



# Comparison of Physical Activity, TV/Video Watching/Gaming, and Usage of a Portable Electronic Devices by Children With and Without Autism Spectrum Disorder

Kristi S. Menear<sup>1</sup> · James M. Ernest<sup>1</sup>

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## Abstract

**Objective** Individuals with autism spectrum disorder (ASD) participate in less physical activity (PA) and more sedentary behavior than their peers without ASD.

**Methods** The study employed Chi-square analyses of the NSCH 2016–2017 data to compare PA, TV/video watching/gaming, and usage of portable electronic devices by children with and without ASD by age and ASD severity.

**Results** Results suggest more than two and a half times as many children 6–11 and 12–17 years old with ASD failed to engage in 60 min of PA during the past week compared to peers without ASD. As children aged, their PA time decreased, with a larger percentage drop for children with ASD. For children ages 6–11 years, an inverse relationship was found between PA and ASD severity that was not found for older children. As the children got older, children with ASD spent more time watching TV/video watching/gaming than peers without ASD, with differing results by ASD severity. More children Birth to 5 years ASD used portable electronic devices than their peers without ASD and more young children with ASD used devices for 3 or more hours a day. Roughly the same proportions of children 12–17 years old used devices for more than 3 h a day but differential results were found between children with and without ASD for less than 1 h of device use.

**Conclusions for Practice** These data can be used to advocate for individualized PA interventions and services to increase PA and decrease sedentary behaviors of children with ASD.

**Keywords** Autism · Physical activity · Exercise · TV/video watching/gaming · Portable electronic device

## Significance

*What is already known on this subject?* Previous research shows children with autism spectrum disorder (ASD) participate less in physical activity (PA) and exercise than their typically developing peers and spend more time than their peers in sedentary behaviors.

*What this study adds?* This study analyzes the newest data from a national data set. The study compares participation by children 0–17 years old without ASD to children with ASD, by severity level, in PA, time spent TV/video watching/gaming, and use of a portable electronic device. To our

knowledge, this is the first study to include data on a wide range of electronic devices, inclusive of tablets, that takes into account the recent large swings in how often children watch TV/video watching/gaming and use portable electronic devices. Given prior research that indicates strong relationships between technology use and PA, this is the first study to explore the severity levels of ASD as they relate to technology use and PA. These data can be used to advocate for individualized PA interventions and the appropriate supporting services in order to increase the PA behaviors and decrease the sedentary behaviors of children with ASD.

## Introduction

New *Physical Activity Guidelines for Americans* (U.S. Dept. of Health and Human Services 2018) recognize the importance of physical activity (PA) on health. However, research shows that individuals with autism spectrum disorder (ASD)

✉ Kristi S. Menear  
kmenear@uab.edu

<sup>1</sup> School of Education, University of Alabama at Birmingham, 1720 2nd Ave S., EEC 321E, Birmingham, AL 35294-1250, USA

participate in less PA and more sedentary behavior than their peers without ASD (Corvey et al. 2016). Similar to individuals who follow typical development, this lower PA and higher sedentary behavior in children and adolescents with ASD has been associated with a negative impact on the physical domain. However, an association was found with poor cognitive or social skills in children and adolescents who exhibit less PA and more sedentary behavior (Memari et al. 2017).

When they do participate in PA, individuals with ASD can experience benefits to physiological, cognitive, psychological, and behavioral functioning (Sorensen and Zarrett 2014). PA by individuals with ASD was shown to significantly improve sleep quality and cognition in individuals (Tse et al. 2019), motor skills and executive function (Pan et al. 2017), physical fitness (Ana-Maria and Ion-Sebastian 2018), and multiple domains of their health-related quality of life (Hamm and Yun 2019). Most notably, exercise has been identified as an evidence-based practice for students with ASD (Sam et al. 2019). However, implementing PA interventions can be quite challenging with this population. Barriers to PA for individuals with ASD may include deficits in motor skills, sedentary behavior and obesity, social and behavior deficits associated with ASD, parental concerns, and lack of appropriate programs (Nichols et al. 2019).

Another barrier to PA for children with ASD may be the amount of time they spend with TV/video games or using a portable electronic device, or overall screen time (Mazurek et al. 2012). Mazurek and Wenstrup (2013) collected data on the use of electronic devices by 202 children and adolescents with ASD and 179 typically developing siblings. The children with ASD spent more time watching TV and playing video games than in all non-screen activities combined and more hours per day playing video games. They also had higher levels of problematic video game use.

In a systematic review of 35 studies, none of which included digital tablets but some of which included other screen usage, Jones et al. (2017) studied the prevalence and correlates of physical activity and sedentary behaviors in children with ASD compared to typically developing peers. Children with ASD spent more time with screens, more time in sedentary behaviors, and less time in PA than typically developing peers. Age was inversely associated and sex inconsistently associated with PA, and age and sex were inconsistently associated with sedentary behavior.

Healy and Garcia (2019) compared psychosocial factors related to PA and screen-time of children 9 years old with and without ASD. The children with ASD participated in less PA than their typically developing peers. A significant association between ASD and bullying was found for light PA. Children with ASD who reported having been bullied were less likely to participate in light PA. No significant differences were found in participation of lower PA or daily

screen time of two groups of children. Children with ASD had lower perceptions of their popularity, greater anxiety, more peer challenges, and lower ratings of prosocial behavior.

Research studies have explored the independent relationship of PA and sedentary behaviors on health outcomes for typically developing children, but not for children with ASD. In typically developing children, there appears to be independent positive impacts on their health and fitness, particularly those children who are overweight or obese, when sedentary behaviors, often defined as TV viewing, are reduced and/or physical activity levels are increased. One study showed that reducing sedentary behaviors had the greater positive impact (Epstein et al. 1995). Mitchell et al. (2012) positively associated sedentary behavior with obesity in 12-year-olds, and found that low levels of moderate-to-vigorous physical activity increased the sedentary 12-year-olds' odds of being obese. With evidence that excessive use of screen-based media is linked to overweight and obesity in children, reducing TV viewing is associated with decreased health risk factors (Marshall and Ramirez 2011). We do not have data on whether or not reducing screen-based media usage by individuals with ASD might improve participation in PA, as has been shown in typically developing peers. A better understanding of time spent by children with ASD in PA, with TV/videos, and with other portable electronic devices is needed in order to determine if research such as these studies with typically developing children should be replicated with children with ASD.

The National Survey of Children's Health (NSCH) data set has been previously analyzed to better understand use of screens, prevalence of overweight/obesity, and PA by children and adolescents with and without ASD. In an analysis of the 2011–2012 data, Montes (2016) did not find evidence that children with ASD differ in their screen time habits from other children (both groups had high screen usage); however, ASD data were not analyzed by severity level. Johnson et al. (2016) used the same data set and found children and adolescents with ASD had higher prevalence of being obese and overweight than children and adolescents without ASD, with television time as a predictor for both groups. The analysis also indicated that children with ASD who used portable electronic devices for 4 or more hours per day were more likely to be overweight or obese than those who did not use devices. Healy et al. (2018) looked at NSCH 2011–2012 data for children 6 years of age and up with and without ASD. Focusing on their results for children with ASD, the researchers found no environmental factors were associated with PA, and the presence of a bedroom TV and the lack of limits on screen time were associated with screen time.

As reviewed above, children with ASD participate in less PA and more sedentary behaviors, including more screen time, than their peers without ASD even though they receive

similar benefits from PA as their peers. Evidence suggests characteristics of the diagnosis, parental influence, community factors, and screen time may contribute to these findings related to activity levels. National data (Anderson 2015) indicate that by 2015, 68% of adults had a smartphone and 45% had a tablet computer. These percentages were up from 35% with smartphones and only 3% having a tablet in 2010. In addition, by 2017, 98% of children age 8 and under live in a home with a mobile device (Common Sense Media 2017). Prior research about technology has often focused on watching TV and DVD/Video, using video game equipment, and using laptop or tower computers. The Common Sense Media survey found decreases in TV/DVD/Video gaming and computer use for children, with a ninefold (from 4% in 2011 to 35% in 2017) increase in how much time was spent with mobile devices. The increased availability of smart phones and electronic tablets at home, in schools, and during intervention means that individuals with ASD likely have more opportunities for screen time usage.

During a time of more access to screens, do individuals with ASD continue to exhibit low levels of PA? Given the amount of time that individuals with ASD have been shown to spend with screens used by a variety of devices (not including tablets), given the many benefits of PA, and given the widespread understanding that PA should be individualized in order to have optimal benefit, it is important to know what the most current data suggest about children with ASD. It is also important to explore PA and screen time that includes tablets by age and ASD severity level. Current data regarding how time is spent by children and adolescents with and without ASD can inform decisions regarding future individualized behavioral interventions and educational lessons that aim to increase PA and decrease sedentary behaviors in children with ASD, including subgroups of children and adolescents with similar ASD severity levels.

The purpose of this research was to analyze the NSCH 2016–2017 data by comparing PA, TV/video watching/gaming, and usage of portable electronic devices by children with and without ASD by age and severity level of ASD. The NSCH 2016–2017 data set identifies the severity level of the child with ASD. Even though the 2011–2012 data set included a question about children's use of TV/video watching/gaming and a question about using portable electronic devices, usage of these devices has changed considerably over the past decade (Alkhayat et al. 2020). For example, one survey found a 50% decrease in TV/video watching and a 350% increase in mobile device use for young children from 2011 to 2017 (Common Sense Media 2017). We have not seen current data that compare children with ASD by age from 0 to 17 years and by severity level to children without ASD regarding PA, TV/video watching/gaming, and usage of portable electronic devices. Therefore, our specific research questions were, are there statistically significant

differences in (1) the weekly amount of exercising, playing a sport, or participating in PA for at least 60 min differ by age groups and severity levels for children with ASD compared to typically developing peers, (2) the average time on a weekday spent in front of a TV watching TV programs, videos, or playing video games differ by age groups and severity levels for children with ASD compared to typically developing peers, and (3) the average time on a weekday spent with computers, cell phones, handheld video games, and other electronic devices, doing things other than school-work, differ by age groups and severity levels for children with ASD compared to typically developing peers.

## Methods

The NSCH, funded and directed primarily by the United States Health Resources and Services Administration's Maternal and Child Health Bureau, provided national and state-level data on the physical and emotional health of American children 0–17 years old (2016/2017 National Survey of Children's Health 2019). The 2016–2017 surveys were conducted by the United States Census Bureau. Random sampling by mail occurred to identify households with one or more children under 18 years old. One child per household was randomly selected to be the subject of the survey, with an oversampling of children with special health care needs and children 0–5 years of age. For 2016–2017, a total of 71,811 surveys were completed (50,212 in 2016 and 21,599 in 2017). An initial screen questionnaire was used prior to a more detailed, age-specific questionnaire that was applied to only one child per household. Respondents were a parent or caregiver with knowledge of the health and health-care of the child. Households had the option to respond via a web instrument or a paper instrument, both of which were available in English and Spanish. The combined data set for 2016 and 2017 allows for more opportunities to analyze variables with small sample sizes or low prevalence and to conduct more complex analysis across variables.

From the completed questionnaires, 1711 respondents to the 2016–2017 NSCH indicated they currently had a child with Autism, Autism Spectrum Disorder, Asperger's syndrome, or Pervasive Developmental Disorder (survey grouped all 5 into "ASD"). The 1711 families in the sample represent 2.4% of all participants in the survey. Compared to the families who did not have children with ASD, there were slightly more families (15.3% vs. 10.5%) with a child with ASD that were 0–99% of the federal poverty level, and fewer families with a child with ASD (35.5% vs. 43.1%) that earned 400% or more of the federal poverty level (Table 1). A frequency analysis of the racial make-up of the sample of families indicated small differences between the two groups.

**Table 1** Household income and racial background by ASD status

	No ASD		ASD	
	<i>n</i>	%	<i>n</i>	%
Federal poverty level using DHHS guidelines	69,717	97.6	1711	2.4
0–99%	7333	10.5	261	15.3
100–199%	10,868	15.6	321	18.8
200–399%	21,435	30.7	521	30.5
400% or higher	30,081	43.1	608	35.5
Race of child				
White	53,853	77.2	1318	77
Black or African American	4359	6.3	124	7.2
American Indian or Alaska Native	510	.7	17	1
Asian	3802	5.5	71	4.1
Native Hawaiian and Other Pacific Islander	205	.3	3	.2
Other race	1771	2.5	44	2.6
Two or more races	5217	7.5	134	7.8

Chi-squared analyses explored percentage responses regarding children with and without ASD on the child's: (1) weekly amount of exercising, playing a sport, or participating in PA for at least 60 min by age groups and severity levels ("PA time"), (2) average time on a weekday spent in front of a TV watching TV programs, videos, or playing

video games ("TV/video watching/gaming"), and (3) average time on a weekday spent with computers, cells phones, handheld video games, and other electronic devices, doing things other than schoolwork ("portable electronic devices"). Respondents for the NSCH were only asked to indicate PA time for at least 60 min within a day during the last week if the child was 6 or more years of age. In the combined 2016–2107 data set, a new data variable was created that aggregated children with ASD if the response was moderate or severe. However, the authors of this research article chose to analyze the ASD data using the 2016 and 2017 criteria of mild, moderate, and severe for exploratory purposes related to practical implications for the field.

## Results

The first set of analyses examined the weekly amount of exercising, playing a sport, or participating in PA for at least 60 min by age groups and severity levels. Chi-square analyses found significant differences among the percentages of children with and without ASD that engaged in PA for greater than 60 min at least once a day (see Table 2). Almost 21% of children with ASD did not have a single day of 60 min or more PA during the week which contrasts with only 8% of children without ASD. For children ages 6–11 years old, 11.4% of those with ASD versus 3.6% of

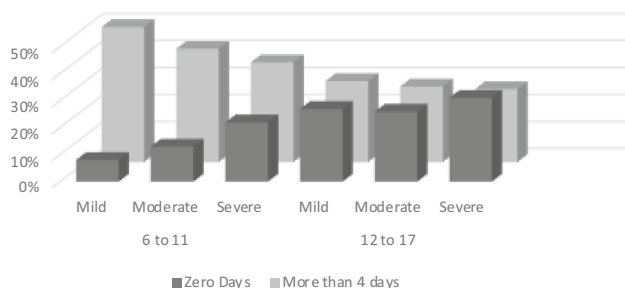
**Table 2** Chi-square analyses of diagnosis, severity of ASD, and PA, TV watching/gaming, and portable device use

	Chi-Square	df	P value	Eta
PA for > 60 min by diagnosis	394	3	< .001	.09
6–11 year olds	129	3	< .001	.08
12–17 year olds	266	3	< .001	.10
PA for > 60 min by severity of ASD	11	6	.079	.08
6–11 year olds	17	6	.008	.17
12–17 year olds	3	6	.810	.04
TV watching/video game play by diagnosis	270	5	< .001	.06
1–5 year olds	62	5	< .001	.06
6–11 year olds	45	5	< .001	.05
12–17 year olds	130	5	< .001	.07
TV watching/video game play by severity of ASD	35	5	< .001	.12
1–5 year olds	8	10	.606	.17
6–11 year olds	41	10	< .001	.20
12–17 year olds	15	10	.134	.10
Using portable electronic devices by diagnosis	232	5	< .001	.06
1–5 year olds	104	5	< .001	.07
6–11 year olds	125	5	< .001	.08
12–17 year olds	186	5	< .001	.08
Using portable electronic devices by severity of ASD	45	10	< .001	.15
1–5 year olds	7	10	.733	.16
6–11 year olds	25	10	.005	.19
12–17 year olds	36	10	< .001	.17

those without ASD reported zero days of 60 min of PA. With the older age group, 27.3% of the 12–17-year-olds with ASD and 11.2% of their peers without ASD had zero days where they engaged in 60 min or more PA. Findings indicated 16.5% of 12–17-year-olds without ASD and 27.9% of 6–11-year-olds without ASD were engaged in PA every day compared with 10.6% of 12–17-year-olds with ASD and 20.3% of 6–11-year-olds with ASD.

Children that were 6–11 years old engaged in significantly more PA for 60 min than 12–17-year-old children. The same percentage (44%) of younger and older children with ASD engaged in PA for 1–3 days. However, 24.8% of 6–11-year-old children with ASD and only 18.3% of 12–17-year-old children with ASD met the PA criteria for 4–6 days. The largest difference was 20.3% of younger children with ASD versus 10.6% of older children with ASD met the PA requirement every day. Results also varied by ASD severity for engagement in PA (see Fig. 1). For the younger 6–11-year-old children, children with more severe levels of ASD engaged in less PA of 60 min or more than children with milder forms of ASD. At the same time, analysis indicated a corresponding decrease in the number of children from mild to moderate to severe ASD that had 60 min of PA for 4 or more days. No significant differences across ASD severity levels were found for the 12–17-year-old children with ASD (see Table 2).

The second set of analyses examined the average time on a weekday spent in front of a TV watching TV programs, videos, or playing video games, with response options of: Less than 1 h, 1 h, 2 h, 3 h, or 4 or more hours per day. Results indicated Chi-square statistically significant differences (Table 2) for all of the three age groups by time and diagnosis of ASD. Children with ASD engaged in substantially more TV/video watching/gaming than children without ASD. For example, results for watching TV/video watching/gaming for more than 4 h a day were: 12% of 0–5-year-old children with ASD versus 3.7% of their peers without ASD; 9.7% of 6–11-year-old children with ASD versus 5.0% of their peers without ASD; and 21% of 12–17-year-old children with ASD vs. 10.9% of their peers without ASD.

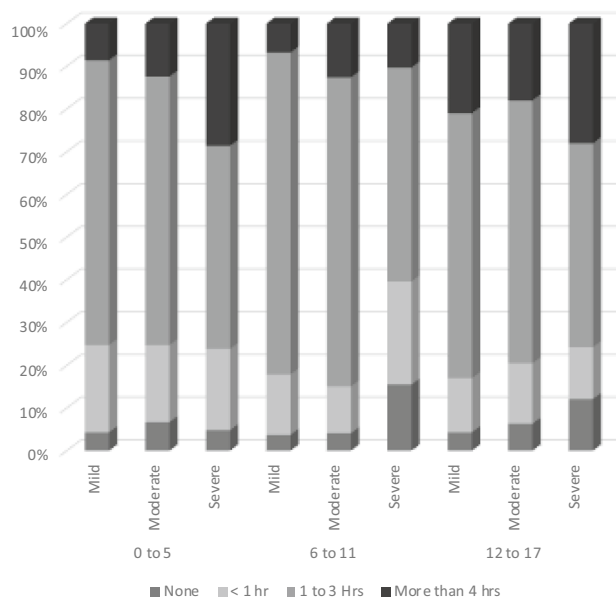


**Fig. 1** Physical activity for 60 min/day in the past week by ASD severity and age

Three times as many children with ASD (16.2%) vs. 5.4% of 0–5-year-old children without ASD did not watch/participate in any TV/video watching/gaming. This result for young children contrasts with the two older groups of children that had similar percentages for children with ASD and without ASD who did not engage in TV/video watching/gaming.

Chi squared analyses indicated that the only statistical difference for TV/video watching/gaming and severity of ASD was with the 6–11-year-old children (Table 2). Of note (Fig. 2), 16% of children with severe ASD watched no TV compared to 4.1% of children with moderate ASD and 3.7% of children with mild ASD. Results indicated 16.6% of children with mild ASD, 28.9% of children with moderate ASD, and 24.1% of children with severe ASD spent 3 h or more with TV/video watching/gaming.

The final set of analyses explored children with and without ASD and average time on a weekday spent with computers, cells phones, handheld video games, and other electronic devices, doing things other than schoolwork. Chi-square analyses indicated significant differences for all three age groups of children by diagnosis (Table 2). The largest differences were between 12 and 17-year-old children with and without ASD. Children with ASD used a portable electronic device for an average of 3+ h/weekday more often than children without an ASD, with differential effects for the age of the child. Findings indicate contrasts of 15% of 0–5 years-old children with ASD vs. 4.5% of children without an ASD; 23.3% of 6–11-year-old children with ASD versus 12.3% of children without ASD; and 46% 12–17-year-old children with ASD vs. 41% of children without ASD.



**Fig. 2** Average time per day in front of a TV by ASD severity and age



A Chi squared comparison of age by ASD severity for using portable electronic devices found significant differences for children ages 6–11-years-old and 12–17-years-old, but not for the 0–5 year-old children (Table 2). For children 6–11-years-old and 12–17-years-old, data indicated an increasing trend (Fig. 3) of children with a greater degree of severity of disability not using a portable electronic device. At the same time, for all three age groups, children with more severe ASD used portable electronic devices for more than 4 h to a greater degree than children with mild or moderate levels of ASD.

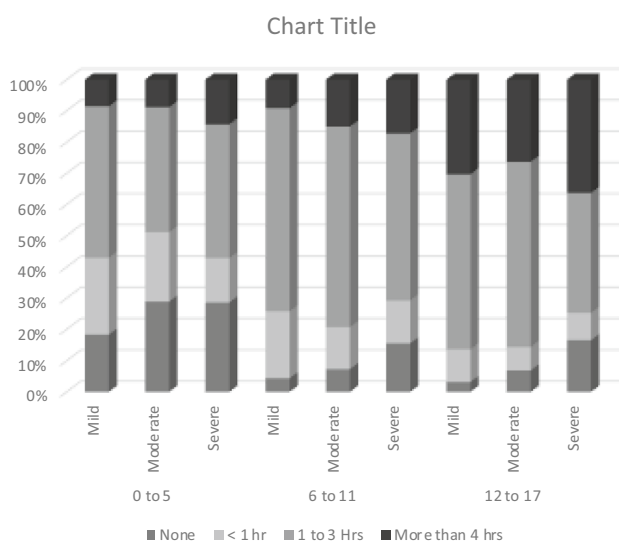
## Discussion

Results of this study support existing literature that indicates there is a notable difference in PA participation by children with and without ASD from birth to 17 years old. Of particular concern is the finding in this study that more than two and a half times as many children 6–11 years old and 12–17 years old with ASD failed to engage in 60 min or more of PA time during the past week compared to age-matched children without ASD. In many schools and communities, these age ranges are the ones with school-based and community-based opportunities for PA, including physical education, inclusive sports and recreational opportunities, after-school non-profit services, and various programs for therapeutic recreation. Additionally, the current national guideline (U.S. Dept. of Health and Human Services 2018) of participation in PA at least 60 min daily by children in these age groups has been a recommendation since the original guideline was published in 2008.

Yet, even with the guideline and the likelihood of multiple PA opportunities, as all children in this study increased in age, their PA time decreased but the percentage drop was larger for children with ASD. This begs the question, “How are children and adolescents with ASD spending their time?” For the age-related results of our other two research questions, our analysis indicated that as the ages of most children in this study increased, children with ASD spent more time watching TV/video watching/gaming than their peers without ASD and they engaged with portable electronic devices for longer periods of time than their peers without ASD, a finding that provides new information given the previous lack of research that included portable electronic devices.

This study provides initial data on ASD severity levels related to PA, time spent watching TV/video watching/gaming, and use of portable electronic devices. As severity of ASD increased across all age groups, time spent in PA decreased. However, it is interesting that results for time spent watching TV/video watching/gaming did not show trends by severity of ASD across the age ranges. Children 6–11 years old with severe ASD spent the least amount of time with TV/video watching/gaming, yet children 0–5 years and 12–17 years with severe ASD spent the most amount of time with TV/video watching/gaming compared to their age group peers with mild or moderate ASD. The largest percentage of children watching more than 4 h of TV/video watching/gaming were the Birth to age 5 children with severe ASD. Like time spent in PA, as ASD severity levels increased across all age groups, there was more daily usage of portable electronic devices doing things other than schoolwork.

The findings for PA and sedentary behaviors of children with ASD are largely supported by prior research regarding American children, as presented in a systematic review by Jones et al. (2017). In addition, using the 2016 NSCH data set, Ratcliff et al. (2018) found that children with ASD from 6 to 7 years old had significantly lower participation levels in *physical, recreational, social, skill, and jobs/chores activities* than typically developing children. Older children with ASD had greater disparity among the types of leisure activities. The same 2016 NSCH data set was analyzed by McCoy and Morgan (2020), who found adolescents (10–17 years old) with ASD were less likely to engage in 60 min of PA as the severity of their diagnosis increased. Using the same data set we used, McCoy and Morgan (2020) found that adolescents with ASD (severity was not analyzed) were more likely than their typically developing peers to watch TV for more than 2 h/day but were not more likely to use computers/portable electronic devices for more than 2 h/day. Factors that inhibit or prohibit PA by children with ASD could be related to symptoms of ASD, the PA environment, family context that limits or provides related supports or resources,



**Fig. 3** Average time per day using a portable electronic device by ASD severity and age

availability of trained PA professionals, and neighborhood or home environment (Healy et al. 2018).

Collectively, our results and research reviewed in this article indicated that children with ASD do not follow the American Academy of Pediatrics' most recent policy statement on screen time (AAP Council on Communications and Media, Media and Young Minds 2016). The policy statement reviews research on the impact of screen time on overall development, sleep, obesity, and parent interaction. The policy discourages use of screen media other than video-chatting for children younger than 18 months, advises only high-quality programming/apps for children 18–24 months with shared usage between parent and children and an avoidance of the child using the screen solo, and promotes a limit of 1 h or less a day of high-quality programming for children older than 2 years.

Notably, the NSCH data we analyzed did not include questions about what portable electronic devices are used for, except noting “other than ‘schoolwork’”. It is possible the time children with ASD spend with portable electronic devices may be caused by adult-directed interaction with the devices. Although typically conducted with a low number of participants, studies employing video games as a form of intervention have been used to teach children with ASD skills such as sportsmanship (Ferguson et al. 2013); motor skills (Taheri and Sotoodeh 2018); functional skills for use in contexts such as home, school, community, and job (Goo et al. 2019); daily living and motor skills (Kellems et al. 2018); social interactions (Stone et al. 2019); social skills, living skills, and academic skills (Withey 2017); social play (Francis et al. 2019); music education in an environment that decreased stress, and anxiousness, increased socialization, and promoted friendships (Hillier et al. 2016); and improved communication skills (Alzrayer and Banda 2017).

Also important to note is the time with portable electronic devices may not equate to child being sedentary during that time. It would be informative for future research to explore how children with ASD at all severity levels interact with portable electronic devices, and determine the percentage of time this interaction represents sedentary behaviors vs. PA. If a significant amount of time spend with portable electronic devices is in sedentary behaviors, then this time along with the time spent watching TV/video watching/gaming and using home gaming system, may be opportunities for caregivers to encourage the child with ASD to participate in PA. Using portable electronic devices to increase PA may also capitalize on the preference visual input of individuals with ASD (Mazurek et al. 2012).

Capitalizing on their familiarity with videos and portable electronic devices, exergaming may be one way to improve the PA time for children with ASD (Dickinson and Place 2014; Golden and Getchell 2017). It may also be a way to address the results we found regarding ASD severity levels

because exergaming may be more accessible and adaptable to individual preferences and developmental levels than in-person PA. Stanish et al. (2017) found adolescents with ASD spent less time in moderate and vigorous PA than typically developing peers, but the time they did spend was most often via walking/hiking or active video gaming. Other research indicated exergaming sessions provided a significant increase in heart rate (Bittner et al. 2017; Ryuh et al. 2019). Given the common usage of portable electronic devices by young children with any ASD severity level, as shown in this study, and the positive outcomes cited above, exergaming may be an appropriate form of PA intervention for young children with ASD, as well as one that could potentially remain viable as they age, and should be explored in future research studies.

In order for any form of virtual reality, including exergaming, to have a long-term positive impact on individuals with ASD, research shows that the space must be tailored to their individual need, which would include ASD severity level. A systematic literature review of studies employing PA-based interventions for adolescents with ASD found that highly effective intervention mechanisms included prompting, modeling, praise, and structured teaching (Sorensen and Zarrett 2014). The sensory load in the system must also be appropriately controlled and adapted to meet the sensory needs of the individual (Boyd et al. 2018). Therapeutic ‘games’ (or exergames) should integrate the expertise of clinicians, input of children, and experience of designers to achieve objectives and be enjoyable for children (Malinverni et al. 2017). Applications that aim to teach basic relational concepts should employ best practices from early intensive behavioral intervention (Mykyta and Zhou 2017).

The results of this study should be interpreted in consideration of its limitations. The survey relies on self-report, which yielded a data set limited to cross-sectional analysis. The authors did not control the questions in the survey and were unable to explore variables, specifically; (1) we do not know what the portable electronic devices were used for “other than schoolwork”, and some of that usage could have included PA; therefore, we cannot assume that all of the time reported as device usage time employed sedentary behaviors; (2) we do not know the children’s gross motor proficiency levels and can only make somewhat educated assumptions about such based on ASD severity level; (3) we do not know the family context, particularly how much parents or other caregivers do or do not engage in PA and how influential their behaviors are on their children; and (4) we do not know the specifics of the PA. In addition, we did not control for comorbidities, maladaptive behaviors, or medications. While previous research has not shown strong associations with these factors and levels of PA by children with ASD (Corvey et al. 2016; Jones et al. 2017), those studies did not include portable electronic device use. Finally,

demographic information for the families who had a child with ASD indicated a slightly larger percentage of families in the 0–99% category of Federal Poverty Level. Although prior research (Rideout and Katz 2016) has indicated few differences between household income, other research (Common Sense Media 2019) has indicated that tweens from higher-income homes are on social media less than tweens from lower-income households. The availability and use of electronic handheld devices, and these relationships to physical activity remains an area of limited research when considering children with ASD.

These data, which used a large sample size from a national study and included a comparison group, can be used to advocate for individualized PA interventions and the appropriate supporting services in order to increase the PA behaviors and decrease the sedentary behaviors of children with ASD. As children spend a large portion of the year in schools, teachers, and physical educators in particular, should create positive and supportive opportunities for children to engage in PA, with particular emphasis on teaching motor skills to young children and helping them implement them in appropriate environments, establishing healthy habits that could help increase time spent in PA as they age (Jones et al. 2017). This is especially important for children with a greater severity of ASD, as this study demonstrated that these children spend a disproportionate amount of time TV/video watching/gaming and using portable electronic devices, while at the same time having the largest percentage of days without a single 60-min bout of PA.

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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