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Physical activity and screen time among youth with autism: A longitudinal analysis from 9 to 18 years

J Dahlgren[1], S Healy[2], M MacDonald[1], J Geldhof[1], K Palmiere[2] and JA Haegele[3]

Abstract

To date, studies using cross-sectional methodologies make up a majority of the literature surrounding children with autism spectrum disorders and participation in physical activity and screen time. Longitudinal studies are needed to examine how physical activity and screen time behaviors co-develop for children with and without an autism spectrum disorder. To address this research gap, this study compared how physical activity and screen time levels changed over time (9 to 18 years of age) between youth with autism spectrum disorder and youth with neurotypical development. Data on the levels of moderate-to-vigorous physical activity, light physical activity, television-, and video game-based screen time, collected as a part of the "Growing up in Ireland" study, were compared between youth with autism spectrum disorder and a propensity-matched sample of youth with neurotypical development ($n = 88$ per group; 176 in total). Robust regression analyses indicated that children with autism spectrum disorder became less active over time compared to children with neurotypical development and that video game screen time also differed significantly between the groups when children were 9 years old. These findings elucidate important disparities present between these groups of children during pivotal developmental times.

Lay abstract

To date, studies using cross-sectional methodologies make up a majority of the literature surrounding children with autism spectrum disorders and participation in physical activity and screen time. Longitudinal studies are needed to examine how physical activity and screen time behaviors co-develop for children with and without an autism spectrum disorder. To address this research gap, this study compared how physical activity and screen time levels changed over time (from 9 to 18 years of age) between youth with autism spectrum disorder and youth with neurotypical development. Data on the levels of moderate-to-vigorous physical activity, light physical activity, television-, and video game-based screen time, collected as a part of the "Growing up in Ireland" study, were compared between youth with autism spectrum disorder and a propensity-matched sample of youth with neurotypical development ($n = 88$ per group; 176 in total). Robust regression analyses indicated that children with autism spectrum disorder became less active over time compared to children with neurotypical development and that video game screen time also differed significantly between the groups when children were 9 years old. These findings elucidate important disparities present between these groups of children during pivotal developmental times.

Keywords

autism spectrum disorders, neurotypical development, physical activity, screen time

Youth with autism spectrum disorder (ASD) are at an increased risk of poor health outcomes compared to youth with neurotypical development (ND; Mannion & Leader, 2013). For example, youth with ASD tend to have a higher prevalence of obesity (23.05% vs 15.91%; Healy et al., 2018) and obesity-related health conditions, including Type II diabetes, hypertension, and hyperlipidemia (Shedlock et al., 2016) compared to their peers with ND. These health

[1]Oregon State University, USA
[2]University of Delaware, USA
[3]Old Dominion University, USA

Corresponding author:
J Dahlgren, College of Public Health & Human Sciences, Oregon State University, Women's Building, 160 SW 26th Street, Corvallis, OR 97331-4501, USA.
Email: alonsoj@oregonstate.edu

disparities exacerbate as youth with ASD enter adulthood (Croen et al., 2015; Eaves & Ho, 2008). Approximately 40% of adults with ASD have obesity and 25% are hypertensive, as compared to 23% and 15% of adults with ND, respectively (Croen et al., 2015; Eaves & Ho, 2008). In an effort to understand and ultimately reduce these health disparities, it is critical to examine the modifiable behaviors that impact health, including physical activity (PA) and sedentary behavior (SB). As health behaviors in childhood track into adulthood (Hayes et al., 2019; Malina, 2001; Telama, 2009), a focus on understanding trajectories of health behaviors in childhood among individuals with ASD is of utmost importance.

Children (i.e. aged <13 years) with ASD tend to have lower (Ayvazoglu et al., 2015; Pan et al., 2016; Tyler et al., 2014) or comparable (Bandini et al., 2013; Boddy et al., 2015; Corvey et al., 2016) levels of PA compared to children with ND. As children move into adolescence, the disparity in PA levels between groups is clear. PA levels of adolescents with ASD are most often reported to be lower than that of their peers with ND (MacDonald et al., 2011; McManus et al., 2012; Memari et al., 2013; Pan et al., 2016). Reflecting this deviation, age is consistently identified as being negatively associated with PA levels among youth with ASD (Jones et al., 2017). Highlighting this, MacDonald and colleagues (2011) examined the PA patterns of youth with ASD between the ages of 9 and 18 years and demonstrated that the mean amount of time spent in moderate-to-vigorous PA (MVPA) was 17 min for the youngest group and 10 min for the older group.

Comparisons of levels of SB, often represented by screen time (ST), between youth with ASD and youth with ND lead to mixed conclusions. Heavy ST use is well documented among youth with ASD (Stiller & Mößle, 2018), and several studies report higher levels of ST among youth with ASD compared to youth with ND (Chonchaiya et al., 2011; Engelhardt et al., 2013; Kuo et al., 2015; South et al., 2005). On the contrary, however, studies comparing levels of ST between youth with ASD and youth with ND have also reported no differences (McCoy et al., 2016; Montes, 2016; Potvin et al., 2013). Difference in trajectories of ST use with age do, however, appear to differ between youth with ASD and ND; ST levels appear to be positively associated with age among youth with ASD and are negatively associated with age among youth with ND (Montes, 2016; Must et al., 2014; South et al., 2005). In other words, ST increases with age for youth with ASD and ST decreases for youth with ND.

Thus far, studies of PA and ST among youth with ASD have relied on cross-sectional studies, providing us with a "once off" insight into PA and ST levels among this population (Scharoun et al., 2017; Stiller & Mößle, 2018). While informative for comparing samples, cross-sectional methodologies do not observe trends over time, which is essential for drawing conclusions on how PA and ST behaviors develop (Gordon-Larsen et al., 2004; Taylor et al., 2013). A paucity of longitudinal studies is a major gap in the literature. Longitudinal methods can enhance our understanding of the timing, nature, and extent of the changes among PA and ST behaviors across time and informs the development of targeted interventions at times when health behaviors are at risk of worsening. Therefore, to begin to address this research gap, this study compared how PA and ST levels changed over time (aged from 9 to 18 years) between youth with ASD and youth with ND.

Methods

Procedures and participants

Data came from waves 1, 2, and 3 of the nationally representative longitudinal study "Growing up in Ireland." This study began in 2006 and employed a fixed panel design, following the progress of a cohort of 9-year-old children born between November 1997 and October 1998. Data were collected at three time points. Wave 1 (9 years) was collected between September 2007 and April 2008. Wave 2 (13 years) was collected between August 2011 to March 2012, and Wave 3 (17/18 years) was collected between April 2015 and August 2016. The study administered child- and caregiver-report surveys garnering information on youth and their families and explored the following key domains of the youths' lives: health and physical development, educational/cognitive development, socio-emotional and behavioral well-being, and economic and civic participation. A total of 8568 children who were 9 years of age and their families were surveyed at Wave 1. At Wave 2, 7525 families participated in the study, a retention rate of 89%. At Wave 3, data were collected on 6216 children who were 17/18 years of age representing a 74% retention rate, excluding the 172 families who were positively identified during Wave 1 or Wave 2 fieldwork as no longer living in Ireland from the base of 8568 families who were initially interviewed in Wave 1. Data were successfully collected at all waves on 6039 children. At Waves 2 and 3, data were collected from the adolescent. Several strategies were employed to elicit an accurate response from participants. For example, the interviewer received training about how to establish a good rapport with the adolescent and the power imbalance that may exist between interviewer and participant (Murray et al., 2010). In addition, the interviewer was instructed to explain a question when not understood by the respondent, and prompt cards were available with the possible answers if necessary (Murray et al., 2010).

For the purpose of this study, youth with ASD were defined as those who were identified by their parents as having a current diagnosis of ASD, received by a medical professional at any time in Wave 1 (9 years), Wave 2 (13 years), or Wave 3 (17/18 years). By Wave 3, 91 children were identified as having a diagnosis of ASD. A propensity

Table 1. Propensity-matched sample demographics.

	ASD (n = 88) % (n)	No ASD (88) % (n)
Gender (male)	78.4 (69)	78.4 (69)
ID diagnosis	38 (33)	2.2 (2)
Number of services and supports received		
0	37.5 (33)	92 (81)
1	18.2 (16)	5.7 (5)
2	18.2 (16)	1.1 (1)
3	11.4 (10)	0
4	6.9 (6)	1.1 (1)
5	5.7 (5)	0
6	1.1 (1)	0
7	1.1 (1)	0
Adjusted income (€)	14068.18	14068.18

ID = intellectual disability.

score matched (PSM) sample of 88 youth with ND was then created, matched to the youth with ASD based on gender and income adjusted for household size at Waves 1, 2, and 3. This resulted in a full sample of 176 children.

The propensity-matched sample included 138 males and 38 females. At Wave 3, the mean income adjusted for household size was €14,068 (standard deviation (SD) = 7811). Of the youth with ASD, 62.5% (n = 55) received at least one type of support or service, compared to 8% (n = 7) of youth with ND. Resource teaching/learning support was the most frequently reported support received by youth with ASD (50%, n = 44), followed by special needs assistant (29.5%, n = 26). A third (n = 38) of youth with ASD also had an intellectual disability. No race or ethnicity information was available to be utilized for this study. See Table 1 for an overview of sample demographics.

Measures

Demographic measures. Demographic variables examined in this study included gender and income adjusted for household size. To further characterize the sample with ASD, data were also provided on (1) the presence of an intellectual disability and (2) the number and type of services received by the child, including (a) teaching/learning support, (b) special needs assistant, (c) speech and language therapy, (d) management programs, (e) school psychologist, (f) occupational therapist, (g) physical therapist, (h) psychiatrist, and (i) special help or resources in such because of limitations. This information was parent-reported at Wave 2 (see Table 1).

PA. Data on MVPA levels were collected on children at each wave using the question:

> How many times in the past 14 days has [the Study Child/you] done at least 20 minutes of exercise hard enough to make him/her breathe heavily and make his/her heart beat faster? [Hard exercise includes, for example, playing football, jogging, or fast cycling]. Include time in physical education class.

Response options included none, 1–2, 3–5, 6–8, and 9 days or more. Similarly, data on light physical activity (LPA) were collected via the question:

> How many times in the past 14 days has [the Study Child/you] 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? [Light exercise includes, walking or slow cycling]. Include time in physical education class.

Response options included none, 1–2, 3–5, 6–8, and 9 days or more. The questions were posed to the parent at Wave 1 and the child at Wave 2 and 3.

ST. Time spent watching television (TV) was assessed during all three Waves of data collection. At waves 1 and 2, respondents were asked "on a normal weekday during term-time, how many hours does [the Study Child/you] spend watching TV, videos or DVDs? Please remember to include time before school as well as time after school?" Response options included none, less than an hour, 1 hour to less than 3 hours, 3 hours to less than 5 hours, 5 hours to less than 7 hours, or 7 hours or more. At Wave 3, respondents were asked:

> How much time do you spend on each of the following activities on a typical day (where it is your main activity at the time)? Respondents reported time spent "Watching television/films

on a weekday. Response options were 30-min increments from (1) 0–30 min to (13) 361 min or more. The questions were posed to the parent at Wave 1 and the child at Wave 2 and 3.

Time spent playing video games (VGs) was also assessed during each wave of data collection. At Waves 1 and 2, respondents were asked

> on a normal weekday, during term-time, about how much time does spend playing videogames such as, Playstation, X-box, Nintendo etc? Please include time before school as well as time after school. DO NOT include time spent using computers in school.

At Wave 3, the question posed was

> How much time do you spend on each of the following activities on a typical day (where it is your main activity at the time)?

Respondents reported time spent "Playing video/computer games" on a weekday. Response options were 30-min increments from (1) 0–30 min to (13) 361 min or more. The questions were posed to the parent at Wave 1 and the child at Waves 2 and 3. For consistency across waves, ST variables were coded across waves as "1 = no screen time," "2 = less than 1 hour of screen time," "3 = 1–3 hours of screen time," and "4 = 4 or more hours of screen time."

Community involvement

As this is a national data collection effort, children with an ASD were not directly involved in the design, implementation, analysis, or interpretation of the "Growing Up in Ireland" study.

Statistical analysis

Our analytic approach employed PSM between youth with ND and youth with ASD. PSM was utilized to estimate the model similarly to an experimental design by creating a group with ASD and a control group (i.e. children with ND) matched on key socio-demographic variables (Rosenbaum & Rubin, 1983). The two groups were matched using income adjusted for household size at all three waves of data and child gender. PSM models function under the assumption that the matched groups are demographically similar, yet differ on a grouping variable of interest (Austin, 2011); for this study that included the presence of ASD.

The matched sample was then utilized to run chi-square tests on variables of interest such as MVPA and LPA, time spent watching TV, and time spent playing VGs. These preliminary analyses were used to understand how youth with ASD and youth with ND compared descriptively on each variable across each wave of data from the original study.

Several robust regression models were run via the RREG command in Stata 14.0 to further understand the relationship between the matched sample and the variables of interest at the final wave of data collection while controlling for prior time points. Robust regression weights each observation based on absolute residuals, with data possessing larger residuals being assigned smaller weights. Separate models regressed each outcome variable of interest—vigorous and light PA, and TV- and VG-ST—on the binary ASD/ND predictor. Four separate models were run, one for each outcome of MVPA, LPA, TV-ST, and VG-ST. All models utilized ASD status (ASD or ND) as the independent variable and Wave 3 assessment of each respective variable as the dependent variable. All models controlled for participate sex, income adjusted for household size, and the prior scores of each respective outcome variable at Waves 1 and 2. These prior time points were utilized in order to understand how ASD status predicted participation in both PA and ST activities when children were aged 17/18 years while controlling for prior participation.

Results

Descriptive results

PA. At the age of 9 years, 44.3% ($n = 39$) of children with ASD engaged in 9 or more days of MVPA compared to 62.5% ($n = 55$) among children with ND, but this difference was not statistically significant ($\chi^2(4) = 9.14$, $p = 0.057$). MVPA decreased for both groups by the age of 13 years, with this decrease being greater among children with ASD. At the age of 13 years, adolescents with ASD most commonly participated in 1–2 days of MVPA (31.8%, $n = 28$) compared to adolescents with ND who most frequently engaged in 9 or more days of MVPA (36.3%, $n = 32$; $\chi^2(4) = 17.49$, $p < 0.001$). Levels of MVPA continued to decrease through the age of 17/18 years, whereby adolescents with ASD participated in significantly fewer days compared to adolescents with ND ($\chi^2(4) = 17.97$, $p < 0.001$; see Table 2 and Figure 1). More specifically, by the age of 17/18 years, adolescents with ASD most frequently participated in no days of MVPA (29.5%, $n = 26$), compared to adolescents with ND who most frequently engaged in 6–8 days of MVPA (26.1%, $n = 23$).

Levels of LPA did not significantly differ between children with ASD and children with ND at the age of 9 years ($\chi^2(4) = 3.32$, $p = 0.506$). Children with ASD and children with ND most commonly participated in 9 or more days of LPA (65.9%, $n = 58\%$ and 76.1%, $n = 67\%$, respectively). However, by the age of 13 years, the difference in LPA levels between groups increased as adolescents with ASD participating in fewer days compared to adolescents with ND ($\chi^2(4) = 15.22$, $p = 0.001$). By the age of 13 years, adolescents with ASD most commonly participated in 3–5 days of LPA (28.4%, $n = 25$) compared to adolescents with ND who most frequently engaged in 9 or more days of LPA (36.3%, $n = 32$). The difference in LPA was not significant between groups at the age of 17/18 years ($\chi^2(4) = 5.61$, $p = 0.230$; see Table 2). At the age of 17/18 years, adolescents with ASD and adolescents with ND most commonly participated in 9 or more days of LPA (32.9%, $n = 29\%$ and 37.5%, $n = 33$, respectively; see Table 3 and Figure 1).

ST. Time spent watching TV did not differ between groups at any data collection time points ($p > 0.05$ for Waves 1, 2, and 3; see Table 4 and Figure 1). At Wave 1 and 2, youth with ASD and youth with ND most commonly watched 1–3 hour of TV per day (Wave 1: 61.3%, $n = 54\%$ and 71.5%, $n = 63$, respectively and Wave 2: 40.9%, $n = 36\%$ and 59%, $n = 52$, respectively). At Wave 3, adolescents with ND were still most likely to engage in 1–3 hour of TV time per day (47.7%, $n = 42$), whereas adolescents with ASD were most likely to engage in 1–3 hour per day (30.6%, $n = 27$) or 0 hour per day (30.6%, $n = 27$).

VG-related ST only significantly differed between groups during Wave 1 of data collection ($\chi^2(3) = 8.42$, $p = 0.027$; see Table 5). At Wave 1, children with ASD and children with ND most commonly engaged in 1–3 hour of VG play per day (34%, $n = 30\%$ and 54.5%, $n = 48$, respectively). At Wave 2, most adolescents with ASD and ND participants reported spending less than 1 hour playing VG per day (31.8%, $n = 28\%$ and 48.8%, $n = 43$, respectively). At Wave 3, adolescents with ASD and ND reported to most often spend no time playing VG (see Figure 1).

Table 2. Cross tabulations and chi-squared fisher's exact test for participation in MVPA.

	Youth with ASD	Youth with ND	$\chi^2(df)$	p
Wave 1				
None	7	1	9.14 (4)	0.057
1–2 h	8	4		
3–5 h	16	13		
6–8 h	18	15		
9 or more hours	39	55		
Wave 2				
None	11	6	17.49 (4)	0.001
1–2 h	28	15		
3–5 h	22	16		
6–8 h	11	19		
9 or more hours	12	32		
Wave 3				
None	26	12	17.97 (4)	0.001
1–2 h	21	14		
3–5 h	22	17		
6–8 h	11	23		
9 or more hours	8	22		

MVPA: moderate-to-vigorous physical activity.

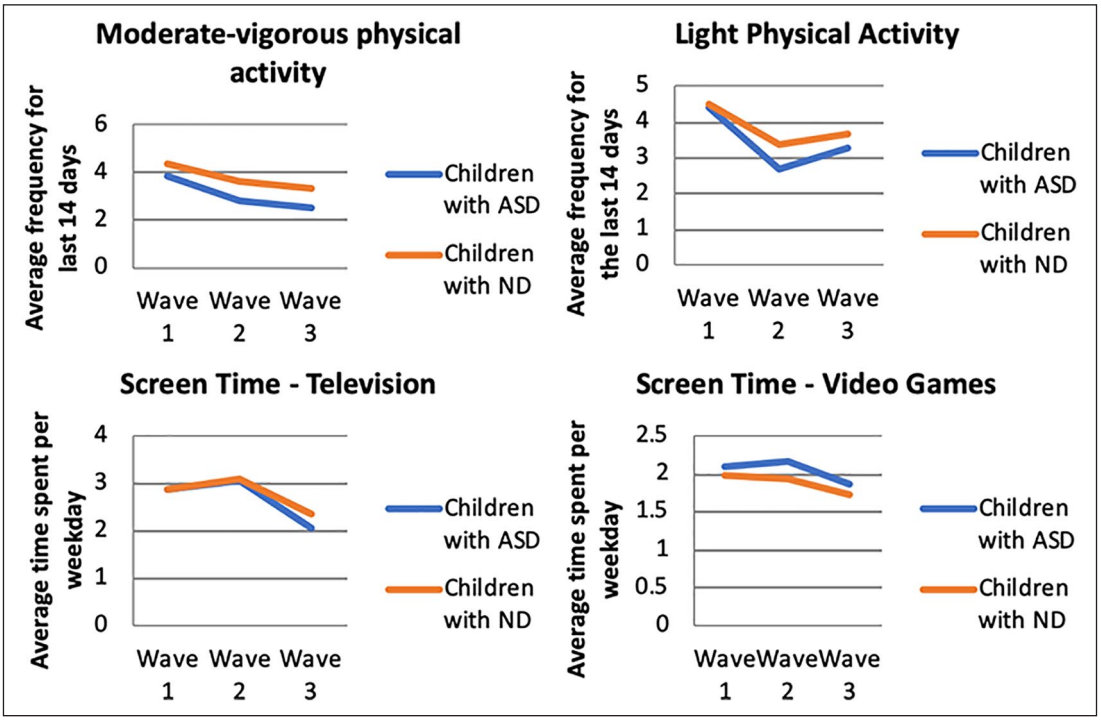

Figure 1. Trends in physical activity and screen time from 9 to 18 years.

Regression results

A robust regression analysis was run on each outcome of interest (i.e. MVPA, LPA, ST-TV, and ST-VG) at Wave 3 when children were aged 17/18 years in order to understand if ASD status was related to participation in each outcome at Wave 3 when controlling for earlier participation at Waves 1 and 2. The only statistically significant difference found in activity participation at Wave 3 was for MVPA. Specifically, having ASD was related to significantly less participation in MVPA when participants were aged 17/18 years compared to their ND peers after controlling for prior time points of MVPA participation ($b = -0.67$, $p = 0.002$). There were no statistically significant differences based on ASD status for Wave 3 outcomes of LPA, ST-TV, or ST-VG (see Table 6).

Table 3. Cross tabulations and chi-squared fisher's exact test for participation in LPA.

	Youth with ASD	Youth with ND	$\chi^2(df)$	*p*
Wave 1				
None	1	1	3.32 (4)	0.475
1–2 h	4	5		
3–5 h	14	9		
6–8 h	11	6		
9 or more hours	58	67		
Wave 2				
None	17	9	15.22 (4)	0.004
1–2 h	22	17		
3–5 h	25	26		
6–8 h	9	4		
9 or more hours	11	32		
Wave 3				
None	14	7	5.61 (4)	0.235
1–2 h	17	13		
3–5 h	19	18		
6–8 h	9	17		
9 or more hours	29	33		

LPA: light physical activity.

Table 4. Cross tabulations and chi-squared fisher's exact test for participation in TV-ST.

	Youth with ASD	Youth with ND	$\chi^2(df)$	*p*
Wave 1				
None	2	0	4.11 (3)	0.263
Less than 1 h	20	18		
1–3 h	54	63		
3 and more hours	12	7		
Wave 2				
None	1	0	4.46 (3)	0.175
Less than 1 h	18	14		
1–3 h	36	52		
3 and more hours	26	22		
Wave 3				
None	27	15	6.91 (3)	0.068
Less than 1 h	26	29		
1–3 h	27	42		
3 and more hours	3	2		

TV-ST: television screen time.

Discussion

By adolescence, youth with ASD are significantly less physically active compared to their peers with ND (MacDonald et al., 2011; McManus et al., 2012; Memari et al., 2013; Pan et al., 2016; Ratcliff et al., 2018). Our understanding of when this disparity in PA levels develops is hampered by a lack of longitudinal studies. This study, for the first time, begins to address this research gap by revealing that disparities in MVPA levels between children with ASD and children with ND, which exist at the age of 9 years, progressively worsen between the age of 9–13 years, and further worsen from the age of 13–17/18 years. Moreover, this study suggests that the disparities in LPA between groups emerge between the age of 9 and 13 years.

An age-related decline in PA levels is well documented among youth with ND, as demonstrated by longitudinal studies (Sallis, 2000); this study suggests that this phenomenon is exacerbated among youth with ASD. Several social factors are reported to contribute to the decline of PA from childhood to adolescents among youth with ND. These factors include a lack of social support and negative self-perceptions of competence to perform (Bélanger et al., 2011). These factors may be compounded among children with ASD due to their unique social and communication behaviors associated with ASD (Corvey et al., 2016). This speculation is supported by research in which children with ASD and their parents reported a host of social barriers to PA, including stress that arise from social interaction (Arnell et al., 2020), being victims of bullying in PA settings, being excluded from activities by peers or

Table 5. Cross tabulations and chi-squared fisher's exact test for participation in VG-ST.

	Youth with ASD	Youth with ND	$\chi^2(df)$	*p*
Wave 1				
None	26	22	8.42 (3)	0.027
Less than 1 h	30	48		
1–3 h	30	17		
3 and more hours	2	1		
Wave 2				
None	42	44	6.29 (3)	0.100
Less than 1 h	17	26		
1–3 h	17	17		
3 and more hours	7	1		
Wave 3				
None	27	27	6.79 (3)	0.083
Less than 1 h	43	28		
1–3 h	15	20		
3 and more hours	3	9		

VG-ST: video games screen time.

Table 6. ASD status related to Wave 3 outcome participation controlling for previous time points.

Variable name	*B* (*SE*)	*p*
Wave 3 MVPA		
ASD	−0.67 (0.22)	0.002
Wave 2 MVPA	0.25 (0.08)	0.004
Wave 1 MVPA	0.09 (0.09)	0.369
Sex	−0.71 (0.25)	0.005
Age	−0.33 (0.18)	0.060
Adjusted income	0.01 (0.001)	0.857
Wave 3 LPA		
ASD	−0.24 (0.24)	0.313
Wave 2 LPA	0.27 (0.09)	0.002
Wave 1 LPA	0.05 (0.12)	0.712
Sex	0.53 (0.28)	0.063
Age	−0.05 (0.20)	0.801
Adjusted income	−0.01 (0.001)	0.852
Wave 3 TV-ST		
ASD	−0.13 (0.22)	0.560
Wave 2 TV-ST	0.24 (0.17)	0.158
Wave 1 TV-ST	−0.12 (0.19)	0.541
Sex	0.33 (0.27)	0.218
Age	−0.12 (0.20)	0.543
Adjusted income	0.001 (0.001)	0.550
Wave 3 TV–VG		
ASD	0.10 (0.15)	0.522
Wave 2 TV–VG	0.12 (0.09)	0.195
Wave 1 TV–VG	0.05 (0.10)	0.609
Sex	−0.38 (0.19)	0.041
Age	−0.20 (0.13)	0.174
Adjusted income	−0.001 (0.001)	0.274

MVPA: moderate-to-vigorous PA; LPA: light physical activity; ST: screen time; TV: television; VG: video games; SE: standard error.

practitioners (e.g. physical education teachers) (Blagrave & Colombo-Dougovito, 2019; Healy et al., 2013; Must et al., 2015), and having difficulty initiating social interactions (Obrusnikova & Miccinello, 2012). To improve health behavior trajectories and reduce the steep decline in PA levels among children with ASD, a multi-pronged approach to increase or maintain PA among this population, as they enter adolescence, is critical. Combatting the more-severe decline in PA levels that exists for children with ASD will demand a focus on providing appropriate physical education, school-based extracurricular PA opportunities, and community and home-based PA opportunities. Examining the multi-level factors that distinguish between children with ASD who decrease, maintain, or increase their PA participation as they enter adolescence is an important precursor to these efforts.

Our data showed both ST-TV and ST-VG levels were comparable among children with ASD and children with ND at the age of 9, 13, and 17/18 years, with the exception of ST-VG at the age of 9 years. These results reflect previous studies reporting comparable levels of ST between youth with ASD and youth with ND (McCoy et al., 2016; Montes, 2016; Potvin et al., 2013). Interestingly, TV-ST levels among children with ASD decreased from the age of 13–17/18 years (to illustrate; only 30% of 17/18 years with ASD participated in more than an hour of TV-ST at the age of 17/18 years compared to 66% and 62% of children with ASD at the age of 9 and 13 years, respectively). A lack of studies of ST-TV of youth with ASD at this age make it difficult to ascertain the novelty of this finding. These data suggest that intervening to reduce levels among children with ASD *and* children with ND might be particularly warranted between the age of 9 and 13 years, when increases in VG-ST and TV-ST occur. Increased ST is positively associated with conditions including obesity, sleep problems, depression, and anxiety (Domingues-Montanari, 2017) and negatively associated with academic performance (Zimmerman & Christakis, 2005). Increased ST has also been associated with lower PA levels (Sandercock et al., 2012). The interdependence between PA and ST may contribute to the inverse relationship that appears to exist between trajectories of these behaviors, particular between LPA and ST levels for children with ASD. Giving further credence to the interdependence between PA and ST behaviors among children

with ASD, the factors reported to promote ST use among children with ASD reflect the barriers this population reports for PA (e.g. the non-social aspect of TV and VGs, the consistency and predictability of these forms of entertainment (Durkin, 2010)). Combatting decreasing levels of PA and intervening to reduce ST levels might be best tackled in unison, with multi-behavior interventions, targeting common social factors.

Strengths and limitations

The longitudinal nature of the data, collected at three time points across a critical, formative period of development (i.e. 9–17/18 years) was a strength of the study. These data provide insight into how PA and ST behaviors change or intensify through childhood to adolescence. The propensity-matched groups of youth with ASD and ND was also a strength, ensuring samples were comparable by gender and socioeconomic status.

Several limitations should also be noted and considered in the interpretation of findings. First, data collection was self- and parent-report which can increase the risk of bias as some participants may not accurately recall information. For example, previous studies have found that parent-reported measures tend to overestimate children's PA (Adamo et al., 2009). Moreover, some adolescents with ASD may not have been able to respond to the survey at the age of 13 or 17/18 years, despite the efforts made to make data collection accessible and thus dropped out of the study. Data on reasons for attrition are not available. Second, the sample size of this study was relatively small, decreasing the statistical power of the results and making generalizability difficult. This is particularly salient among the heterogeneous population of children with ASD. Third, data collection began in 2003 and ended in 2016. The benefit of having such a long time-period to study also incurs the issue of having to consider socio-cultural and technological changes that occur during this time-period. For example, use of the Internet has grown exponentially in the last decade (Anderson et al., 2017). It is unknown how trajectories of PA and ST from the age of 9–17/18 years will evolve in the coming decades.

Conclusion

Our understanding of PA and ST levels among children with ASD is largely derived from cross-sectional studies, which limit our ability to observe trajectories of behavior. This study expands upon this research by examining PA and ST over a longer time-period (8 years), with data collected at three different time points. This longitudinal data provide a comprehensive account of PA and ST patterns. Most notably, the data demonstrate disparities in MVPA between children with ASD and ND to progressively worsen from the age of 9–18 years, and disparities in levels of LPA to worsen from the age of 9–13 years. Longitudinally studies of PA and ST among younger children with ASD, larger samples, and using objective measures of PA and ST are urgently required.

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ORCID iDs

J Dahlgren https://orcid.org/0000-0003-2356-7838
S Healy https://orcid.org/0000-0003-3233-8287
JA Haegele https://orcid.org/0000-0002-8580-4782

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