Journal of Autism and Developmental Disorders
https://doi.org/10.1007/s10803-018-3818-0

ORIGINAL PAPER

Environmental Factors Associated with Physical Activity and Screen Time Among Children With and Without Autism Spectrum Disorder

Seán Healy[1] · **Jeanette M. Garcia**[2] · **Justin A. Haegele**[3]

Abstract
This study aimed to examine how environmental factors are associated with physical activity (PA) and screen-time (ST) among children with and without ASD (n = 1380 and 1411, respectively). For TD children, the absence of a bedroom television and neighborhood support were associated with PA. For children with ASD, no environmental factors were associated with PA. Regarding ST, the presence of a bedroom television, absence of limits on ST, lack of neighborhood amenities and support, and adverse neighborhood factors were all associated with ST among TD children. For children with ASD, the presence of a bedroom television and the absence of limits on ST were associated with ST. Potential explanations for this dichotomy and suggestions for future research are discussed.

Keywords Physical activity · Sedentary behavior · Environment · Neighborhood · Home

Introduction

Children, with and without ASD, who regularly engage in physical (PA) enjoy a plethora of physical, psychological, and social benefits (Centers for Disease Control and Prevention (CDC), 2014; Healy et al. 2018). Conversely, sedentary activities, such as screen-time (ST) activities (e.g. TV, computer, video games, etc) have been associated with a host of negative outcomes, including adiposity (Bener et al. 2010; Falbe et al. 2013; Johnson et al. 2016) and poor sleep (Beyens and Nathanson 2018; Mazurek et al. 2016). There has been growing interest in the importance of the environment in explaining the health behaviors of children, including physical activity (PA) and sedentary behavior, particularly screen-time (ST) (Ding and Gebel 2012). Reviews of literature have identified several environmental features that may encourage or discourage youth PA: for example, access to infrastructure that promotes active transport is positively associated with PA, while infrastructure that discourages active transport (e.g. number of roads to cross and traffic density/speed) and adverse neighborhood conditions (e.g., crime, area deprivation) are negatively associated with children's PA (e.g. Ding et al. 2011; Davison and Lawson 2006). For adolescents, supportive correlates of PA are land-use mix (where residential, commercial, cultural, institutional, or industrial uses are integrated) and residential density (Ding et al. 2011). Environmental factors within the home may also affect PA and ST behavior (Maitland et al. 2013). A review of 49 studies on the influence of the home environment on children's PA and ST concluded that media equipment in the home, and specifically the bedroom, is associated with ST (Maitland et al. 2013). Interestingly, evidence of the influence of other factors within the home environment and PA an ST have been inconclusive, suggesting the need for further exploration into the link between home environment and PA/ST. There is limited evidence of the influence of home environment (i.e., PA equipment, presence of a yard) on PA, however, inverse correlations have been found between the availability of PA equipment and ST (Maitland et al. 2013). The limited evidence demonstrates the need to further investigate the environment-PA/ST relationship, and to determine whether certain demographic factors may moderate this relationship (Ding & Geleb, 2012). For intervention development and individualization, an understanding of how the environment-PA/ST relationship differs for sub-groups of

✉ Seán Healy
Healys@udel.edu

[1] Department of Behavioral Health and Nutrition, University of Delaware, Newark, DE 19711, USA

[2] Department of Educational and Human Services, University of Central Florida, Orlando, FL, USA

[3] Department of Human Movement Sciences, Old Dominion University, Norfolk, VA, USA

Published online: 16 November 2018

the population is required. Thus far, research on this phenomenon is limited to examination by specific age (Burdette and Whitaker 2005; Adkins et al. 2004; Dunton et al. 2003), gender (Bocarro et al. 2015; Hume et al. 2004), and ethnicity groups (Adkins et al. 2004; McKenzie et al. 2008). However, no studies have examined whether the environmental-PA/ST relationship differs among individuals with a disability, such as autism spectrum disorder (ASD). Given the increasing prevalence of ASD, it is imperative to understand how the presence of this disorder may alter the relationship between the environment and PA/ST.

In addition to the core characteristics of deficits in social communication and social interaction, and restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association 2013), children with ASD often experience a range of co-morbidities such as anxiety, attention-deficit hyperactivity disorder, bipolar disorder, developmental coordination disorder, and intellectual disability (Treating Autism and Autism Treatment Trust 2013). For some individuals with ASD, these symptoms and co-morbidities may pose significant challenges regarding participation in PA. Despite all of the benefits of PA participation, youth with ASD may view PA experiences as socially demanding, unpredictable, sensory-stimulating, and uncomfortable, which may elicit an increased stress response (Healy et al. 2013) resulting in many children with ASD opting for more sedentary pursuits. As such, researchers have demonstrated that the PA levels of children with ASD tend to be below that of their TD peers (Scharoun et al. 2017), especially during adolescence (Healy et al. 2017; MacDonald et al. 2011). Similarly, research has demonstrated that children with ASD (aged 3 to 11) are more likely to exceed the recommended two hours of ST on weekdays and at weekends than their TD peers (63% vs 40%, and 90% vs 62% respectively) (Must et al. 2014).

To aid intervention development for this population, researchers have examined factors associated with participation in PA and ST. For example, Memari et al. (2015) sought to identify the individual and social factors that contributed to participation in leisure physical activities among 83 children with ASD (aged 6–15 years), and gender, family income, and household structure were found to be associated with activity levels. More recently, a review (Jones et al. 2017) of correlates of PA among children with ASD reported a consistent negative association between age and PA and an inconsistent association between sex and PA, which differs from the majority of findings in TD youth that show males as having greater levels of PA compared to females. While Jones and colleagues (2017) reported the correlates of PA in youth with ASD, the authors acknowledged that there is a need for studies investigating the comparison of correlates of PA/ST between children with ASD and TD children. Further, they asserted that correlates of PA and ST among children with ASD and how they differ from TD children remains largely unknown (Jones et al. 2017).

It is logical to suggest that the interaction with the environment, and its effect on health behavior choices, may differ among children with ASD and their families in comparison to TD peers. Different social, sensory, and behavioral characteristics may result in the environment influencing PA and ST differently. Indeed, in research examining barriers to PA participation among this population, environmental barriers were reported and children with ASD rated community barriers (such as a lack of transportation to PA programs) and physical barriers (such as a lack of or unsafe equipment) among the most frequent barriers they faced (Obrusnikova and Miccinello 2012). Thus, there is a clear need for understanding how environmental factors influence PA and ST among children with ASD. Therefore, the purpose of this study was to examine how neighborhood and home environmental factors are associated with PA and ST among children with and without ASD.

Method

Data from the 2011–2012 cross-sectional National Survey of Children's Health (NSCH) was used was in this study. The NSCH assesses the health and well-being of children aged 0 to 17 years, including several psychosocial and environmental factors. Data from the current study included children who were at least 6 years in age. Data were collected from parents or guardians by telephone, from February 2011 to June 2012. List-assisted random-digit dialing was used to identify households with children aged 0–17 years. After screening for the presence of children in the home, one child per household was randomly selected for the study. Additional information about the 2011–2012 NSCH can be found in the Centers for Disease Control and Prevention (2013) frequently asked questions document.

Sample

The current study included youth whose parents reported a current diagnosis of ASD, and a comparative sample of TD youth matched by age level (6–11; 12–17) and gender. Therefore, the current sample involved 2791 participants (1380 with ASD and 1411 TD children). Children were included in the 'ASD group' if the respondent answered 'yes' to the following two questions: (1) 'please tell me if a doctor or other health care provider ever told you that (child) had autism, Asperger's disorder, pervasive developmental disorder, or other autism spectrum disorder, even if he/she does not have the condition now?'; and (2) 'If yes, does (child) currently have the condition?' In order to select a matching group of TD counterparts, all

participants who had no reports of a diagnosed mental or physical disorder were extracted into a new dataset. Participants were further categorized by gender (males, females) and age group (children 6–11; adolescents 12–17) in order to ensure a comparable TD sample of age group- and gender-matched participants. Then, participants from each of the four categories were randomly selected for the TD comparison sample, with oversampling occurring in order to account for missing data.

Measures

Demographics

Demographic variables included as covariates included gender, age, race, and body mass index (BMI). Since the majority of participants were of Caucasian descent, race was collapsed into a dichotomous variable with participants classified as "Caucasian" or "Not-Caucasian". BMI was calculated based on height and weight information derived from the parent-report, as well as participant age and gender. For the purposes of this paper, we created two dichotomous categories of overweight and obese (greater than 85th percentile) and not overweight or obese (less than 85th percentile). Although typically the child's age in months is used to calculate BMI for age, the NSCH reports age in full years. Thus, all participants were assumed to be at the midpoint of their age-year for this calculation.

Physical Activity and Screen-time

Respondents reported on their child's PA participation, answering the question 'during the past week, on how many days did (child) exercise, play a sport, or participate in PA for at least 20 min that made (him/her) sweat or breathe hard?' If needed, examples were provided including 'active sports such as baseball, softball, basketball, swimming, soccer, tennis, or football; riding a bike or roller-skating; walking or jogging; jumping rope; gymnastics; and active dance such as ballet.' Responses ranged from 0 to 7 days. This measure has been used in previous research using the NSCH to examine PA behaviors of children with ASD (McCoy et al. 2016). To assess ST levels, parents responded to the question; 'on an average weekday, about how much time (hours and minutes) does (child) usually spend in front of a TV watching TV programs, videos, or playing video games?' Two additional factors related to household ST environment include the following: (1) Does your child have a TV in his/her room; and (2) Do you place limits on the amount of TV. Response options were dichotomous (yes/no).

Environmental Factors

Due to the exploratory nature of the current study, all environmental variables in the NSCH were included in the analysis. Neighborhood amenities were assessed by questioning the parents on whether 'the following places and things are available to children in your neighborhood, even if the study child does not actually use them.' Respondents answered yes or no on the presence of (1) sidewalks or walking paths, (2) a park or playground area, (3) a recreation center, community center, or boys' or girls' club, and (4) a library or bookmobile? A summary variable, "overall neighborhood amenities" was then calculated by adding the number of reported amenities in the neighborhood indicating that a higher value was indicative of a greater number of neighborhood features. The condition of the child's neighborhood was assessed with the questions: 'In your neighborhood; (1) is there litter or garbage on the street or sidewalk?'; (2) 'How about poorly kept or rundown housing?'; and (3) 'How about vandalism such as broken windows or graffiti?' A summary variable "overall adverse neighborhood conditions" was then calculated by summing the total number of adverse neighborhood features reported by parents/caregivers. A higher value indicated a greater number of adverse neighborhood features existed in the neighborhood. To assess neighborhood social capital, respondents were asked how much they agreed on a 4-point Likert scare ranging from 0 (definitely agree) to 4 (definitely disagree) with each of the following statements about their neighborhood or community: (1) 'people in this neighborhood help each other out'; (2) 'we watch out for each other's children in this neighborhood'; (3) 'there are people I can count on in this neighborhood'; and (4) 'if my child were outside playing and got hurt or scared, there are adults nearby who I trust to help my child.' A summary variable was calculated to indicate the perception of neighborhood support, with a high number indicative of *lower* perceived neighborhood support. Finally, the parents perceived safety of the neighborhood was assessed with the question 'How often do you feel the study child is safe in your community or neighborhood?' Responses ranged from 0 (never) to 3 (always).

Analysis

Independent t-tests were conducted to compare the differences in demographic (gender, race, BMI, age) and lifestyle factors (days per week of physical activity, hours of daily screen time) between TD children and children diagnosed with ASD. A multiple regression analysis was conducted to examine the association of standard demographic variables (gender, race, BMI, age), environmental factors, and diagnosis of ASD with both days per week of exercise and hours of daily ST. Based on prior findings that health behaviors may

differ according to ASD diagnosis (Srinivasan et al. 2014), if a significant association existed between either outcome variable and ASD diagnosis, additional multiple regression analyses, stratified by ASD diagnosis, would be conducted to examine differences in the association of environmental factors and health behaviors according to diagnosis of ASD and the number of days children reported exercising per week as well as daily hours of ST. Standard demographic variables (age, gender, BMI percentile, race) were also included in the analyses. All analyses were conducted using SAS 9.4 with a significance level set at 0.05.

Results

A significantly greater percentage of children diagnosed with ASD (40%) were classified as overweight or obese compared to TD children (31%; $p < 0.0001$). There were no other significant differences in demographic variables between the two groups. The comparison of lifestyle factors revealed that children diagnosed with ASD engaged in significantly fewer days per week of exercise (3.96 vs 4.7 days per week; $p < 0.0001$) and watched more hours of daily ST (2 h vs 1.83; $p < 0.01$),) compared to TD children. Table 1 compares means, standard deviations (SD) and frequencies (%) between the two groups. A greater proportion of TD children (32%) reported engaging in exercise all 7 days of the week compared to only 25% of children with ASD ($p < 0.0001$), and significantly fewer TD children (7%) reported engaging in 0 days of exercise compared to 13% of children with ASD ($p < 0.0001$).

For the entire sample, number of days of exercise was positively associated with being male ($p < 0.0001$), younger in age ($p < 0.0001$), no diagnosis of ASD ($p < 0.0001$), being of normal weight ($p = 0.004$), and less hours of ST ($p = 0.0005$), with 10% of the variance explained by the model. For hours of ST less days of exercise ($p = 0.0005$), older age ($p = 0.0002$), being overweight ($p < 0.0001$), having no limits on ST ($p < 0.0001$), and having a television in the child's room ($p < 0.0001$) are associated with greater hours of ST, with 11% of the variance explained by the model. Since ASD diagnosis was a significant factor in the model examining child exercise, regression models, stratified by ASD diagnosis were then conducted. It is also important to note that severity of ASD symptoms was also examined (data not shown), however, results did not differ according to severity levels, and therefore, it was sufficient to stratify by ASD diagnosis.

Stratified by ASD diagnosis

PA and Environmental Factors

For TD children, gender ($p < 0.0001$), age ($p < 0.0001$), normal weight status ($p = 0.02$), the absence of a television in the child's room ($p = 0.01$), and increased perceptions of neighborhood support ($p = 0.03$) were associated with greater number of days of exercise. In contrast, for children with ASD, only normal weight status ($p = 0.05$) and younger age ($p < 0.0001$) were associated with a greater number of reported exercise days. Both regression models were significantly associated with exercise frequency with 11% and 7% of the variance for exercise frequency explained in TD children and children with ASD, respectively (see Table 2).

ST and Environmental Factors

For both TD children ($p = 0.0001$) and children with ASD ($p = 0.0007$), a greater BMI (those considered "overweight") was associated with greater ST. For environmental factors in TD children, presence of a television in the child's room ($p = 0.002$), absence of limits placed on television viewing ($p = 0.0006$), lack of neighborhood amenities ($p = 0.02$), perceived lack of neighborhood support ($p = 0.02$), and the presence of adverse neighborhood factors that detract from the environment ($p = 0.05$) were all associated with increased ST. For children with ASD, however, only the presence of a television in the child's room ($p < 0.0001$) and the absence of limits placed on television viewing ($p = 0.005$) were associated with increased ST. The overall models for both TD children and children with ASD were significant ($p < 0.0001$),

Table 1 Comparison of demographic and health behavior factors in children (n = 1380) with ASD and TD children (n = 1411)

Variables[a]	Diagnosed with ASD	TD children	p-value
Males; n (%)	1129 (82%)	1148 (81%)	0.76
Age; M (SD)	11.52 (3.29)	11.49 (3.35)	0.81
Overweight/obese; n (%)	369 (40%)	287 (31%)	< 0.0001
Caucasian; n (%)	1074 (79%)	1041 (76%)	0.1
Days of exercise; M (SD)	3.96 (2.4)	4.7 (2.1)	< 0.0001
Hours of daily TV time; M (SD)	2 (1.81)	1.83 (1.58)	0.01

[a]Percentages are based on the number of participant responses. Missing data was not included in the calculated percentages

Table 2 Regression results (β (SE)) for physical activity between children with ASD and TD children

Variables	Diagnosed with ASD ($r^2 = 0.07$, $p < 0.0001$)	TD children ($r^2 = 0.11$, $p < 0.0001$)
Male	0.33 (0.2)	1.16 (0.18)***
Age	−0.18 (0.04)***	−0.18 (0.03)***
Normal weight	0.41 (0.2)*	0.5 (0.21)*
Caucasian	0.1 (0.12)	−0.15 (0.11)
No limits TV time	−0.3 (0.21)	0.06 (0.18)
No TV in the bedroom	−0.002 (0.16)	0.37 (0.15)*
Parent perceive neighborhood as unsafe	−0.22 (0.27)	−0.46 (0.3)
Presence of amenities (parks, sidewalk)	−0.13 (0.07)	−0.04 (0.07)
Lack of neighborhood support	0.23 (0.21)	−0.5 (0.24)*
Presence of adverse neighborhood factors	−0.04 (0.1)	−0.04 (0.07)

*p < 0.05; **p < 0.01; ***p < 0.001; $^{+}$p < 0.1

accounting for 9% and 7% of the variance in ST, respectively (see Table 3).

Discussion

Ecological models have long been used to explain health behaviors and guide interventions, with the central tenet being that levels of influence are important in understanding and modifying behavior (Sallis et al. 2015). Within ecological models, the influence of the environment is receiving increased attention (Ding and Gebel 2012). Many of the findings in previous research on the association between the environment and health behaviors is consistent with the findings on the TD children involved in the current study. For example, similar to previous research examining PA participation among TD children and adolescents (Sirard et al. 2010; Franzini et al. 2009), in the current study, the absence of a television in the child's bedroom and increased perceptions of neighborhood support were linked with increased PA participation. Conversely, though, environmental factors were not significantly associated with PA for children with ASD. The lack of significant findings may be due to the importance of psychological and social factors that have been reported to affect PA and ST in children with ASD (Jones et al. 2017; Memari et al. 2015). For example, parents have reported barriers to PA for children with ASD to include fear of getting hurt during sports and exercise, stakeholders lacking skills needed to include their child, a lack of friends to be active with, and other children excluding their child (Must et al. 2014; Stanish et al. 2015). The relative influence of the levels of the ecological model may differ between children with and without ASD. Furthermore, the environmental factors that need to be present in order for a child with ASD to be active may be different from that for the TD child. For example, in the current study, while neighborhood support was associated with increased PA among the TD children, it was not the case for the children

Table 3 Regression results for screen-time in children with ASD and TD children

Variables	Diagnosed with ASD ($r^2 = 0.07$, $p < 0.0001$)	TD children ($r^2 = 0.09$, $p < 0.0001$)
Male	0.25 (0.15)	0.19 (0.13)
Age	0.01 (0.03)	−0.04 (0.02)
Normal weight	−0.52 (0.15)***	−0.59 (0.15)***
Caucasian	0.1 (0.12)	0.03 (0.08)
No limits on TV time	0.4 (0.69)**	0.44 (0.13)***
No TV in the bedroom	−0.63 (0.12)***	−0.35 (0.11)**
Parent perceives neighborhood as unsafe	−0.1 (0.22)	0.21 (0.22)
Presence of amenities (parks, sidewalk)	−0.06 (0.05)	−0.11 (0.05)*
Lack of Neighborhood support	−0.01 (0.16)	0.35 (0.17)*
Presence of adverse neighborhood factors	0.13 (0.08)	0.14 (0.07)*

*p < 0.05; **p < 0.01; ***p < 0.001

with ASD. The support required for a child with ASD to be independently active in their neighborhood may, depending on their social and behavioral needs, be more substantial than that for a TD child. Also, due to the limited research on environmental characteristics and health behaviors among children with ASD, several environmental factors, such as the presence of trained practitioners or modified sports programs, have been relatively unexplored. Future research should seek to examine, in depth, the possible unique environmental factors that can inhibit or encourage activity for children with ASD.

This study also demonstrated some differences relating to the environmental factors that were associated with ST between children with and without ASD. A lack of neighborhood amenities, a lack of neighborhood support, and the presence of adverse neighborhood factors were associated with increased ST for the TD children, but not children with ASD. This may support the suggestion that other factors further down the hierarchical ecological model may be more influential for children with ASD. At the home level, two environmental factors were significant for both groups; having no limits on television time and the presence of a television in the child's room. Due to the higher levels of sedentary behavior among children with ASD (Must et al. 2014), this finding is particularly noteworthy. Previous research examining factors associated with ST among this population is scarce. Research involving parents of children with ASD (Nally et al. 2000) offers some insight into why ST levels may be higher among this population. For example, parents have discussed the importance of television and ST as mechanisms for managing undesirable behaviors (Nally et al. 2000). Moreover, it has been proposed that the appeal of screen-based activities may be greater among individuals with ASD due to the visually-orientated nature of ASD (Must et al. 2014). Such factors may result in the implementation of ST rules—including the enforcement of rules regarding the presence of a television in the bedroom—more difficult for the families with a child with ASD. The effect of the home environment, including the presence of screens in the bedroom and rules regarding ST, should be further examined for children with ASD. The feasibility of interventions focused on altering screen-based activity use should also be assessed, including the possible replacement of sedentary ST with active ST activities, such as exergaming. Previous research has revealed exergaming to be an effective means of reducing repetitive behaviors in children with ASD (Anderson-Hanley et al. 2011).

The current study benefited from having a relatively large sample size, a comparison group, and the examination of a range of environmental factors and their association with PA and ST previously unexplored for this population. However, several limitations should be acknowledged. First, due to the nature of the NSCH questionnaires, there were limited questions, and detail, available on the variables of interest. For example, a range of environmental barriers previously demonstrated to be influential for TD children were not available for the current study, including transport infrastructure and residential density (Davison and Lawson 2006; Ding et al. 2011). Future research should seek to conduct a more comprehensive examination of influential environmental factors among children with ASD. Third, this study did not allow for the examination of how the heterogeneity of ASD (e.g. cognitive, sensory, motor profile) may moderate the relationship between the environment and PA and ST. Fourth, information was gathered via parent-report, which may be prone to recall error or bias. Some questions used are particularly subject to interpretation, for example the question regarding the parents' perception of neighborhood safety. Future research should seek to use more objective measures, of both health behaviors and environmental factors. Finally, the current study utilized the 2011/2012 NCSH; the newly released 2016 NSCH data may provide a more updated account of the environmental correlates associated with PA and ST among children with ASD. For the purpose of this study, however, the 2011/2012 data set was considered preferable due to the discrete nature of the physical activity measure (a categorical variable was used in the 2016 data set).

Conclusions

Two main findings emerged from the current study. First, the environmental factors associated with PA appear to differ between children with and without ASD; whereas absence of a television in the child's room and increased neighborhood support were associated with PA among the TD children, no significant environmental factors were identified for the children with ASD. This finding prompts further investigation into the influence of the environment on PA participation of children with ASD. Second, some commonalities in environmental factors associated with ST appear to exist between groups; for both groups having no limits on television time, and the presence of a television in the child's bedroom were associated with increased levels of ST. A large proportion of unexplained variance exists in both PA and ST levels among children with ASD, suggesting that the contribution of the physical and social environment requires further exploration.

Funding There is no funding to report for this study.

Compliance with Ethical Standards

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

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. This article does not contain any studies with animals performed by any of the authors.

Informed Consent It was obtained from all individual participants included in the study.

References

Adkins, S., Sherwood, N. E., Story, M., & Davis, M. (2004). Physical activity among African-American girls: the role of parents and the home environment. *Obesity, 12*, S9.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Anderson-Hanley, C., Tureck, K., & Schneiderman, R. L. (2011). Autism and exergaming: Effects on repetitive behaviors and cognition. *Psychology Research and Behavior Management, 4*, 129.

Bener, A., Al-Mahdi, H. S., Ali, A. I., Al-Nufal, M., Vachhani, P. J., & Tewfik, I. (2010). Obesity and low vision as a result of excessive internet use and television viewing. *International. Journal of Food Sciences and Nutrition, 62*(1), 60–62.

Beyens, I., & Nathanson, A. I. (2018). Electronic media use and sleep among preschoolers: Evidence for time-shifted and less consolidated sleep. *Health Communication*. https://doi.org/10.1080/10410236.2017.1422102.

Bocarro, J. N., Floyd, M. F., Smith, W. R., Edwards, M. B., Schultz, C. L., Baran, P., … Suau, L. J. (2015). Social and environmental factors related to boys' and girls' park-based physical activity. *Preventing Chronic Disease, 12*(6), E97–E97.

Burdette, H. L., & Whitaker, R. C. (2005). A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics, 116*(3), 657–662.

Centers for Disease Control and Prevention. (2013). *National center for health statistics, state and local area integrated telephone survey. 2011–2012 National survey of children's health frequently asked questions*. Atlanta: US Department of Health and Human Services.

Centers for Disease Control and Prevention (CDC). (2014). *State indicator report on physical activity, 2014*. Atlanta: U.S. Department of Health and Human Services.

Davison, K. K., & Lawson, C. T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *International Journal of Behavioral Nutrition and Physical Activity, 3*(1), 19–28.

Ding, D., & Gebel, K. (2012). Built environment, physical activity, and obesity: What have we learned from reviewing the literature? *Health & Place, 18*(1), 100–105.

Ding, D., Sallis, J. F., Kerr, J., Lee, S., & Rosenberg, D. E. (2011). Neighborhood environment and physical activity among youth: A review. *American journal of Preventive Medicine, 41*(4), 442–455.

Dunton, G. F., Jamner, M. S., & Cooper, D. M. (2003). Assessing the perceived environment among minimally active adolescent girls: Validity and relations to physical activity outcomes. *American Journal of Health Promotion, 18*(1), 70–73.

Falbe, J., Rosner, B., Willett, W. C., Sonneville, K. R., Hu, F. B., & Field, A. E. (2013). Adiposity and different types of screen time. *Pediatrics, 132*(6), e1497–e1505.

Franzini, L., Elliott, M. N., Cuccaro, P., et al. (2009). Influences of physical and social neighborhood environments on children's physical activity and obesity. *American Journal of Public Health, 99*(2), 271–278.

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.

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., Nacario, A., Braithwaite, R. E., & Hopper, C. (2018). The effect of physical activity interventions on youth with autism spectrum disorder: A meta-analysis. *Autism Research, 11*(6), 818–833.

Hume, C., Salmon, J., & Ball, K. (2004). Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: A qualitative and quantitative study. *Health Education Research, 20*(1), 1–13.

Johnson, M. K., McInerney, M. C., Yen, W. J., & Hutchins, M. D. (2016). Television and electronic device use and overweight/obesity status: Children and adolescents with and without autism spectrum disorders. *Universal Journal of Public Health, 4*(5), 259–267.

Jones, R. A., Downing, K., Rinehart, N. J., et al. (2017). Physical activity, sedentary behavior and their correlates in children with Autism Spectrum Disorder: A systematic review. *PloS one, 12*(2), .e0172482.

MacDonald, M., Esposito, P., & Ulrich, D. (2011). The physical activity patterns of children with autism. *BMC Research Notes, 4*(1), 422–431.

Maitland, C., Stratton, G., Foster, S., Braham, R., & Rosenberg, M. (2013). A place for play? The influence of the home physical environment on children's physical activity and sedentary behavior. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 99–111.

Mazurek, M. O., Engelhardt, C. R., Hilgard, J., & Sohl, K. (2016). Bedtime electronic media use and sleep in children with autism spectrum disorder. *Journal of Developmental & Behavioral Pediatrics, 37*(7), 525–531.

McCoy, S. M., Jakicic, J. M., & Gibbs, B. B. (2016). Comparison of obesity, physical activity, and sedentary behaviors between adolescents with autism spectrum disorders and without. *Journal of Autism and Developmental Disorders, 46*(7), 2317–2326.

McKenzie, T. L., Baquero, B., Crespo, N. C., Arredondo, E. M., Campbell, N. R., & Elder, J. P. (2008). Environmental correlates of physical activity in Mexican American children at home. *Journal of Physical Activity and Health, 5*(4), 579–591.

Memari, A. H., Panahi, N., Ranjbar, E., Moshayedi, P., Shafiei, M., Kordi, R., & Ziaee, V. (2015). Children with autism spectrum disorder and patterns of participation in daily physical and play activities. *Neurology Research International*. https://doi.org/10.1155/2015/531906.

Must, A., Phillips, S. M., Curtin, C., et al. (2014). Comparison of sedentary behaviors between children with autism spectrum disorders and typically developing children. *Autism, 18*(4), 376–384.

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.

Sallis, J. F., Owen, N., & Fisher, E. (2015). Ecological models of health behavior. *Health Behavior: Theory, Research, and Practice, 5*(1), 43–64.

Scharoun, S. M., Wright, K. T., Robertson-Wilson, J. E., Fletcher, P. C., & Bryden, P. J. (2017). Physical Activity in Individuals with Autism Spectrum Disorders (ASD): A Review. In

Autism-Paradigms, Recent Research and Clinical Applications. InTech.

Sirard, J. R., Laska, M. N., Patnode, C. D., Farbakhsh, K., & Lytle, L. A. (2010). Adolescent physical activity and screen time: Associations with the physical home environment. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 82–91.

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.

Treating Autism and Autism Treatment Trust. (2013). *Medical Comorbidities in Autism Spectrum Disorders*. London: Treating Autism Publications.