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ORIGINAL PAPER

Environmental Correlates of Physical Activity and Screen-Time in Youth with Autism Spectrum Disorder: A Seven-Country Observational Study

Justin A. Haegele[1,2] · Fenghua Sun[3] · Chunxiao Li[4,5] · Kwok Ng[6,7,8] · Jihyun Lee[9] · Stefanie Hwee Chee Ang[10] · Maria Luiza Tanure Alves[11] · Hannah Yang[12] · Yandan Wu[13] · Jernice Sing Yee Tan[14] · Pauli Rintala[15] · Wendy Yajun Huang[16] · Sean Healy[17] · Isabella dos Santos Alves[11] · Andre Lisandro Schliemann[11] · Hyokju Maeng[18] · Eija Karna[8] · Ding Ding[19]

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Abstract

This cross-sectional observational study sought to examine the environmental correlates of physical activity and screen-time among youth with autism spectrum disorder (ASD). Parents of youth with ASD ($n = 1{,}165$) from seven countries/regions provided responses to an online survey form measuring environmental correlates (i.e., physical activity neighborhood environment, social network, social trust and cohesion, bedroom media, social home environment) and outcomes (i.e., physical activity, screen-time). Multiple linear regression analyses were conducted to determine environmental predictors of the outcomes. Physical activity neighborhood environment (B = 0.15, $p = 0.047$), social network (B = 0.16, $p = 0.02$), and social home environment (B = 1.07, $p < 0.001$) were significantly associated with physical activity, whereas social trust and cohesion and bedroom media were not. Further, social trust and cohesion (B = -0.14, $p = 0.001$), bedroom media (B = 0.10, $p = 0.001$), and social home environment (B = -0.16, $p < 0.001$) were significantly associated with screen-time while neighborhood environment and social network were not. The identified environmental attributes of physical activity and screen-time behaviors should be targeted for health promotion among youth with ASD.

Keywords Environment · Adolescent · Disability · Physical exercise · Sedentary behavior

Physical activity and screen-time are modifiable lifestyle behaviors with important implications on the physiological and psychological health of youth (Tremblay et al., 2016; Zhu et al., 2020). For example, regular engagement in physical activity has been associated with more favorable obesity and depression-related outcomes (Zhu et al., 2019; Zhu et al., 2020), whereas reductions in screen-time have been associated with healthier weight and sleep among youth (Hale & Guan, 2015; Tripathi & Mishra, 2020). As such, it is unsurprising that interventions and policies to promote physical activity and reduce screen-time among youth have received considerable attention from researchers and decision-makers (van Sluijs et al., 2021). Despite these efforts, vulnerable groups, such as youth with autism spectrum disorder (ASD), tend not to adhere to physical activity and screen-time guidelines (Healy et al., 2017; Kong et al., 2022; Li et al., 2022; Liang et al., 2020). For example, in a recent analysis of lifestyle behaviors among 1,165 youth with ASD across seven countries, only 7.2% met the physical activity guidelines of 60 minutes daily and 46% met screen-time recommendations of 2 or less hours per day (Li et al., 2022). In an analysis of the 2016 National Survey of Children?s Health (NSCH) in the US, only 14% and 40% of youth aged 10-17 years with ASD were identified as meeting physical activity and screen-time guidelines (Healy et al., 2020). In addition, a systematic review found that only 42% of children and youth with ASD met the guideline of daily 60 min moderate-to-vigorous physical activity (Liang et al., 2020). Another systematic review showed that children and youth with ASD tended to have low physical activity levels

Justin A. Haegele, Fenghua Sun and Prof. Chunxiao Li contributed equally to this work as co-first authors.

Extended author information available on the last page of the article

and high sedentary behaviors including screen-time (Jones et al., 2017).

To inform intervention and policy development for this population, it is critical to understand factors associated with physical activity and screen-time in youth with ASD (Healy et al., 2020). As postulated by the social ecological model (McLeroy et al., 1988), physical activity and screen-time are influenced by numerous complex and interacting factors operating at multiple levels, such as individual, interpersonal, and organizational (Hu et al., 2021; Zhang et al., 2015). Research exploring physical activity and screen-time among youth with ASD has grown dramatically over the past decade, and to date, most studies in this area have focused primarily on exploring intrapersonal (e.g., motivation), interpersonal (e.g., social support), and organizational factors (e.g., access to trained physical educators) (Brown et al., 2020; Eversole et al., 2016; Liang et al., 2020).

In addition to aforementioned factors, the social-ecological model suggests that health behaviors can also be influenced by the social and built environment (McLeroy et al., 1988). This assertion was supported by a recent systematic review by Hu and colleagues (2021), who identified environmental variables, such as neighborhood safety, are crucial in supporting the physical activity engagement for youth without disabilities. According to Healy and colleagues (2020), the environment may influence health behavior differently for youth with ASD, given their unique social, sensory, and behavioral characteristics. Thus, understanding environmental influences on physical activity and screen-time behaviors among youth with ASD is an important endeavor and deserves further investigations.

To date, few studies have explored environmental correlates of lifestyle behaviors among youth with ASD (Liang et al., 2020) and the findings are mixed. For example, Fiscella and colleagues (2021) found that, among several environmental variables, only neighborhood safety was significantly associated with physical activity among 494 children with ASD from the 2016 and 2017 NSCH in the US. Based on the 2011–2012 NSCH data, Healy and colleagues (2020) found no environmental variables significantly associated with physical activity, whereas the presence of a television was positively associated with screen-time among children with ASD. To fill this knowledge gap, we aimed to examine the environmental correlates of physical activity and screen-time in a sample of youth with ASD from seven countries/regions. We examined the following domains of environments: neighborhood environment, social environment (i.e., social network, social trust and cohesion), physical home environmental (i.e., bedroom media), and social home environment.

Methods

Study Design

This cross-sectional survey was conducted from August 2020 to April 2021 across seven countries/regions: Brazil, Finland, Hong Kong, Mainland China, Singapore, South Korea, and the US. Ethics approval was obtained from the Human Research Ethics Committee of The Education University of Hong Kong (ref. no. A2019-2020-0431). Local ethics guidelines were also followed by each participating university and institution in each of the seven countries/regions.

Sampling and Procedures

A standardized protocol was used across all countries/regions to recruit a purposive sample of parents or guardians of youth with ASD to participate in this study. To be eligible, parents had to have a child who (a) had an ASD diagnosis, (b) was aged 10 to 17 years, and (c) lived in one of seven targeted countries/regions. Recruitment materials were shared through emails from ASD organizations, social media posts, and direct contact with school principals. Parents who were interested in participation were provided a URL link to an online survey package. Incentives were not distributed from the large research international project group; however, a few countries/regions such as Mainland China and the US provided incentives to recruit participants. In total, 1580 parents entered the online survey after reading the project information sheet. Of those, 1210 (77%) reviewed consent documents and provided informed consent, whereas 370 (23%) exited the survey prior to completing the informed consent document.

Measures and Variables

All the survey items were adopted from previous research (more details are provided below). We initially prepared the parent proxy-report survey form in English language. We then translated the form into different languages through a standardized translation procedure, which included an iterative process of translation and back-translation (Brislin, 1980). The total survey included 26 items.

Demographics

Demographic variables included parent-reported ASD diagnosis, severity, age, and sex. These questions were adopted from the 2018 NSCH, which has been previously used in research exploring health behaviors of youth with disabilities (Haegele et al., 2021; Li et al., 2021), including those

with ASD (Healy et al., 2020). The diagnosis of ASD was measured using one question, 'Has a doctor or other health care provider ever told you that your child has autism or autism spectrum disorder?'. Response options for this question were dichotomous (yes, no). For those who answered 'yes', parents were asked to report the severity of their child's ASD as mild, moderate, or severe. If the answer was "no", parents were instructed to leave the survey and their data were removed from further analysis. In addition, age (year), sex (male, female), height (cm), and weight (kg) were collected for the child with ASD. Following the growth standards of the World Health Organization (Onis et al., 2007), each child's height and weight information was converted to age- and gender-specific BMI *z*-scores (*z*BMI). We then categorized *z*BMI into weight status: underweight (< 5th percentile), healthy weight (5th to 84th percentile), overweight (85th to 94th percentile), and obesity (≥ 95th percentile).

Physical Activity and Screen-Time

Physical activity was measured using one question adopted from the 2018 NSCH, 'During the past week, on how many days did this child exercise, play a sport, or participate in physical activity for at least 60 min?'. Response options included: '0 days', '1 day', '2 days', '3 days', '4 days', '5 days', '6 days', or 'every day'. Screen-time was measured using one question adopted from Moore and colleagues (2020), 'On average, how many total hours per day did your child watch TV, use the computer, use social media and interactive play video games, during their free time over the last week?'. Response options for this question were 'none', 'less than 1 h', '1 h', '2 h', '3 h', and '4 or more hours'.

Environmental Correlates

Five different environmental variables were measured as correlates in this study: (a) physical activity neighborhood environment ('neighborhood environment' hereafter), (b) social network, (c) social trust and cohesion, (d) bedroom media, and (e) social home environment.

The neighborhood environment subscale included four items from the Physical Activity Neighborhood Environment Survey (Sallis et al., 2009) which measures attributes of the neighborhood environment within a 10- to 15- minute walk from home. The four items asked parents to report on the presence of sidewalks, bicycle facilities, free or low-cost recreation facilities, and crime-related safety. Parents were asked to respond to each item on a four-point scale, with options ranging from 'strongly disagree' (1) to 'strongly agree' (4). A higher total mean score represents better neighborhood environment attributes for physical activity participation. Item scores had an internal reliability (α) value of 0.63 in the present sample.

Neighborhood social environment was composed of two subscales measuring participants' social network and social trust and cohesion. The social network subscale was composed of three items adapted from work by Veitch and colleagues (2012) which asked parents to report their agreement with the statements (e.g., 'This child knows many people in this neighborhood'). Social trust/cohesion was measured using four items adapted from Sampson et al. (1997) and used by Veitch et al. (2012) which asked parents to report their level of agreement with the statements (e.g., 'People around my neighborhood are willing to help their neighbors'). Parents were asked to respond to each neighborhood social environment item on a five-point scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Higher scores on these scales were more favorable, suggesting stronger social networks and better social trust and cohesion. The social network scale had an α value of 0.78 and the social trust/cohesion scale showed an α value of 0.84 in our sample.

Bedroom media environment was measured using four items developed and used by Tandon et al. (2014) (e.g., "Does this child have a computer or laptop in his/her bedroom"). Response options were 'yes' (1) and 'no' (0). A greater total summed score means a more negative bedroom media environment. Item scores had an α value of 0.62 in the present sample.

Social home environment was measured using a 3-item parent support for physical activity questions developed and used by Tandon et al. (2014). These questions asked parents to report how many days during a typical week a parent would provide support for their child's physical activity participation (e.g., 'Watch child participate in sports or physical activity'). Five responses options ranged from 'never' (0) to 'everyday' (4). A greater total mean score indicates a better social home environment. Item scores had an α value of 0.75 with our sample.

Statistical Analyses

First, we pooled the data from seven countries/regions and then removed incomplete observations and continuous outliers ($z > |\pm 3.29|$). Second, we calculated means (*M*) and standard deviation (*SD*), or frequencies and percentages for each variable. Finally, we performed linear regression analyses to examine the associations between environmental predictors and each of the two outcomes (i.e., physical activity, screen time). For each outcome, we conducted two separate regression analyses: (a) a multiple linear regression model with each of the environmental predictors (Model 1); and (b) a multiple linear regression model with all

Table 1 Participant Characteristics and Descriptive Statistics

Characteristics	Overall [b] (*n* = 1,165)	Brazil (*n* = 228)	Finland (*n* = 278)	Hong Kong (*n* = 96)	Mainland China (*n* = 186)	Singapore (*n* = 89)	South Korea (*n* = 202)	US (*n* = 86)
Age, year (10–17) [a]	13.08 (2.18)	13.01 (2.09)	13.34 (2.06)	13.50 (2.50)	12.43 (2.15)	13.20 (2.62)	13.01 (2.06)	13.34 (2.01)
Sex								
Male	881 (75.6%)	199 (87.3%)	185 (66.5%)	85 (88.5%)	153 (82.3%)	71 (79.8%)	125 (61.9%)	63 (73.3%)
Female	284 (24.4%)	29 (12.7%)	93 (33.5%)	11 (11.5%)	33 (17.7%)	18 (20.2%)	77 (38.1%)	23 (26.7%)
Severity level of ASD								
Mild	568 (48.8%)	132 (57.9%)	140 (50.4%)	67 (69.8%)	54 (29.0%)	46 (51.7%)	92 (45.5%)	37 (43.0%)
Moderate or severe	597 (51.2%)	96 (42.1%)	138 (49.6%)	29 (30.2%)	132 (71.0%)	43 (48.3%)	110 (54.5%)	49 (57.0%)
*z*BMI	0.60 (1.38)	0.90 (1.35)	0.50 (1.42)	0.56 (1.26)	0.53 (1.48)	0.24 (1.59)	0.60 (1.06)	0.71 (1.53)
Body weight status								
Underweight	76 (6.5%)	9 (3.9%)	20 (7.2%)	4 (4.2%)	17 (9.1%)	13 (14.6%)	3 (1.5%)	10 (11.6%)
Normal weight	611 (52.4%)	97 (42.5%)	152 (54.7%)	50 (52.1%)	88 (47.3%)	47 (52.8%)	142 (70.3%)	35 (40.7%)
Overweight	194 (16.7%)	50 (21.9%)	37 (13.3%)	21 (21.9%)	38 (20.4%)	11 (12.4%)	24 (11.9%)	13 (15.1%)
Obesity	284 (24.4%)	72 (31.6%)	69 (24.8%)	21 (21.9%)	43 (23.1%)	18 (20.2%)	33 (16.3%)	28 (32.6%)
Environmental predictors								
Neighborhood environment (1–4) [a]	2.92 (0.69)	2.59 (0.78)	3.06 (0.65)	3.04 (0.52)	3.13 (0.68)	3.06 (0.68)	2.85 (0.52)	2.80 (079)
Social network (1–5) [a]	2.91 (0.90)	2.67 (0.86)	2.94 (0.95)	2.78 (0.75)	3.01 (0.97)	2.82 (0.89)	2.95 (0.80)	3.42 (0.87)
Social trust and cohesion (1–5) [a]	2.13 (0.99)	2.02 (1.01)	1.83 (0.87)	1.97 (0.77)	2.33 (1.16)	1.65 (0.71)	2.71 (0.85)	2.33 (0.98)
Bedroom media (0–4) [a]	1.86 (1.33)	1.79 (1.29)	1.94 (1.21)	1.49 (1.19)	2.82 (1.19)	0.74 (0.89)	1.68 (1.26)	1.67 (1.43)
Social home environment (0–4) [a]	1.59 (1.03)	1.26 (0.95)	1.25 (0.83)	1.78 (0.97)	2.24 (1.21)	1.19 (0.83)	1.90 (0.93)	1.65 (0.99)
Outcomes								
Physical activity (0–7) [a]	2.30 (2.04)	1.55 (1.76)	2.93 (2.09)	2.16 (2.09)	2.80 (2.41)	2.06 (1.96)	1.96 (1.46)	2.44 (1.99)
Screen-time (0–5) [a]	3.43 (1.51)	4.21 (1.30)	4.07 (1.06)	3.50 (1.35)	2.37 (1.54)	3.06 (1.23)	2.35 (1.29)	3.81 (1.37)

Note. ASD = autism spectrum disorder; *z*BMI = *z*-score of body mass index

[a] Response range of instrument

[b] Values are presented as *M* (*SD*) or *n* (%)

significant environmental predictors identified in Model 1 (Model 2). All regression models were adjusted for country/region, severity of ASD, age, sex, and *z*BMI. We did not use multilevel approaches to analyze the data given less than 10 countries/regions were involved in this study (Stegmueller, 2013). We conducted statistical analyses using SPSS (Version 25, IBM; Armonk, New York) and set statistical significance at $P < 0.05$.

Results

Demographics and Descriptive Data

Detailed demographic characteristics of the participants and their children are provided in Table 1. Our final sample included 1,165 youth with ASD for analysis after removal of incomplete observations and continuous outliers ($n = 55$). Participant age ranged from 10 to 17 years ($M = 13.08$, $SD = 2.18$). There were more male participants than females (male = 75.6%) and over half of the participants were reported to experience moderate or severe ASD (51.2%). About two-fifth of the participants were overweight or obese (41.1%). In general, the participants reported mild to moderate levels of neighborhood environment, social network, social trust and cohesion, bedroom media, and social home environment (see Table 1). On average, the participants were physically active on around two days per week ($M = 2.30$, $SD = 2.04$) and had over 2 h of screen-time daily ($M = 3.43$, $SD = 1.51$).

Table 2 Associations Between Environmental Predictors and Physical Activity

	Physical Activity [a]		Physical Activity [b]	
	B (95%CI)	*p*	B (95%CI)	*p*
Environment				
Neighborhood environment	**0.39 (0.22, 0.56)**	**< 0.001**	**0.15 (0.002, 0.30)**	**0.047**
Social network	**0.28 (0.15, 0.43)**	**< 0.001**	**0.16 (0.03, 0.28)**	**0.02**
Social trust and cohesion	**0.22 (0.10, 0.34)**	**0.01**	0.06 (-0.06, 0.18)	0.31
Bedroom media	0.05 (-0.04, 0.15)	0.25	—	—
Social home environment	**1.09 (0.99, 1.19)**	**< 0.001**	**1.07 (0.96, 1.17)**	**< 0.001**
R^2	—		29.3%	

Note. B = unstandardized coefficients; CI = confidence interval

[a] Model 1: Multiple linear regression model with only one environmental predictor

[b] Model 2: Multiple linear regression model with all significant environmental predictors identified in model 1

All models are adjusted for country/region, severity level of autism spectrum disorder (ASD), age, sex, and z-score of body mass index (*z*BMI). Statistically significant associations ($p < 0.05$) are highlighted in bold

Table 3 Associations Between Environmental Predictors and Screen-Time

	Screen-time [a]		Screen-time [b]	
	B (95%CI)	*p*	B (95%CI)	*p*
Environment				
Neighborhood environment	-0.08 (-0.20, 0.04)	0.18	—	—
Social network	-0.05 (-0.14, 0.04)	0.30	—	—
Social trust and cohesion	**-0.15 (-0.24, -0.07)**	**< 0.001**	**-0.14 (-0.23, -0.06)**	**0.001**
Bedroom media	**0.11 (0.04, 0.17)**	**0.001**	**0.10 (0.04, 0.17)**	**0.001**
Social home environment	**-0.17 (-0.25, -0.09)**	**< 0.001**	**-0.16 (-0.24, -0.07)**	**< 0.001**
R^2	—		16.0%	

Note. B = unstandardized coefficients; CI = confidence interval

[a] Model 1: Multiple linear regression model with only one environmental predictor

[b] Model 2: Multiple linear regression model with all significant environmental predictors identified in Model 1

All models are adjusted for country/region, severity level of autism spectrum disorder (ASD), age, sex, and z-score of body mass index (*z*BMI). Statistically significant associations ($p < 0.05$) are highlighted in bold

Associations Between Environmental Attributes and Physical Activity

Table 2 presents the associations between environmental predictors and physical activity. The results of multiple linear regression analysis (Model 1) indicated that bedroom media was not significantly associated with physical activity (B = 0.05, $p = 0.25$), whereas neighborhood environment, social network, social trust and cohesion, and social home environment were (B = 0.22 to 1.09, all $p < 0.05$). According to the results of Model 2, neighborhood environment, social network, and social home environment remained significantly associate with physical activity (B = 0.15 to 1.09, all $p < 0.05$). However, social trust and cohesion was no longer significant (B = 0.06, $p = 0.31$). These variables explained 29.3% of the total variance in physical activity.

Associations Between Environmental Attributes and Screen Time

Table 3 presents the associations between environmental predictors and screen-time. The results of multiple linear regression analysis (Model 1) indicated screen-time was not significantly associated with neighborhood environment (B = -0.08, $p = 0.18$) and social network (B = -0.05, $p = 0.30$). However, screen-time was significantly associated with social trust and cohesion (B = -0.15, $p < 0.001$), bedroom media (B = 0.11, $p = 0.001$), and social home environment (B = -0.17, $p < 0.001$). These three variables remained significant in Model 2 (B = -0.16 to 0.10, all $p < 0.01$, $R^2 = 16.0\%$).

Discussion

In this study, we examined environmental correlates of physical activity and screen-time among 1,165 youth with ASD across seven countries/regions. Generally, our average participants met recommended thresholds of physical activity (i.e., 60 min daily) only two days per week, and spent more than two hours per day engaging in screen-time behaviors. These findings are consistent with many prior studies demonstrating that youth with ASD are unlikely to meet published guidelines for these lifestyle behaviors (Healy et al., 2017; Liang et al., 2020). In addition, approximately 41% of our sample was identified as overweight or obese, which is well-aligned with high overweight or obesity rates that are commonly depicted among youth with ASD in the US

(Healy et al., 2019). Cumulatively, these findings reinforce the need to identify correlates and determinants of physical activity and screen-time engagement among youth with ASD to inform intervention and policy development.

The findings in this study partially support and extend previous work exploring the association between environmental attributes and physical activity among youth with ASD. For example, our findings support that the neighborhood environment (e.g., presence of sidewalks and recreation facilities) had a significant association with physical activity among youth with ASD. While this finding is well-aligned with research examining physical activity determinants of youth without disabilities (Cohen et al., 2007; Edwards et al., 2014), and has been suggested in qualitative work with youth with ASD (Obrusnikova & Cavalier, 2011), it conflicts with some prior analyses among a US sample of youth with ASD where few environmental attributes were found to be associated with physical activity and screen-time (Healy et al., 2020). Contextual and age differences may partially explain the discrepancy. Specifically, our current study explored associations across seven countries/regions with youth aged between 10 and 17 years, whereas Healy and colleagues (2020) focused only within the US and their participants were as young as six years old. It is also possible that the inclusion of a neighborhood safety question within the neighborhood environment variable in our study has elevated this particular construct, given the importance of perceptions of safety that have emerged in other studies in this area (Fiscella et al., 2021).

According to Fiscella and colleagues (2021), feeling safe within one's neighborhood may be particularly important for youth with ASD to be physically active, given the unique behaviors or characteristics of youth with ASD (e.g., social and sensory problems) coupled with constraining behaviors of parents when they perceive neighborhood to be unsafe for their child. As such, it may be unsurprising as well that social network as well as social trust and cohesion were also significantly associated with physical activity engagement in our sample, given the safety-related elements related to knowing and trusting others in the neighborhood of these factors. Believing one's neighborhood is safe may also have other indirect impacts on physical activity, such as enhancing parents' support behaviors toward physical activity, which is commonly associated with physical activity of youth with ASD (Brown et al., 2020). Future research may seek to understand this potential indirect relationship, to further unravel the complex and multifaceted factors that can influence physical activity participation among youth with ASD (Zhang et al., 2015).

Whereas some studies have explored the association between environmental factors and physical activity engagement among youth with ASD, less have considered their associations with screen-time behaviors (Healy et al., 2020). This is somewhat surprising, given that a number of studies have identified that youth with ASD tend to engage in high levels of sedentary behavior, including screen-time (Li et al., 2022; Must et al., 2014). In our study, social trust and cohesion rather than social network was found to be inversely associated with screen-time. The finding is somewhat expected as some youth with ASD tend to play alone or avoid social engagement (Hall, 2018), and thus a strong social network in the neighborhood is not closely tied to their screen-time behaviors. On the other hand, a neighborhood environment that is socially trustable, harmonious, and cohesive would encourage youth with ASD to spend less on screen-time and move more around their neighborhood (Carrillo-Alvarez et al., 2019).

Our study also found that bedroom media environment (access to more media, such as computer and television) was positively associated screen-time engagement. This association has been demonstrated in work for youth without ASD, where scholars suggest that reducing bedroom media availability may impact screen-time, but not necessarily overall sedentary behavior (Atkin et al., 2013). As such, and according to Júdice et al. (2021), 'parents can play a decisional role in youth's screen time by simply removing or at least limiting media sources in their youth's bedroom' (p. 62). This finding provides some extension of prior work for youth with ASD, which has identified an association between screen-time and the existence of a television, specifically, within the bedroom (Healy et al., 2020). As such, it is logical to extend suggestions to remove bedroom media to reduce screen-time to youth with ASD based on our findings. In addition, this is the first study, to our knowledge, to identify a statistically significant association between social home environments and screen-time behaviors. This finding is interesting, given that the social home environment questions generally focus on supporting physical activity, rather than reducing screen-time. This speaks to the interrelated nature of these behaviors, and that perhaps increases in physical activity associated with social home environment may replace time in screen-time activities (Healy et al., 2021). With these findings, it is clear that home environments as well as social trust and cohesion must be considered in policies or interventions attempting to reduce screen-time among youth with ASD.

This study had several strengths, including an international sample of youth with ASD from culturally and geographically diverse countries/regions, the adoption of socioecological model, and the number and variety of social and built environmental attributes included. However, several limitations must be acknowledged. First, our study was based on a convenience sample, and is therefore subject to selection bias. Also, the difference in the number

of participants across participating countries/regions may partly reflect response bias. Therefore, readers should be cautious when attempting to generalize our findings to the populations of youth with ASD in each of the participating countries/regions. Second, the cross-sectional design of our study does not allow for us to make causal inferences on the associations of environmental attributes with physical activity and screen time. Third, while we followed questions from national surveys that are well-used in autism research (Healy et al., 2020), some questions, such as those about autism severity, may be ambiguous given the lack of criteria provided to help parents determine their responses. This feature should be taken into consideration when interpreting our findings, given severity as well as other related variables (e.g., IQ) may be important confounding variables for physical activity and screen-time for youth with ASD. Given that youth with intellectual disabilities tend to engage in insufficient physical activity (Hinckson & Curtis, 2013), as well as the notable rate of intellectual disability among youth with ASD, future research should also consider the intersection of these two impairments when examining health-related behaviors among youth with ASD. However, since questions about intellectual disability were not asked in this study, further analyses were not feasible as part of this project. Fourth, data for this study were collected from August 2020 to April 2021, during which time several countries/regions in this study may have had government mandated quarantine policies related to COVID-19. While we did not ask questions specific to quarantine policies, and therefore we cannot further address this in our analysis, we recognize that the epidemic had an impact on health-related behaviors among youth with ASD (Lee et al., 2022), and therefore this feature of our data collection should be considered when interpreting findings. Finally, parental proxy-reports are prone to response bias, particularly with socially desirable constructs such as physical activity and screen-time (Adamo et al., 2009). However, it is worth noting that proxy-reports like these have maintained significant value in public health surveillance and research internationally. Future work may consider supplementing proxy measures with direct or objective measures of physical activity and screen-time, to capture further information (e.g., time of day) with better validity.

Conclusion

In conclusion, based on an international sample of youth with ASD, we have identified several environmental correlates of physical activity and screen-time behaviors. Importantly, these two behaviors are not determined by identical environmental correlates (e.g., social network only predicts physical activity). The identified environmental attributes coupled with the low compliance level of physical activity and screen-time guidelines suggest the need to target neighborhood, social, and home environments for promoting health behaviors among youth with ASD.

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Authors' Contributions CL, JAH, and FS conceptualized the study. CL, JAH, FS, JL, SH, and DD developed the survey form. CL performed the statistical analysis. JAH, CL, and FS interpreted the data and wrote the first draft. CL, JAH, FS, MLTA, SHCA, JL, KN, IdSA, SH, WYH, PR, JSYT, YW, HY, EK, HM, and ALS collected data. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

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Data Availability Data, code book, and analytic code are available upon request to the corresponding author.

Declarations

Competing Interests Authors have no competing interests.

Ethics Approval Ethics approval was obtained from one of the co-principle investigators' Human Research Ethics Committee of the Education University of Hong Kong, Hong Kong (Ref. no. A2019-2020-0431). For participating universities or institutions in other countries/regions, local research ethics guidelines were followed. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate All participants provided informed consent.

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Authors and Affiliations

Justin A. Haegele[1,2] · Fenghua Sun[3] · Chunxiao Li[4,5] · Kwok Ng[6,7,8] · Jihyun Lee[9] · Stefanie Hwee Chee Ang[10] · Maria Luiza Tanure Alves[11] · Hannah Yang[12] · Yandan Wu[13] · Jernice Sing Yee Tan[14] · Pauli Rintala[15] · Wendy Yajun Huang[16] · Sean Healy[17] · Isabella dos Santos Alves[11] · Andre Lisandro Schliemann[11] · Hyokju Maeng[18] · Eija Karna[8] · Ding Ding[19]

✉ Chunxiao Li
chunxiao.li@m.scnu.edu.cn; cxlilee@outlook.com

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

[2] Center for Movement, Health, & Disability, Old Dominion University, Norfolk, USA

[3] Department of Health and Physical Education, The Education University of Hong Kong, Hong Kong SAR, China

[4] School of Physical Education & Sports Science, South China Normal University, 51006 Guangzhou, China

[5] Adapted Physical Activity + Laboratory, South China Normal University, Guangzhou, China

[6] Physical Activity for Health Research Cluster, Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Finland

[7] Faculty of Education, University of Turku, Turku, Finland

[8] School of Educational Sciences and Psychology, University of Eastern Finland, Kuopio, Finland

[9] Department of Kinesiology, San José State University, San Jose, USA

[10] SportCares, Sport Singapore, Singapore

[11] Faculty of Physical Education, University of Campinas, São Paulo, Brazil

[12] Department of Adapted Physical Education, Baekseok University, Cheonan, South Korea

[13] School of Physical Education & Sports Science, Fujian Normal University, Fuzhou, China

[14] School of Sports, Health and Leisure, Republic Polytechnic, Singapore, Singapore

[15] Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä, Finland

[16] Department of Sport, Physical Education and Health, Hong Kong Baptist University, Hong Kong SAR, China

[17] School of Nursing, Psychotherapy and Community Health, Dublin City University, Dublin, Ireland

[18] College of Education & Human Development, Georgia State University, Atlanta, USA

[19] Sydney School of Public Health, The University of Sydney, Melbourne, Australia