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Brief Report

Accelerometer measured physical activity among youth with autism and age, sex, and body mass index matched peers: A preliminary study

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A B S T R A C T

Background: While research has examined physical activity differences between youth with autism spectrum disorder (ASD) and neurotypical peers, they largely do not consider demographic or anthropomorphic variables when recruiting comparison group participants.

Objective: The purpose of this preliminary study was to compare light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA) between youth with ASD and age, sex, and body mass index (BMI) matched neurotypical peers from the same geographic region.

Method: A sample of 36 participants, including youth aged 13–17 with ASD and age, sex, and BMI-matched neurotypical youth recruited from the same geographic location. Demographic information was obtained via parent report, and physical activity was measured using the ActiGraph GT3x accelerometer. Participants wore monitors for seven consecutive days during waking hours. Descriptive analyses were conducted for participant demographics, LPA, and MVPA, and paired-sample t-tests were employed to examine differences in LPA and MVPA between youth with ASD and age, sex, and BMI-matched neurotypical peers.

Results: Youth with ASD and their age, BMI, and sex matched neurotypical peers demonstrated no significant difference in average daily LPA (201.36 ± 63.50 v. 172.30 ± 54.98) or MVPA (33.54 ± 17.07 v. 37.63 ± 19.94).

Conclusions: Results indicate that youth with ASD did not engage in significantly less MVPA than age, sex, and BMI-matched peers from the same geographic location. Not finding clear distinctions between youth with ASD and neurotypical peers in this study suggest that variability in other social or environmental factors may play a larger role in influencing MVPA than ASD itself.

Introduction

The World Health Organization[1] recommends youth to engage in at least 60 min of moderate-to-vigorous physical activity (MVPA) per day to experience associated physiological and psychological benefits. In addition, light physical activity (LPA) has shown to be favorably associated with cardiometabolic biomarkers among youth.[2,3] Unfortunately, research suggests that youth with autism spectrum disorder (ASD) tend not to engage in sufficient amounts of MVPA and LPA to enjoy benefits associated with these volitional lifestyle behaviors.[4–6] ASD, a neurodevelopmental disorder estimated to affect approximately 1 in 54 children in the United States,[7] is characterized by a variety of physiological and/or behavioral features spanning social, sensory, neurological, and neuromotor functions.[8] Generally, researchers tend to attribute inactivity to behavioral features and social functions associated with ASD, as well as peer, family, and community barriers that inhibit access to MVPA and LPA opportunities.[9,10] Given that youth with ASD tend not to engage in sufficient MVPA or LPA, it is unsurprising that they are at a high risk for developing health-related issues, such as obesity.[13]

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While it appears known that youth with ASD tend to be inactive, it is less clear whether their inactivity should be attributed to characteristics of ASD, or if they are similarly inactive as their neurotypical peers. To date, results are mixed in research comparing physical activity engagement between youth with and without ASD.[6,12] For example, in studies examining accelerometer measured physical activity among young children (<12 years of age), those with ASD tend to spend similar amounts of time engaged in MVPA.[12,13] This finding is important, as it may move the onus of being inactive away from characteristics associated with ASD,[14] and suggests that larger social or environmental constraints may that limit activity for all young children.[5,9] However, a different picture emerges when examining MVPA among older youth, where differences between groups tend to emerge.[6,10] Explicated differences, particularly in MVPA, are commonly attributed to characteristics of ASD, such as high levels of anxiety, difficulties with social interactions, and preferences for structured, repetitive activities.[14]

When examining MVPA and LPA differences between groups, it is critical to include matched peers with similar characteristics in order to identify the impact that target features (e.g., ASD) have on behavior. For example, demographic variables such as sex, with males being more activity than females[4] and age, with older youth being less active than younger children,[15] have been shown to influence physical activity participation. In addition, where people live can have an influence on their physical activity behaviors.[16] However, just one study, to our knowledge, has recruited age and sex-matched neurotypical peers from the same location as a comparison group, which took place in Taiwan.[17] Furthermore, when considering reasons why youth may engage in less time in MVPA than their neurotypical peers, Stanish and colleagues[10] asserted that personal factors, including physical fitness, may warrant further investigation. As such, to help contribute to our understanding whether MVPA and LPA differences between youth with and without ASD should be attributed to characteristics of ASD, we recruited age, sex, and body mass index (BMI) matched peers from the same geographic location in the US as a comparison group. Furthermore, while studies examining objectively measured MVPA are commonplace, few studies have included LPA when comparing physical activity time between youth with ASD and neurotypical peers. Given favorable associations with cardiometabolic biomarkers among youth,[2] we believe comparing LPA will be a valuable added addition to the literature. As such, the purpose of this preliminary study was to compare LPA and MVPA between youth with ASD and age, sex, and BMI matched neurotypical peers from the same geographic region.

Methods

Participant recruitment

A sample of 36 participants with ASD (n = 18) and age, sex, and BMI matched neurotypical peers (n = 18) were recruited from throughout the Hampton Roads area to participate in this study. Hampton Roads is a large metropolitan statistical area located in the Mid-Atlantic Region of the U.S., which is composed of 10 independent cities, and is home to more approximately 2 million residents. This area is Both groups were recruited through the distribution of information flyers through internet-based listservs, social media groups, and family-centered organizations. Information flyers included the study purpose, time commitment, activities, and incentives to participate. Parents interested in their child participating were instructed to contact the first author to express interest via email or telephone. Those who contacted the first author were asked to then complete a brief screening questionnaire.

For parents of potential participants with ASD, the screening questionnaire asked parents to report their child's age and sex, as well as whether they had a formal diagnosis of ASD and any co-existing condition that might interfere with physical activity (e.g., a physical impairment). Potential participants who met inclusion criteria of being 13–18 years of age, having a formal diagnosis of ASD, and not having a co-existing condition were invited to campus for data collection. Upon arrival, parents completed informed consent and youth completed participant assent forms, and parents were asked to share documentation confirming an ASD diagnosis in the form of either medical or educational service documents. Once documents were completed and diagnosis confirmed, participants with ASD were enrolled in the study.

For parents of potential matched peers, the screening questionnaire was used to gather matching data on sex (same sex), age (within one year), and height and weight to estimate BMI (within 2 kg/m^2 variation). Those who met matching criteria were invited for data collection. Screening questionnaire data was saved for those who did not match any existing participants with ASD, and their information was compared to new participants with ASD as participant recruitment progressed. If they eventually matched a participant with ASD, they were notified and asked to come to campus for data collection. Like participants with ASD, parents completed informed consent and youth completed participant assent forms upon arrival. Following, potential participant's height and weight were measured by the research team, and those who matched BMI with participants with ASD were enrolled in the study. In several instances, potential matches were not a BMI match, and they subsequently withdrew from the study and their data were deleted. As such, it is important to note that BMI matches were based on height and weight data measured by the research team, and not estimates provided by parents.

Data collection

The study protocols were reviewed and approved by university institutional review board. After participants were officially enrolled in the study, data collection took place. Parents completed a demographic questionnaire to gather participants' age, sex, and race. Participants' height and weight were measured using a portable stadiometer and scale, respectively. Participants' BMI was computed based on the measured height and weight.

Physical activity was measured using the ActiGraph GT3x accelerometer (ActiGraph, Pensacola, FL). The ActiGraph GT3xs is a small ($4.6 \times 3.3 \times 1.5$ cm), lightweight (19 g) triaxial accelerometer which provides activity counts as composite vector magnitude of all three axes (medio-lateral, vertical, and anteroposterior). This accelerometer was selected because it is considered to be a valid and reliable physical activity measures for youth[18] and it is commonly used for research measuring physical activity among those with ASD.[19] In addition, Rosser and Frey[20] demonstrated that youth with ASD can tolerate instruments similar in size and weight to this model. A 15-s epoch was employed for all participants, and monitors were initiated using each participant's height and weight.

Participants were asked to wear the accelerometers for seven consecutive days and to only remove the monitors when sleeping or during activities in which they would be submerged in water. Recommendations by Hauck and colleagues,[21] including reminding parents to encourage participants to continuously wear the device, providing tips to conceal the device, and providing an incentive to return the device, were implemented to alleviate some wear-time concerns. At the conclusion of the seven days, parents were asked to return the device to the research team. When monitors were received, data were downloaded, screened, and processed using

ActiLife 6 software (ActiGraph LLC, Pensacola, FL). Following, the research team emailed the parents to (a) confirm receipt, (b) answer any outstanding questions about participation, and (c) deliver an electronic link to claim participant incentives.

Participant's data were included in the analysis if monitors were worn for a minimum of four consecutive days, with at least 8 h of wear time per day. To mitigate the potential effects of reactivity,[22] we analyzed the physical activity data from day 2 to day 6, with the first and last days dropped. Published cut points for youth by Evernson and colleagues[18] were used to process the data. More specifically, the cutoff criteria included (a) sedentary activity (0–100 counts per minute [CPM]), (b) LPA (101–2295 CPM), (c) moderate physical activity (2296–4011 CPM), and vigorous physical activity (4012+ CPM). MVPA scores were computed as the sum of the moderate physical activity and vigorous physical activity categories.

Data analysis

We first conducted frequency analyses on participant sex, race, body weight status, and number of days participants met the 60 min MVPA guideline during days 2–6 wearing accelerometers. Additionally, descriptive statistics including arithmetic mean and standard deviation were computed for participants age, LPA, MVPA, and accelerometer wear time. To examine the match on age and BMI, and to examine the difference in LPA and MVPA between youth with ASD and their match neurotypical peers, we conducted paired-sample t-tests on weekday, weekend, and grand mean. The paired-sample t-tests accommodate the matched sample design (i.e., adolescent with ASD and matching neurotypical peer) and provides optimal statistical power for the relatively small sample size. The data analyses were done using SPSS (ver. 25, IBM, Armonk, NY), with statistical significance at 0.05 level.

Results

In addition to similar BMI and age, and identical sex distribution, as per the sample recruitment design, participants with ASD and their matched neurotypical peers shared similar race/ethnicity. As seen in Table 1, the participants averaged about 14.5 years old, ranging from 13 to 18 years old. Participants with ASD and their matched neurotypical peers had similar BMI, $t = 1.05$, $df = 17$, $p = .31$. Participants with ASD had BMI ranging from 15.50 to 34.70 kg/m^2, and their matched neurotypical counterparts ranged from 16.50 to 31.10 kg/m^2. Each group had two participants in the overweight/obese category. No significant differences in wear time were found between groups, $t = 1.13$, $df = 17$, $p = .28$. The race/ethnicity distribution was almost identical for youth with ASD and their peers, with about two thirds Caucasian, over 20% African American, and the remaining Asian American or multiple races. No participant met daily 60 min MVPA guidelines, with just one neurotypical peer reaching 60 min of MVPA for four days. As shown in Table 1, over 80% of the participants with ASD and their matched neurotypical peers met the guideline for 1 or 0 days.

Youth with ASD and their age, sex and BMI matched neurotypical peers had no significant difference in average daily LPA or MVPA ($p > .05$) during days 2–6 wearing time. As displayed in Table 2, while youth with ASD had slightly higher average daily LPA (201.36 ± 63.50 v. 172.30 ± 54.98, $p > .05$), and significantly higher weekend LPA than their matched peers ($p < .05$); their average daily MVPA was slightly lower than the matched peers (33.54 ± 17.07 v. 37.63 ± 19.94, $p > .05$), with similar patterns occurring for weekday and weekend MVPA.

Discussion

The purpose of this preliminary study was to compare LPA and MVPA between youth with ASD and age, sex, and BMI matched neurotypical peers from the same geographic region. Notably, results of this study indicate that youth with ASD did not engage in significantly less MVPA than age, sex, and BMI-matched peers. Supporting this, both groups were unlikely to meet MVPA recommendations of 60 min per day,[1] where 88.9% of those with ASD and 83.3% of neurotypical matches met these guidelines on one or none of the days. The lack of significant difference found in this sample is well-aligned with accelerometer research focusing on younger children[10,11]; however, the results conflict with parent-reported[7] and accelerometer[6,17] research on youth. While the lack of statistical significance may be partially explained by the relatively small sample size in the analysis, the results provide a conflicting narrative to prior research and may speak to the meaningfulness of matching personal characteristics, such as age, sex, BMI, and geographic location. The non-significant differences between the matched youth with ASD and neurotypical peers suggest that variability in other social or environmental factors, such as those explored by Healy and colleagues,[5] may play a larger role in influencing MVPA than ASD itself.

Whereas differences in LPA and MVPA were not statistically significant, it may be important to also consider the clinical or practical meaningfulness of differences between groups, particularly given the small sample size in this study. With that, we believe that the small differences (<5 min per day) in MVPA between those with (33.54 ± 17.07) and without (37.63 ± 19.94) ASD likely does not hold clinical or practical value. That is, differences of less than 5 min are largely below explicated durations of acute physical activity (i.e., approximately 10 min) that may have clinical benefits.[23] Interestingly, differences in LPA, where those with ASD (201.36 ± 63.50) were about 30 min per day more active than their neurotypical peers (172.30 ± 54.98), may hold some clinical value given associations between LPA and health indicators among youth.[2] These larger differences may be a product of different ways in which peer, family, and community barriers influence MVPA versus LPA for these populations.[9,10] However, LPA should not be valued on the same footing as MVPA and should be replaced with MVPA when appropriate to enhance health-related benefits associated with physical activity participation.[3]

The current study extended the existing literature by purposely recruiting age, sex, and BMI-matched neurotypical matches from the same geographic location as participants with ASD. Despite these strengths, several limitations are evident. For example, the low sample size in this study limits the inferences of these findings, and it should be noted that the sample of youth with ASD does not reflect the diversity of all youth with ASD, which should be considered when interpreting the results of this study. Of additional importance, data were limited regarding descriptive information about the participants' ASD diagnosis. While each participants' parents provided either educational or medical paperwork confirming diagnosis, ASD level and ASD particularities were not recorded. It is reasonable to suggest that even though all participants had a formal diagnosis of ASD, they likely experienced different characteristics associated with ASD at various levels, which may have influenced their LPA and MVPA differently.

Implications

This study provides evidence that youth with ASD may engage in similar amounts of MVPA as age, sex, and BMI-matched peers from the same geographic locations. These results have both practical and research implications. For example, these findings

Table 1
Participant demographic information.

Variable	Youth with ASD (n = 18)	Neurotypical Peers (n = 18)
Age (M ± SD, years)	14.61 ± 1.54	14.44 ± 1.38
BMI (M ± SD, kg/m^2)	21.14 ± 4.85	20.65 ± 3.75
Sex (n/%)		
Male	5/27.8%	5/27.8%
Female	13/72.2%	13/72.2%
Race (n/%)		
African American	5/27.8%	4/22.2%
Asian American	1/5.6%	0/0%
Caucasian	12/66.7%	12/66.7%
Multiple races	0/0%	2/11.1%
Met 60 min MVPA (n/%)		
0 of Days 2–6	11/61.1%	8/44.4%
1 of Days 2–6	5/27.8%	7/38.9%
2 of Days 2–6	0/0%	0/0%
3 of Days 2–6	2/11.1%	2/11.1%
4 of Days 2–6	0/0%	1/5.6%
Weekdays (90)	11/12.2%	13/14.4%
Weekend days (36)	6/16.7%	7/19.4%

Note: ASD = autism spectrum disorder, MVPA = moderate to vigorous physical activity, numbers presented with weekdays (90) and weekend days (36) represent the frequency of these days in the dataset.

Table 2
Participant accelerometer light and moderate to vigorous physical activity.

Variable (M ± SD)	Youth with ASD	Neurotypical Peers	Δ ± SE	t	$P_{df=17}$
Weekday MVPA	36.52 ± 18.28	37.00 ± 14.80	-.48 ± 5.80	-.08	.94
Weekend MVPA	27.20 ± 22.04	35.63 ± 45.63	−8.43 ± 13.18	-.64	.53
MVPA (min/d)	33.54 ± 17.07	37.63 ± 19.94	−4.09 ± 5.33	-.77	.45
Weekday LPA	207.48 ± 69.25	182.38 ± 55.51	25.10 ± 23.10	1.09	.29
Weekend LPA	194.25 ± 73.46	149.65 ± 56.15	44.60 ± 20.41	2.19	.04
LPA (min/d)	201.36 ± 63.50	172.30 ± 54.98	29.06 ± 20.00	1.45	.16

Note: ASD = autism spectrum disorder, SE = standard error, LPA = light physical activity, MVPA = moderate to vigorous physical activity.

suggest that rather than attributing inactivity specifically to an ASD diagnosis, practitioners should feel encouraged to promote MVPA engagement to this population with the expectation that they can be similarly active as their neurotypical peers. From a research perspective, further examining how environmental and social factors influence the MVPA and LPA of youth with ASD and neurotypical controls[5] is warranted.

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Disclaimer

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Declaration of competing interest

The Author(s) declare(s) that there is no conflict of interest.

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