity Participation and Screen-Time in Typically Developing Children and Children on the Autism Spectrum

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Abstract

The correlates of physical activity and screen-time among children with autism spectrum disorder (ASD), and how these differ from typically developing (TD) children, remains largely unknown. Method: This study compared psychosocial factors associated with physical activity and screen-time between nine-year old children with ASD ($n = 55$) and TD children ($n = 55$). Variables of interest included self-concept, peer relationship problems, prosocial behaviors, and number of, and time spent, with friends. It was hypothesized that psychosocial correlates of health behaviors differ between children with and without ASD**.** Parents completed questionnaires assessing the child's physical activity, screen-time, and psychosocial characteristics. Regression analyses indicated that for measures of physical activity – hours of moderate to vigorous physical activity (MVPA), daily physical activity, and sports participation – males (TD and ASD) and TD children were more likely to participate, compared to females (TD and ASD) and children with ASD. There was a significant interaction between ASD diagnosis and bullying for light physical activity (LPA), with TD children who experienced bullying significantly more likely to engage in LPA compared to children with ASD who experienced bullying. For screen-time, a greater number of close friends and a lower parent rating of the child's level of prosocial behavior were significantly associated with greater hours of screen-time. Interventions aiming to increase physical activity among children with ASD need to take into account the associated psychosocial factors, and how they may differ from TD children.

Keywords Autism Spectrum disorder · Autism · Physical activity · Sedentary behavior · Health

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Introduction

Regular engagement in physical activity can help children maintain a healthy weight and decrease one's chances of developing chronic diseases (e.g., coronary heart disease, diabetes) throughout the lifespan (Centers for Disease Control and Prevention (CDC) 2014). Participation in physical activity may offer additional benefits to children with social, emotional, and behavioral disorders, such as Autism Spectrum Disorder (ASD) (Srinivasan et al. 2014). For example, among children with ASD, increased exercise can provide gains in social skills (Chu and Pan 2012), and decreases in stereotypical behaviors, hyperactivity, aggression, and self-injury (Oriel et al. 2011). Unfortunately, despite the benefits of physical activity, the majority of children with ASD do not participate in regular physical activity (Srinivasan et al. 2014). Although some research comparing physical activity levels between children with and without ASD reports similar levels of participation during childhood (e.g. among children aged 3 to 11 years; Bandini et al. 2013), differences are apparent at older ages, with children with ASD being less physically active (e.g. 13 to 21 years; Stanish et al. 2015; and, 13-year-olds: Healy et al. 2013). Barriers preventing increased physical activity are plentiful, including a lack of adults with the skills needed to include children with ASD, a lack of exercise partners, and exclusion from other children (Must et al. 2015).

The barriers – listed above – that correlate negatively with physical activity, unsurprisingly, correlate positively with increased screen-time. Research suggests individuals with ASD engage in more sedentary behavior – particularly screen-time – than their typically developing (TD) counterparts (Must et al. 2014; Chonchaiya et al. 2011). For example, Must et al. (2014) demonstrated children (aged 3 to 11 years) with ASD participated in an hour more of sedentary behaviors on weekdays compared to their TD counterparts, and the majority of this time was spent on screen-time activities. Similarly, in research by Chonchaiya et al. (2011) young children (aged 1.5 to 5 years) with ASD spent more time watching television than TD participants. In addition to being associated with higher rates of obesity (Kenney and Gortmaker 2017), screen-time may also contribute to sleep problems (Cain and Gradisar 2010), delayed language development (Christakis et al. 2009), and attention problems (Christakis et al. 2004). One hypothesis for this increase in screen-time behavior, among children with ASD, is the inclination for parents to utilize television and video games as a method of behavior management for the child with ASD (Matheson and Douglas 2017; Nally et al. 2000). This coincides with parents reports that children with ASD need too much supervision for physical activity participation (Must et al. 2015). It is also proposed that children with ASD may view screen-time as a less intimidating interaction platform, compared to physical activities (Matheson and Douglas 2017).

Due to the tremendous amount of physical and psychological benefits of participation in physical activity (CDC 2014), and the detrimental effects of sedentary behavior, particularly screen-time sedentariness (Tremblay et al. 2011), research examining the correlates associated with physical activity and screen-time engagement among children is of the utmost importance. The Youth Physical Activity Promotion (YPAP) model, which has a social-ecological perspective, provides a useful framework for understanding correlates of PA in children

(Welk 1999). Accordingly, correlates of PA in the model include psychological attributes, social influences, and environmental influences. Among TD children, the psychosocial characteristics of the YPAP model have received a lot of attention (Seabra et al. 2012; Strauss et al. 2001). Several psychosocial factors have been found to be associated with physical activity, including self-efficacy, perception of physical or sport competence (Dishman et al. 2005; Sallis et al. 2000; Trost et al. 1997; Van der Horst et al. 2007), the presence of peers (Beets et al. 2006; Salvy et al. 2012; Voorhees et al. 2005), perceived support from peers (Sawka et al. 2013; Voorhees et al. 2005; Zhang et al. 2012), and peer activity levels (Garcia et al. 2016a, b; Sirard et al. 2013). Research on the correlates of sedentary behavior for TD children – often represented by screen-time – is amassing also, but less conclusive. Reviews of the literature (e.g. Stierlin et al. 2015) identify several psychosocial factors associated with increased sedentary behavior, including scoring high on depressive symptoms, absence of social support, and TV-related parenting risk factors.

The psychosocial correlates of health behaviors among children with ASD are less understood. This was highlighted in a systematic review, by Jones et al. (2017), on the correlates of physical activity and sedentary behaviors in children with ASD. Jones and colleagues concluded that correlates of physical activity and sedentary behavior among children with ASD, and how these differ from TD children, remain largely unknown. Only age (negatively associated with physical activity) and sex (null association) were reported sufficiently across studies. Several child-related 'ASD specific' correlates were also examined for physical activity and sedentary behavior, including symptom severity, maladaptive behaviors, and medication use. Although not strongly associated with physical activity or sedentary behavior, it was concluded that they may be important correlates for intervention development. Family variables have also been examined, for both physical activity and sedentary behavior, including parental education, income, marital status, and family size, yet results are inconsistent (Jones et al. 2017). A range of psychosocial variables, deemed to be associated with physical activity and sedentary behavior among TD children, remain unexplored for children with ASD. Yet, due to the unique characteristics of ASD, the correlates for their health behaviors may differ. The relationship between psychosocial factors and health behavior preferences, choices, and opportunities may be moderated by the unique social, behavioral, or sensory characteristics associated with having a diagnosis of ASD. As an understanding of correlates of health behaviors may impact on intervention development, further investigation of additional correlates of physical activity among individuals with ASD is required (Jones et al. 2017).

Despite the information available on the correlates of physical activity and screen-time for children, little is known about the correlates of these behaviors for children with ASD. Additionally, research that compares health behaviors and psychosocial correlates of physical activity participation between TD children and children with ASD is sparse. The purpose of this research was to compare both health behaviors, and psychosocial correlates of health behaviors, between nine-year old children with and without ASD. It is hypothesized that psychosocial correlates of health behaviors – physical activity and screen-time – differ between children with and without ASD.

Methods

Participants and Data Collection

Data from the "Growing up in Ireland" (GUI) study, a nationally representative cohort study of children living in the Republic of Ireland, were used for this study. The GUI study aimed to examine the factors which contribute to or undermine the wellbeing of children in twenty-first Century Ireland (Murray et al. 2012).Wave 1 includes information on nine-year old children ($n = 8570$), collected in 2007/2008, from the children, their parents, and teachers. Data collection occurred during the school year (i.e Spring or Fall). Children were recruited through the national primary school system; 910 schools participated in the study, a response rate of 82%, with 52% of families agreeing to participate. Information on a broad range of factors effecting children's social, emotional, cognitive, and physical development was collected. A GUI interviewer was assigned to each child's home. A letter of introduction, and a phone call, were made prior to the interviewer's home visit. Interviews were recorded on a CAMPE (Computer Assisted Personal Device). Regarding data collection involving the child, the interviewer received training emphasizing the importance of establishing a good rapport, the power imbalance that may exist, and strategies to put the child at ease (for example asking them about their favorite activities) (Murray et al. 2012). The interviewer was instructed to explain a question when not understood by the respondent, but not to prompt an answer. For child-report questions, prompt cards were available with the available possible answers (Murray et al. 2012). Data collection was approved by the Health and Research Boards' research committee. For the technical report on the data set, including the conceptual framework and methodology, see Murray et al. (2012).

Measures

Demographic Measures

Participants were separated into two groups, depending on having a current ASD diagnosis or not. All children were 9 years old. To obtain an understanding of socioeconomic status (SES), parents/caregivers were asked to report their highest education level; a dichotomous variable was created based on whether the parent or caregiver received a college education or higher. In addition, the interviewer measured the weight and height of each child in the household. A Leicester portable height measure was used to record height to the nearest millimeters. A Class III medically approved scale – the SECA 761 flat mechanical scales – was used for recording weight to the nearest kilogram. These measurements allowed investigators to calculate body mass index (BMI) for each child. Children were classified as normal weight or overweight ($BMI \geq 19.46$ for boys, $BMI \geq 19.45$ for girls), according to the guidelines set by the International Obesity Taskforce (IOTF) cut-off points for boys and girls (Cole et al. 2000).

Health Behavior Measures

Physical activity was measured through parental report. The child's parent (mother, or lone father) was asked questions adapted from the leisure time exercise questionnaire (Godin and Shephard 1997). To assess moderate to vigorous physical activity (MVPA) participation, they were asked how many times, in the past 14 days, their child had done at least 20 min of hard exercise. Hard exercise was defined as exercise that made the child breathe heavily and their heart beat faster. Examples of playing football, jogging, and fast cycling were provided. A five-point scale consisted of: none, one to 2 days, three to 5 days, six to 8 days and nine or more days. To assess participation in LPA the parents were asked "How many times in the past 14 days has the Study Child done at least 20 minutes of light exercise that was not hard enough to make him/her breathe heavily and make his/her heart beat fast?" Examples provided included walking or slow cycling. For both questions participants were instructed to include time spent by the child in physical education. Parents responded using a five-point scale, ranging from 1 (none) to 5 (9 or more days). These measures were used in previous research (Cadogan et al. 2014), have demonstrated concurrent validity with measures of maximum oxygen intake (VO2 max) and muscular endurance (Godin et al. 1986), and have acceptable test-retest reliability (0.69 to 0.96) (Sallis et al. 1993). Finally, the teachers were asked about the "number of hours per week of physical education?" that the study child received, with response options of 1 h, 2 h, or 3 or more hours.

The children were also asked about their own physical activity participation over a one-week period: 'Over the past 7 days on how many days were you physically active for a total of at least 60 minutes per day?' The child responded on a scale of 0 (No days) to 7 (7 days). Finally, a question regarding sport participation, asked to the study child, was also included; the question asked 'How often do you play sport?' The child responded on a scale of 1 (never) to 4 (Almost every day).

Three variables relating to screen-time – television, computers, and videos games – were examined. It should be noted that 'term time' in the following questions refers to during the school year. The parents were asked (1) 'on a normal weekday during term time, how many hours does the Study Child spend watching television, videos or DVDs?' (2) 'on a normal weekday, during term-time, about how much time does the Study Child spend using the computer?' and (3) 'on a normal weekday, during term-time, about how much time does the Study Child spend playing video games such as, Playstation, X-box, Nintendo etc?'. Parents were reminded to include time spent engaged in screen-time before and after school, but not during school hours. Parents responded on a scale of 1 (none) to 6 (7 h or more). To create a total screen-time scale variable, the three screen-time variables (television, computer, and video games) were combined, resulting in a 18-point scale. A higher score on all variables reflects higher levels of screen time.

Psychosocial Factors

Multiple psychosocial factors were examined as potential correlates of physical activity and screen-time. First, three subscales, from the Piers-Harris Children's Self-Concept Scale, 2nd Edition (Piers and Herzberg 2002) were examined: (1) Freedom From Anxiety (a subscale of 14 items exploring a variety of feelings including fear,

unhappiness, nervousness, shyness and feeling left out of things) (; (2) Popularity (a subscale of 12 items exploring the Study Child's evaluation of his or her social functioning); and (3) Happiness and Satisfaction (a subscale of 10 items reflecting feelings of happiness and satisfaction with life). Each subscale demonstrates good internal consistency with cronbach's alpha levels of the above mentioned subscales equaling .81, .74, and .77 respectively, and moderate to high construct validity. The questionnaire was administered to the children, in their school, by a GUI interviewer. Scales are scored so that a higher score indicates a more positive self-evaluation in the domain being measured.

Two subscales of the Strengths and Difficulties Questionnaire (SDQ) (Goodman 1997) were included: (1) Peer relationship problems and (2) Prosocial behavior. Each subscale comprises five items. Respondents, the parents, were required to indicate their level of agreement with each item on a three-point scale of 'Certainly true', 'Somewhat true' or 'Not true'. Item scores vary from 0 to 2 depending on the type of endorsement. The SDQ demonstrates moderate to strong internal consistency reliability (0.59 to 0.82) for the parent report version of the instrument (Goodman 2001) and correlates highly with both the Rutter scales (Goodman 1997) and Child Behavior Checklist (Goodman and Scott 1999).

Additional factors were also included: The number of days per week in which the child did something with friends was transformed into a five-point scale variable, ranging from 1 (*never*) to 5 (*6–7 days per week*). The number of close friends that the child had was also included; this scale ranged from 1(*zero*) to 5 (*6 or more friends*). Both questions were parent reported, and based on questions asked in the National Longitudinal Survey of Youth and Children (Collins 2001). To assess negative social experiences, a parent-reported 'victim of bullying' variable was included as a dummy variable (1 = yes; 0 = no). The question was developed by the GUI study team.

Statistical Analysis

Independent t-tests were used to compare the differences in health behaviors (physical activity and screen-time) and psychosocial factors between children with ASD and TD children. Separate multiple linear regression analyses were first conducted for all five dependent variables (MVPA, LPA, days of 60 min of physical activity, sports participation, and screen time). In order to reduce the number of independent variables in the model, Stepwise regression was conducted to determine which independent variables should be entered into the final model or removed from the analysis. Variables with $\alpha < 1.5$, a standard default value used in statistical analysis software (Minitab 2010), remained in the model. The initial model contained only demographic variables, including gender, parent education, BMI category, and ASD status. Next, psychological factors were entered, with removal of any non-significant factors that did not meet the criteria of $\alpha <$ than 1.5. Finally, the social factors were entered into the regression model. The final models consisted of only the significant demographic, psychological, and social factors in order to present the strongest model for each dependent variable. Additionally, interactions were tested between ASD diagnosis and other significant factors to further explore how observed associations differed by ASD diagnosis. All analyses were performed with SAS 9.4 (SAS Institute Inc. 2013).

Results

The current study includes 55 children who were reported, by their primary caregiver, as having ASD diagnosed by a medical professional, and 55 randomly selected TD children for comparison purposes. They were matched by gender, with females comprising 15% ($n = 8$) of both groups. No differences existed in parent education status with 16 (29%) parents of children with ASD and 12 (22%) parents of TD children attaining a college degree or greater ($p = 0.38$). There were no differences in weight status with 13 (22%) of the TD children classified as overweight and 15 (31%) of the children with ASD classified as overweight ($p = 0.31$), although it should be noted that six of the 55 children with ASD had missing BMI. Additionally, hours per week of physical education classes were compared between the two groups with results indicating that there was no significant difference ($p = .35$) between time spent in PE classes for TD children and children with ASD ($1.1 \pm .3$ h vs. $1.17 \pm .38$ h).

Table 1 displays the comparison of health behaviors between the TD children and the children with ASD. The children with ASD had significantly fewer days of MVPA (3.8 ± 1.31 vs. 4.52 ± 1.03; $p = .007$), less participation in sports (10% of sample with ASD did not play sports; $p = .005$), and less days where they participated in the recommended 60 min or more of physical activity (3.96 ± 2.25 vs. 5.87 ± 2.07; $p < .0001$). No differences existed in hours of daily screen-time between the children with ASD (2.69 h/day) and TD children (2.83 h/day, $p = 0.34$). Table 2 displays the comparison of psychosocial factors between the TD children and the children with ASD. Children with ASD had significantly lower perceptions of popularity ($p < .0001$), greater feelings of anxiety ($p = .0006$), more problems with peers ($p < .0001$), and lower ratings of prosocial behavior ($p < .0001$) compared to TD children.

Results from the final multiple regression models for MVPA, LPA, number of days per week of 60 min of physical activity, number of sports, and hours of screen time are displayed in Table 3. Only the demographic and psychosocial variables that met the inclusion criteria of $p < .15$. from the stepwise regression analysis were included in

Table 1 Independent t-test comparisons of health behaviors between children with ASD ($n = 55$) and TD children ($n = 55$)

Variables	Children with ASD	TD children	*p* value
# of days/wk. of 60 min of PA, M(SD)	3.96 (2.25)	5.87 (2.07)	<.0001
# of days of MVPA[a], M (SD)	3.8 (1.31)	4.42 (1.03)	.007
# of days of light PA[a], M (SD)	4.36 (.97)	4.54 (.99)	.33
No organized sports, n(%)	5 (10)	0	.005
< 1 h/day of TV, n (%)[b]	19 (35)	16 (29)	.54
< 1 h/day of computer use, n(%)	48 (87)	51 (93)	.34
< 1 h/day of video games, n(%)	42 (76)	44 (80)	.64

ASD, Autism Spectrum Disorder; *TD*, Typically developing; *PA*, Physical activity; *MVPA*, Moderate-to-vigorous physical activity

[a] In the past 14 days

[b] For descriptive purposes, the composite value of screen time was broken down into the three individual screen time categories

Table 2 Independent t-test comparisons between psychosocial factors in children with ASD & TD children

Variables	ASD sample	TD Sample	*p* value
Perceived as less anxious, M (SD)	9.71 (3.16)	11.25 (2.26)	**0.006***
Perceived popularity, M (SD)	7.17 (2.41)	9.38 (1.82)	**<0.0001**
Perceived happiness, M (SD)	8.38 (1.67)	8.72 (1.48)	0.29
Problems with peer, M(SD)	4.05 (2.21)	0.71 (1.12)	**<0.0001**
Prosocial behavior, M(SD)	6.65 (2.44)	8.91 (1.25)	**<0.0001**
Victim of bullying, n (%)	18 (33)	9 (16)	**0.05**
At least 1 close friend, n (%)	47 (85)	54 (98)	**0.0004**
Spends at least 1 day/wk. with friends, n (%)	40 (73)	53 (98)	**0.0003**

ASD, Autism Spectrum Disorder; *TD*, Typically developing

*Bolded values are significant at $p < .05$

these models. For MVPA, the demographic variables, gender and ASD diagnosis, were the only factors that remained significant, indicating that males and TD children were more likely to participate in greater amounts of MVPA. In the final model for LPA, males ($p = 0.01$), TD children ($p = 0.02$) and children who have not reported being

Table 3 Multiple regression model for entire sample ($n = 110$)

	Independent variables	B (SE)	*p* value	R^2
MVPA[a]			0.0002	0.17
	Gender (male)	0.33 (.13)	0.01	
	ASD diagnosis	0.24 (.11)	0.02	
	Days with friends	0.07 (.03)	0.03	
Light PA[a]			0.002	0.14
	Gender (male)	0.32 (.12)	0.01	
	ASD diagnosis	0.2 (.08)	0.02	
	No report of bullying	0.2 (.12)	0.05	
60 min of PA[b]			<0.0001	0.18
	Gender (male)	1.04 (.64)	0.01	
	ASD diagnosis	0.43 (.21)	<0.0001	
Sports[b]			0.0009	0.15
	Gender	0.61 (.26)	0.02	
	ASD diagnosis	0.44 (.19)	0.03	
	N of close friends	0.13 (.09)	0.1	
Screen time (hrs/day)			0.05	0.06
	N of close friends	0.33 (.14)	0.02	
	Prosocial behavior	−0.1 (.7)	0.1	

ASD, Autism Spectrum Disorder; *PA*, physical activity; *N*, number

[a] Number of days in the past 2 weeks

[b] Number of days in the past week

bullied in the past year ($p = 0.05$), were more likely to engage in greater amounts of LPA compared to females, children with ASD, and children who reported being bullied by their peers in the past year. Only gender and ASD diagnosis were included in the final models for number of days per week participants engaged in 60 min of physical activity or played sports. Males ($p = 0.01$) and TD children ($p < 0.0001$) were more likely to engage in 60 min of physical activity on more days per week, and similarly, males ($p = 0.02$) and TD children ($p = 0.03$) were more likely to play sports on a greater number of days per week than females or children with ASD.

For screen-time, the final model consisted of only two psychosocial factors, number of close friends and prosocial behavior, with a greater number of close friends ($p = 0.01$) and a lower parent rating of their child's level of prosocial behavior ($p = 0.1$) associated with greater hours of screen time.

Since ASD diagnosis was a significant predictor in all but one of the regression models (screen-time), interaction terms were tested to determine whether interactions existed between ASD status and gender on the dependent physical activity factors (MVPA, LPA, 60 min of PA, and sports participation), as well as ASD status and bullying. No significant interactions existed between ASD diagnosis and gender, however, there was a significant interaction between ASD diagnosis and bullying for LPA, with TD children who have experienced bullying ($\beta = 0.43$, SE = 0.16, $p = .01$) significantly more likely to engage in LPA compared to children with ASD who have reported bullying in the past year.

Discussion

The purpose of this research was to compare both health behaviors, and psychosocial correlates of health behaviors, between nine-year old children with and without ASD. Similar to previous work, children with ASD had lower levels of MVPA and spent fewer days participating in at least 60 min of physical activity compared to children with ASD (Table 1). These findings reflect previous research highlighting the inactivity of children with ASD (e.g. MacDonald et al. 2011; Pan et al. 2011). Interestingly, there were no significant difference in participation in LPA or screen-time engagement between the two groups. This indifference has been demonstrated in previous work: for example, research has revealed similarities in physical activity levels (e.g. Bandini et al. 2013; Corvey et al. 2016) and screen-time (Montes 2016). Although evidence on disparities in physical activity and screen-time participation between children with and without ASD is inconsistent, the call for efforts to increase physical activity, and reduce screen-time, is echoed throughout the research base (e.g. Jones et al. 2017; Healy et al. 2017).

A broad range of correlates of physical activity, across all domains of the ecological model, have been documented for TD children (Van der Horst et al. 2007) and influence intervention development to maximize efficacious outcomes. Understanding differences in correlates of physical activity and sedentariness between children with and without ASD, if they in fact exist, will assist practitioners in the individualization of interventions for individuals with ASD. Several factors were shown to be associated with physical activity for both groups, with and without ASD. First, gender was significantly associated with all forms of physical activity. Previous findings on gender

and physical activity have been inconsistent for children with ASD (Jones et al. 2017), yet the association for TD children (favoring males) is well established (Sterdt et al. 2014). Due to the higher representation of males among the population with ASD – odds of having ASD are four times as large for males than females (Kogan et al. 2009) – research on correlates of health behavior among individuals with ASD has particularly focused on males (Jones et al. 2017). As health behaviors (Fakhouri et al. 2013) and their associated factors (Garcia et al. 2016a, b) differ between males and females, future researchers should seek to include more females with ASD in research. The number of days per week in which the child did something with friends also emerged as a significant factor for MVPA for children with and without ASD. The importance of having a peer group has been identified for TD children (Maturo and Cunningham 2013) and, conversely, a lack of exercise partners and exclusion from other children has been revealed as being a barrier for physical activity among children with ASD (Must et al. 2015). This significant associate of physical activity must be further explored in future research, and considered in physical activity intervention design. An unexpected finding was the association of screen-time with number of close friends, which was not affected by ASD diagnosis. A previous study by Garcia et al. (2016b) found that male adolescents preferred playing video games with groups of friends rather than alone or with a single friend. Unfortunately, the specific type of screen-time activity is unknown in the current study, however, given that the majority of the study sample is male, it is plausible to suggest that this finding may be due to video game playing with groups of friends. Future studies should further investigate social correlates of specific screen-time activities, such as video game playing.

Interaction terms were calculated to examine differences in psychosocial factors associated with physical activity and screen-time between TD children and children with ASD. There was a significant interaction between ASD diagnosis and bullying for LPA. Victimization appears to be more of a barrier to LPA for children with ASD, compared to their TD counterparts. The influence of peers is reflected in previous research on the barriers to physical activity among children with ASD. For example, research by Must et al. (2015) revealed that children with ASD whose parents reported that other children excluded their child participated in significantly less physical activity then those who did not experience exclusion. Similarly, a lack of peer exercise partners was reported by parents as being a barrier to physical activity participation among their children with ASD (Obrusnikova and Miccinello 2012). Interventions to increase physical activity among children with ASD should not neglect the importance of the peers; efforts to increase understanding and inclusivity among peers may significantly aid the child with ASD to increase participation in school-time physical activity opportunities. Indeed, peer-mediated interventions have proved successful in previous research; for example, Rodríguez-Medina et al. (2016) involved TD peers in an intervention to increase social interaction in a recess setting among children with ASD. After training of the peer – including in strategies such as using direct instruction, modelling, and social reinforcement – improvements in the recess setting were observed in the rates of imitating and responding to interaction, and time spent alone. Such interactions should be expanded to promote inclusion in physical activities, in settings including recess, physical education, and community-based activity programs.

The differences in psychosocial factors (Table 2) between both groups is also worthy of discussion, particularly in light of how these factors may correlate with health

behaviors. In the current study children with ASD reported lower levels of perceived popularity and prosocial behavior, and greater levels of anxiety and problems with peers than their TD counterparts. Additionally, a greater percentage of parents of children with ASD reported their child being bullied over the past several months, and a lower percentage of parents with children with ASD reported their child having at least one close friend. These findings are supported by previous research stating that children with ASD tend to report more difficulties with social interactions with peers and are at an increased risk of victimization when compared to TD peers and peers with other disabilities (e.g. Kloosterman et al. 2013). Research by Healy et al. (2013) suggests that children with ASD in physical activity settings may not be exempt from this. Children participating in the research reported experiencing bullying – verbal and physical – in physical education. Various potential reasons for this increased vulnerability are posited, including (1) the social deficits characterizing ASD making navigating the social world difficult, (2) ASD is a hidden disability, thus less understood by peers, and (3) support received in school (i.e. in-class adult support) may reduce opportunities for social interaction (Hebron and Humphrey 2014; Symes and Humphrey 2012). Research by Stanish et al. (2015) may add to the argument that physical activity does not provide equal opportunities for positive social experiences for children with ASD; significantly fewer of the participants with ASD (67.7%) reported that sports and exercise is a way to make friends, in comparison to the TD group (96.7%), and 35.5% of the participants with ASD indicated that they dislike team sports, as opposed to 5% of their TD counterparts. Future research, seeking to increase the inclusivity of physical activity settings for children with ASD, should promote positive interactions between all participants, and provide opportunities for participation in less socially demanding activities. In addition, purposeful instruction of social skills for use in physical activity settings should be considered.

Several strengths and limitations of this study should be noted. Compared to previous studies that have examined health behaviors among children with ASD, this is a relatively large sample (Stanish et al. 2015; Pan et al. 2016). Additionally, unlike many previous studies involving children with ASD, the current study was able to utilize a matched sample of TD children for comparison purposes. Another strength was the availability of several psychosocial factors that allowed investigators to examine different dimensions of social interaction, that were both positive (i.e. prosocial behavior) and negative (i.e. bullying).

Several limitations related to the data utilized should be acknowledged. First, all measures were subjective (primarily reported by parents/caregivers), which are prone to bias; furthermore, some questions used (for example the number of 'close friends' of the study child) are up for significant interpretation from the parent. Second, although the self-report measure of self-concept using the Piers-Harris Children's Self-Concept Scale, 2nd Edition (Piers and Herzberg 2002) has been validated for TD children (Alexopoulos and Foudoulaki 2002), this has yet to be completed for children with ASD; this is strongly suggested for future researchers. Third, although ASD diagnosis was assessed in the parent study, there was no indication of ASD severity. Given the variability of symptoms identified in this disorder, presence and severity of specific symptoms (e.g. non-verbal vs verbal), may affect the association of psychosocial factors with physical activity and screen-time. Additionally, the concern with prematurely eliminating variables that are not

related to the dependent variable with Stepwise regression is a limitation of this analysis (Olusegun et al. Dikko & Gulumbe 2015). Finally, the authors were unable to examine specific individual-level psychosocial factors, such as self-efficacy, that have been shown to be associated with physical activity in TD children (Sallis et al. 2000). Although the present study was able to examine several individual-level factors such as perceived happiness and anxiety, there were no measures that specifically assessed self-efficacy or enjoyment of physical activity. Future research should seek to understand how these variables may correlate with health behaviors among children with ASD.

The possible implications of the time of data collection (2007/2008) also deserves discussion. The data set, although ten years old, was deemed appropriate for the current study as it included several variables previously unexamined related to physical activity and screen-time among children with ASD. In addition, research on TD children over the past decade has shown some consistent findings (for example the significance of social factors; Salvy et al. 2012, Voorhees et al. 2005), thus we believe the current findings are relevant and meaningful. The time of data-collection is particularly relevant when examining a sample with ASD as the diagnostic criteria for ASD – outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM) – has evolved overtime. Children of the current study, being 9 years old – thus diagnosed between the years 1998/1999 and 2007 – were diagnosed with the DSM IV. Since 2013, a new version of the DSM was released; the DSM 5 (American Psychiatric Association 2013). Most notably, changes included (1) the elimination of Pervasive Developmental Disorder and the reduction of the five subtypes to a new singular diagnostic category of ASD; (2) a collapse of three-domain criteria to two (social communication/interaction and restrictive, repetitive behavior, and (3) changing the age of onset from 'age 3' to early childhood. In addition, a new diagnostic category was defined, titled social communication disorder (SCD). Research comparing ASD prevalence using DSM-IV and DSM-5 concluded that almost all individuals with DSM IV Autistic Disorder (98%) and Asperger Disorder (92%) met the new DSM 5 ASD diagnostic criteria (Kim et al. 2014). With these results in mind, we propose that research on children with ASD diagnosed prior to 2013 is still generalizable to children with ASD diagnosed post 2013. Nevertheless, we recommend that future researchers seek to collect and explore more recent data to continue to understand the correlates of health behaviors among this population, extending findings to children with a diagnosis of SCD.

Finally, although the technical report on study procedures (Murray et al. 2012) states that every effort was made to maximize participation of the involvement of children with learning disabilities or other special needs, little information is provided on specific strategies, and it is not known how many children with ASD were excluded from participation or for whom participation was impacted due to the characteristics of ASD (e.g. communication deficits) or comorbidities (e.g. intellectual disability). Future research should seek to clearly define the participating sample with ASD. If the responses of the sample with ASD cannot be deemed valid, researchers should rely solely on the parent or teacher report data. Furthermore, national data collection efforts should ensure interviewers are trained to interact and elicit accurate responses from individuals with ASD so their perspective is reflected in nationally representative data-sets.

The results of this study have several implications. First, the present study confirms previous research that suggests that children with ASD engage in less MVPA, are less likely to meet physical activity guidelines, and participate in fewer sports than their TD counterparts. Differences are apparent relating to the effect of bullying on PA participation: children with ASD who were bullied were significantly less likely to participate in LPA compared to TD children who were bullied. Studies should examine the association between negative social interactions and lower levels of physical activity in children with ASD, and develop interventions that focus on improving social interactions between children with ASD and their peers in physical activity settings. Finally, it is important to note that a large amount of variance in physical activity levels was unexplained by the examined psychosocial correlates in this study. Future studies should include additional correlates that have been linked with physical activity in TD children such as self-efficacy and enjoyment, activity preferences, and environmental correlates (e.g. the presence of facilities nearby), and correlates that may be unique or more influential in children with ASD (e.g. ASD severity, sensory issues, social and behavioral attributes, caregiver attitudes and support). Research is needed to gain a better understanding the multi-level correlates of physical activity for children with ASD.

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Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent This is a secondary analysis of a national dataset so informed consent was not required.

Conflicts of Interest All authors declare no conflicts of interest.

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References

Alexopoulos, D. S., & Foudoulaki, E. (2002). Construct validity of the Piers-Harris children's self-concept scale. *Psychological Reports, 91*(3), 827–838.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Washington, D.C: American Psychiatric Association.

Bandini, L. G., Gleason J., Curtin, C., Lividini, K., Anderson, S. E., Cermak, S. A., . . . Must, A. (2013). Comparison of physical activity between children with autism spectrum disorders and typically developing children. *Autism, 17*(1), 44–54.

Beets, M. W., Vogel, R., Forlaw, L., Pitetti, K. H., & Cardinal, B. J. (2006). Social support and youth physical activity: The role of provider and type. *American Journal of Health Behavior, 30*(3), 278–289.

Cadogan, S. L., Keane, E., & Kearney, P. M. (2014). The effects of individual, family and environmental factors on physical activity levels in children: A cross-sectional study. *BMC Pediatrics, 14*(1), 107–120.

Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Medicine, 11*(8), 735–742.

Centers for Disease Control and Prevention (CDC). (2014). *State Indicator Report on Physical Activity, 2014*. Atlanta, GA: U.S. Department of Health and Human Services.

Chonchaiya, W., Nuntnarumit, P., & Pruksananonda, C. (2011). Comparison of television viewing between children with autism spectrum disorder and controls. *Acta Paediatrica, 100*(7), 1033–1037.

Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics, 113*(1), 708–713.

Christakis, D. A., Gilkerson, J., Richards, J. A., Zimmerman, F. J., Garrison, M. M., Xu, D., . . . Yapanel, U. (2009). Audible television and decreased adult words, infant vocalizations, and conversational turns: A population-based study. *Archives of Pediatrics and Adolescent Medicine, 163*(1), 554–558.

Chu, C. H., & Pan, C. Y. (2012). The effect of peer-and sibling-assisted aquatic program on interaction behaviors and aquatic skills of children with autism spectrum disorders and their peers/siblings. *Research in Autism Spectrum Disorders, 6*(3), 1211–1223.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal, 320*(7244), 1240–1243.

Collins, C. (2001). Design of the national children's strategy longitudinal study of children. Unpublished report submitted to the health research board by the consortium represented by Greene, S., Hyland, A., Kelleher, C., Mennell, S., Whelan, B., & Wilde, J.

Corvey, K., Menear, K. S., Preskitt, J., Goldfarb, S., & Menachemi, N. (2016). Obesity, physical activity and sedentary behaviors in children with an autism Spectrum disorder. *Maternal and Child Health Journal, 20*(2), 466–476. https://doi.org/10.1007/s10995-015-1844-5.

Dishman, R. K., Motl, R. W., Sallis, J. F., Dunn, A. L., Birnbaum, A. S., Welk, G. J., . . . Jobe, J. B. (2005). Self-management strategies mediate self-efficacy and physical activity. *American Journal of Preventive Medicine, 29*(1), 10–18.

Fakhouri, T. H., Hughes, J. P., Brody, D. J., Kit, B. K., & Ogden, C. L. (2013). Physical activity and screen-time viewing among elementary school–aged children in the United States from 2009 to 2010. *JAMA Pediatrics, 167*(3), 223–229.

Garcia, J. M., Healy, S., & Rice, D. (2016a). The individual, social, and environmental correlates of physical activity and screen time in Irish children: Growing up in Ireland study. *Journal of Physical Activity and Health, 13*(12), 1285–1293.

Garcia, J. M., Sirard, J. R., Deutsch, N. J., & Weltman, A. (2016b). The influence of friends and psychosocial factors on physical activity and sedentary behavior in adolescents: A mixed-methods study. *Journal of Behavioral Medicine, 39*(4), 610–623.

Godin, G., & Shephard, R. J. (1997). Godin leisure-time exercise questionnaire. *Medicine & Science in Sports & Exercise, 29*(6), 36–38.

Godin, G., Jobin, J., & Bouillon, J. (1986). Assessment of leisure time exercise behavior by self-report: A concurrent validity study. *Canadian Journal of Public Health, 77*(5), 359–362.

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*(5), 581–586.

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*(11), 1337–1345.

Goodman, R., & Scott, S. (1999). Comparing the strengths and difficulties questionnaire and the child behavior checklist: Is small beautiful? *Journal of Abnormal Child Psychology, 27*(1), 17–24.

Healy, S., Msetfi, R., & Gallagher, S. (2013). 'Happy and a bit nervous': The experiences of children with autism in physical education. *British Journal of Learning Disabilities, 41*(3), 222–228.

Healy, S., Haegele, J. A., Grenier, M., & Garcia, J. M. (2017). Physical activity, screen-time behavior, and obesity among 13-year olds in Ireland with and without autism spectrum disorder. *Journal of Autism and Developmental Disorders, 47*(1), 49–57.

Hebron, J., & Humphrey, N. (2014). Mental health difficulties among young people on the autistic spectrum in mainstream secondary schools: A comparative study. *Journal of Research in Special Educational Needs, 14*(1), 22–32.

Jones, R. A., Downing, K., Rinehart, N. J., Barnett, L. M., May, T., McGillivray, J. A., . . . Hinkley, T. (2017) Physical activity, sedentary behavior and their correlates in children with autism spectrum disorder: A systematic review. *PLoS One, 12*(2): e0172482.

Kenney, E. L., & Gortmaker, S. L. (2017). United States adolescents' television, computer, videogame, smartphone, and tablet use: Associations with sugary drinks, sleep, physical activity, and obesity. *The Journal of Pediatrics, 182*, 144–149.

Kim, Y. S., Fombonne, E., Koh, Y.-J., Kim, S.-J., Cheon, K.-A., & Leventhal, B. (2014). A comparison of DSM-IV PDD and DSM-5 ASD prevalence in an epidemiologic sample. *Journal of the American Academy of Child and Adolescent Psychiatry, 53*(5), 500–508.

Kloosterman, P. H., Kelley, E. A., Craig, W. M., Parker, J. D., & Javier, C. (2013). Types and experiences of bullying in adolescents with an autism spectrum disorder. *Research in Autism Spectrum Disorders, 7*(7), 824–832.

Kogan, M. D., Blumberg, S. J., Schieve, L. A., Boyle, C. A., Perrin, J. M., Ghandour, R. M., . . . van Dyck, P. C. (2009) Prevalence of parent-reported diagnosis of autism spectrum disorder among children in the US, 2007. *Pediatrics, 124*(5), 1395–1403.

MacDonald, M., Esposito, P., & Ulrich, D. (2011). The physical activity patterns of children with autism. *BMC Research Notes, 4*(1), 422.

Matheson, B. E., & Douglas, J. M. (2017). Overweight and obesity in children with autism spectrum disorder (ASD): A critical review investigating the etiology, development, and maintenance of this relationship. *Review Journal of Autism and Developmental Disorders, 4*(2), 1–15.

Maturo, C. C., & Cunningham, S. A. (2013). Influence of friends on children's physical activity: A review. *American Journal of Public Health, 103*(7), 23–38.

Minitab 17 Statistical Software (2010). [Computer Software]. State College, PA: Minitab, Inc. (www.minitab.com).

Montes, G. (2016). Children with autism spectrum disorder and screen time: Results from a large, nationally representative US study. *Academic Pediatrics, 16*(2), 122–128.

Murray, A., McCrory, C., Thornton, M., Williams, J., Quail, A., Swords, L., . . . Harris, E. (2012). *Growing up in Ireland: Design, instrumentation and procedures for the child cohort*, *Technical Report Number 1. 2012;* Dublin: Office of the Minister for Children.

Must, A., Phillips, S. M., Curtin, C., Anderson, S. E., Maslin, M., Lividini, K., & Bandini, L. G. (2014). Comparison of sedentary behaviors between children with autism spectrum disorders and typically developing children. *Autism, 18*(4), 376–384.

Must, A., Phillips, S., Curtin, C., & Bandini, L. G. (2015). Barriers to physical activity in children with autism Spectrum disorders: Relationship to physical activity and screen time. *Journal of Physical Activity and Health, 12*(4), 529–534.

Nally, B., Houlton, B., & Ralph, S. (2000). Researches in brief: The management of television and video by parents of children with autism. *Autism, 4*(3), 331–337.

Obrusnikova, I., & Miccinello, D. L. (2012). Parent perceptions of factors influencing after-school physical activity of children with autism Spectrum disorders. *Adapted Physical Activity Quarterly, 29*(1), 63–80.

Olusegun, A. M., Dikko, H. G., & Gulumbe, S. U. (2015). Identifying the limitation of stepwise selection for variable selection in regression analysis. *American Journal of Theoretical and Applied Statistics, 4*(5), 414–419.

Oriel, K. N., George, C. L., Peckus, R., & Semon, A. (2011). The effects of aerobic exercise on academic engagement in young children with autism spectrum disorder. *Pediatric Physical Therapy, 23*(2), 187–193.

Pan, C. Y., Tsai, C. L., & Hsieh, K. W. (2011). Physical activity correlates for children with autism spectrum disorders in middle school physical education. *Research Quarterly for Exercise and Sport, 82*(3), 491–498.

Pan, C. Y., Tsai, C. L., Chu, C. H., Sung, M. C., Ma, W. Y., & Huang, C. Y. (2016). Objectively measured physical activity and health-related physical fitness in secondary school-aged male students with autism spectrum disorders. *Physical Therapy, 96*(4), 511–520.

Piers, E. V., & Herzberg, D. S. (2002). *Piers-Harris 2: Piers-Harris children's self-concept scale*. Western Psychological Services.

Rodríguez-Medina, J., Martín-Antón, L. J., Carbonero, M. A., & Ovejero, A. (2016). Peer-mediated intervention for the development of social interaction skills in high-functioning autism spectrum disorder: A pilot study. *Frontiers in Psychology, 7*(1), 1986.

Sallis, J. F., Buono, M. J., Roby, J. J., Micale, F. G., & Nelson, J. A. (1993). Seven-day recall and other physical activity self-reports in children and adolescents. *Medicine & Science in Sports & Exercise, 25*(1), 99–108.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine & Science in Sports & Exercise, 32*(5), 963–975.

Salvy, S. J., De La Haye, K., Bowker, J. C., & Hermans, R. C. (2012). Influence of peers and friends on children's and adolescents' eating and activity behaviors. *Physiology and Behavior, 106*(3), 369–378.

SAS Institute Inc. (2013). *SAS/ACCESS 9.4 Interface to ADABAS: Reference*. Cary, NC: SAS Institute Inc.

Sawka, K. J., McCormack, G. R., Nettel-Aguirre, A., Hawe, P., & Doyle-Baker, P. K. (2013). Friendship networks and physical activity and sedentary behavior among youth: A systematized review. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 130–139.

Seabra, A. C., Seabra, A. F., Mendonça, D. M., Brustad, R., Maia, J. A., Fonseca, A. M., & Malina, R. M. (2012). Psychosocial correlates of physical activity in school children aged 8–10 years. *The European Journal of Public Health, 23*(5), 794–798.

Sirard, J. R., Bruening, M., Wall, M. M., Eisenberg, M. E., Kim, S. K., & Neumark-Sztainer, D. (2013). Physical activity and screen time in adolescents and their friends. *American Journal of Preventive Medicine, 44*(1), 48–55.

Srinivasan, S. M., Pescatello, L. S., & Bhat, A. N. (2014). Current perspectives on physical activity and exercise recommendations for children and adolescents with autism spectrum disorders. *Physical Therapy, 94*(6), 875–889.

Stanish, H., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. (2015). Enjoyment, barriers, and beliefs about physical activity in adolescents with and without autism spectrum disorder. *Adapted Physical Activity Quarterly, 32*(4), 302–317.

Sterdt, E., Liersch, S., & Walter, U. (2014). Correlates of physical activity of children and adolescents: A systematic review of reviews. *Health Education Journal, 73*(1), 72–89.

Stierlin, A. S., De Lepeleere, S., Cardon, G., Dargent-Molina, P., Hoffmann, B., Murphy, M. H., . . . De Craemer, M. (2015). A systematic review of determinants of sedentary behavior in youth: A DEDIPAC-study. *International Journal of Behavioral Nutrition and Physical Activity, 12*(1), 133.

Strauss, R. S., Rodzilsky, D., Burack, G., & Colin, M. (2001). Psychosocial correlates of physical activity in healthy children. *Archives of Pediatrics & Adolescent Medicine, 155*(8), 897–902.

Symes, W., & Humphrey, N. (2012). Including pupils with autistic spectrum disorders in the classroom: The role of teaching assistants. *European Journal of Special Needs Education, 27*(4), 517–532.

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., & Colley, R. C. (2011). Systematic review of sedentary behavior and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity, 8*(1), 98–120.

Trost, S. G., Pate, R. R., Saunders, R., Ward, D. S., Dowda, M., & Felton, G. (1997). A prospective study of the determinants of physical activity in rural fifth-grade children. *Preventive Medicine, 26*(2), 257–263.

Van der Horst, K., Paw, M. J. C. A., Twisk, J. W., & Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine & Science in Sports & Exercise, 39*(8), 1241–1250.

Voorhees, C. C., Murray, D., Welk, G., Birnbaum, A., Ribisl, K.M., Johnson, C.C., . . . Jobe, J. B. (2005). The role of peer social network factors and physical activity in adolescent girls. *American Journal of Health Behavior, 29*(2), 183–190.

Welk, G. J. (1999). The youth physical activity promotion model: A conceptual bridge between theory and practice. *Quest, 51*(1), 5–23.

Zhang, T., Solmon, M. A., Gao, Z., & Kosma, M. (2012). Promoting school students' physical activity: A social ecological perspective. *Journal of Applied Sport Psychology, 24*(1), 92–105.

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