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Observational Study

Organized physical activity and sedentary behaviors in children and adolescents with autism spectrum disorder, cerebral palsy, and intellectual disability

Amin Nakhostin-Ansari, Monir Shayestehfar, Alireza Hasanzadeh, Fateme Gorgani, Amirhossein Memari

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Abstract

BACKGROUND

There is little data on physical activity (PA), organized PA (OPA), and sedentary behaviors in autism spectrum disorders (ASD) and other neurodevelopmental disorders in developing countries.

AIM

To examine OPA, non-OPA, and sedentary behaviors and their associated factors in children and adolescents with ASD, cerebral palsy (CP), and intellectual disability (ID).

METHODS

A total of 1020 children and adolescents with ASD, CP, and ID were assessed regarding the child and family information as well as the Children's Leisure Activities Study Survey.

RESULTS

The results showed that the OPA level was significantly lower than non-OPA in all groups. Furthermore, the OPA level was significantly lower in the CP group compared to ASD and ID groups ($P < 0.001$). Also, moderate ($P < 0.001$), vigorous ($P < 0.05$), and total ($P < 0.001$) physical activity levels were significantly different between all three groups, with the values being higher in the ASD group

compared to the other two. The mean of the total sedentary behavior duration in the ASD group (1819.4 min/week, SD: 1680) was significantly lower than in the CP group (2687 min/week, SD: 2673) ($P = 0.007$) but not ID group (2176 min/week, SD: 2168.9) ($P = 0.525$).

CONCLUSION

Our findings remark on the participation rate of PA, OPA, and sedentary behaviors of children and adolescents with ASD, CP, and ID in a developing country. In contrast, the need for developing standards of PA/OPA participation in neurodevelopmental disorders is discussed.

Key Words: Neurodevelopmental disorders; Physical disability; Mental disability; Active lifestyle

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Core Tip: There is little data on physical activity (PA), organized PA (OPA), and sedentary behaviors in autism spectrum disorder (ASD) and in developing countries. A total of 1020 children and adolescents with ASD, cerebral palsy (CP), and intellectual disability (ID) were assessed regarding their physical activity. Our findings remark on the participation rate of PA, OPA, and sedentary behaviors of children and adolescents with ASD, CP, and ID in a developing country.

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INTRODUCTION

Sedentary behavior has been defined as any waking behavior with an energy expenditure ≤ 1.5 metabolic equivalents while in a sitting, reclining, or lying posture and is associated with chronic underlying diseases such as diabetes and cardiovascular diseases[1-3]. On the other hand, non-organized physical activity (PA) is defined as any bodily movement that requires energy expenditure higher than sedentary behavior level, and organized PA (OPA) is defined as involving in regular and structured health and leisure activities with peers, coaches, and group leaders such as tennis, football, etc [4].

Plenty of literature points to the importance of PA in children; however, levels of PA are insufficient for different groups of children, particularly those with disabilities[5]. The optimal level of PA can increase health status and decrease the incidence of chronic disorders such as cancer, diabetes, cardiovascular disorders, and mood disorders[6]. Mental, intellectual, and motor disabilities negatively impact the opportunities to participate in an optimal level of PA to gain health benefits and limit sedentary behaviors consequences[7]. In other words, children with particular disabilities, such as neurodevelopmental disorders, may be limited regarding motor disabilities and social skills[8]. For example, children with autism spectrum disorders (ASD) participate in less PA[9] and more sedentary behaviors than their peers leading to greater body mass index (BMI) in comparison to typically developing (TD) children[10-12]. In addition, according to estimates of developed countries, children with neurodevelopmental disorders such as ASD, cerebral palsy (CP), and intellectual disability (ID) also participated less in a regular and OPA than those children without a neurodevelopment disability[13-17]. Studies have also shown children with neurodevelopmental disabilities encounter additional personal and environmental barriers that hinder their participation in physical activities compared to TD children[10,18].

Although the disability characteristics should be considered[8], participation in PA, benefiting from its psychosocial and motor advantages, is of paramount importance for children with neurodevelopmental disorders[8,19]. PA could also enhance cognitive and meta-cognitive function and improve educational performance[20-22]. Moreover, OPA provides additional benefits, including promoting inclusion, facilitating social connection, improving social and emotional well-being, and reducing functional decline[23]. For example, Sun *et al*[24], in a clinical trial, assessed the effects of an adapted PA consisting of moderate-intensity aerobic and resistance exercises on health-related physical fitness in adolescents with ID. The authors declared significant changes were observed in cardiorespiratory fitness, running/walking tests, and flexibility in the intervention group compared to the control group. In addition, in a recent systematic review and meta-analysis, Howells *et al*[23] represented that group-based OPA participation improves overall social functioning in children with ASD. Moreover, Mak *et al*[25] reported the positive effect of a regular 8-wk mindfulness yoga program on attention outcomes of children with CP. However, due to motor skill limitations, such a positive impact was not observed in their physical skills outcomes. Given the above, OPA is a constructive and helpful context in which children and adolescents with neurodevelopmental disorders could benefit from opportunities, including social engagement, promoting social skills, enhancing mental health, and improving quality of life[26,27].

Despite valuable research in terms of the effect of PA and OPA on different aspects of neurodevelopmental disorders, there are few studies assessing the rate of OPA participation in children with ASD in comparison to other neurodevelop-

mental groups and not TD children. Arim *et al*[8] assessed the PA/OPA participation rate in 4-9 years old Canadian children with neurodevelopmental disorders (including epilepsy, CP, ID, and learning disability) compared to TD children. Their results represented that although the frequency of OPA participation in this population varied depending on the child's health condition, there was no significant difference in general PA participation among different neurodevelopmental groups.

Thus, the current study aimed to assess and compare sedentary behavior, OPA, and non-OPA levels, as primary outcomes in children and adolescents with ASD, ID, and CP. We also aimed to determine the personal and familial factors associated with PA and sedentary behavior among these children. This is one of the few studies on PA levels among children with neurodevelopmental disorders in the context of a developing country, utilizing a large sample size. The findings of this study may help to identify the groups which benefit the most from the interventions to improve PA levels and can be a basis for future studies in the context of developing countries.

MATERIALS AND METHODS

Study design and setting

The data for the current cross-sectional study were drawn from a longitudinal survey of "Quality of life and psychophysical function in children and adolescents with developmental disabilities; evaluating risk factors and developmental trend", which was conducted from 2011 to 2021 with a sample size of 1850 participants (1040 boys and 810 girls) aged 6-18 years from special schools in Tehran, Iran. Participants were included in the study by stratified random sampling. The population was stratified into different strata by disorders; each stratum was divided into different clusters (schools), respectively. Then five schools were included for each stratum (disorder). Afterward, children's parents/caregivers responded to the Children's Leisure Activities Study Survey (CLASS questionnaire) to examine the children's non-OPA (*i.e.*, general routine PA), OPA, and sedentary behavior activities. The study was approved by the ethics committee of Tehran University of medical sciences (ethics code: IR.TUMS.NI.REC.1401.031), and written consent was obtained from participants' parents/caregivers before entering the study.

Participants

Children and adolescents with neurodevelopmental disorders were included in the current study. The diagnosis of ASD was confirmed by DSM-IV, and the autism diagnostic inventory-revised by a professional child psychiatrist. The participants were excluded if they had two or three of the conditions (*i.e.*, ASD, CP, or ID) together and being less than six years of age.

Measurements

Basic and sociodemographic data: Parents/caregivers of the participants were asked to fill the items of a questionnaire containing child and family basic and sociodemographic information, including the child's age, gender, childcare status (two parents, single parent, and other), household status (owner, tenant, and other), parents' age, and parents' educational level. Physical therapists also conducted a physical examination to measure participants' height, weight, waist circumference, and hip circumference. Moreover, the existence of any musculoskeletal disorder preventing physical movements was assessed based on physical examination as well as the participants' medical history by a physical therapist.

Non-OPA/OPA and sedentary behavior data: We used the Persian version of the CLASS to assess non-OPA/OPA and sedentary behavior. This survey measures the type, frequency, and duration of different types of PA, including non-OPA and OPA as well as sedentary behavior among children. The CLASS checklist contains items for both non-OPA (such as playing indoors with toys, walking the dog, *etc.*) and OPA (such as football, basketball, aerobics, *etc.*), as well as items for sedentary behaviors (such as sitting, talking, listening to music, and reading). Previous studies have demonstrated test-retest reliability (ICC > 0.58 across different domains) and criterion validity CLASS[28].

Statistical methods

First, descriptive statistics for basic, demographic, and sociodemographic variables, PA/OPA, and sedentary behavior data were calculated for each group. We used the chi-square test to compare the categorical variables between groups. We also used the Kolmogorov-Smirnov test to test if the continuous variables are distributed normally. As none of the continuous variables had normal distribution, we used non-parametric tests, such as the Kruskal-Wallis test, to compare them between groups. Moreover, the Mann-Whitney *U* test was also conducted to compare two individual groups whenever the difference between the three groups was significant. Finally, the Wilcoxon test was used to compare OPA and non-OPA levels in all groups. All analyses were conducted using SPSS version 26, while a *P* value of less than 0.05 was considered significant.

RESULTS

Descriptive statistics

In the current study, 1020 participants (ASD: 248, CP: 306, ID: 466) were included in the final analysis (Table 1 shows the

Table 1 Basic and demographic data of participants in autism spectrum disorders, intellectual disability, and cerebral palsy groups, *n* (%)

Variables	ASD	ID	CP	<i>P</i> value
Gender; Female	9 (3.6)	247 (53.0)	160 (52.3)	< 0.001
Age (yr); mean (SD)	11.15 (2.7)	12.69 (3.0)	12.11 (3.2)	< 0.001
Height (cm); mean (SD)	145.51 (16.20)	141.55 (17.30)	137.01 (18.70)	< 0.001
Weight (kg); mean (SD)	44.98 (19.10)	42.70 (18.10)	38.73 (20.70)	< 0.001
WC (cm); mean (SD)	70.90 (13.60)	72.19 (15.10)	66.53 (11.80)	< 0.001
HC (cm); mean (SD)	81.16 (12.60)	82.72 (15.40)	76.23 (12.80)	< 0.001
WHR; mean (SD)	0.86 (0.10)	0.87 (0.20)	0.87 (0.10)	0.691
Musculoskeletal disorder	27 (10.9)	70 (15.0)	78 (25.5)	< 0.001
Household				
Owner	131 (55.0)	239 (54.2)	108 (37.9)	< 0.001
Tenant	92 (38.7)	178 (40.4)	141 (49.5)	
Other	15 (6.3)	24 (5.4)	36 (12.6)	
Childcare				
Two parents	201 (91.8)	350 (85.8)	242 (89.3)	0.157
Single parent	17 (7.8)	48 (11.8)	25 (9.2)	
Other	1 (0.5)	10 (2.5)	4 (1.5)	
Father's education				
Lower than diploma	39 (16.5)	217 (48.5)	122 (43.9)	< 0.001
Diploma (11 yr of education)	70 (29.5)	134 (30.0)	89 (32.0)	
Higher than diploma	128 (54.0)	96 (21.5)	67 (24.1)	
Mother's education				
Lower than diploma	37 (15.3)	215 (48.4)	105 (36.1)	< 0.001
Diploma (11 yr of education)	85 (35.1)	159 (35.8)	132 (45.4)	
Higher than diploma	120 (49.6)	70 (15.8)	54 (18.6)	
Father's age (yr); mean (SD)	43.98 (6.70)	46.2 (7.7)	43.2 (6.9)	< 0.001
Mother's age (yr); mean (SD)	38.30 (6.50)	41.2 (7.1)	38.1 (6.7)	< 0.001

ASD: Autism spectrum disorders; CP: Cerebral palsy; HC: Hip circumference; ID: Intellectual disability; SD: Standard deviation; WC: Waist circumference; WHR: Waist to hip ratio.

descriptive statistics). In the ASD group, 3.6% of participants were female, which is significantly lower than the ID and CP groups (53% and 52.3%, respectively; $P < 0.001$). In pairwise comparison, there were significant differences between groups regarding their ages ($P < 0.05$), with the ASD group being the youngest (mean = 11.15, SD = 2.66) and the ID group being the oldest (mean = 12.69, SD = 3.15). Similarly, height was significantly different between all three groups ($P < 0.05$). Also, children with CP had lower weights ($P < 0.01$), smaller waist circumferences ($P < 0.01$), and smaller hip circumferences ($P \leq 0.001$) than the other groups. In addition, the prevalence of musculoskeletal disorders was significantly higher in the CP group compared to both ASD and ID groups ($P < 0.001$). The parents in the ASD group were more educated than both CP and ID groups ($P < 0.001$). Parents of children with ID were significantly older than the parents of the other two groups ($P \leq 0.001$).

Non-OPA/OPA and sedentary behavior results

Table 2 presents and compares the physical activity levels of children with ASD, ID, and CP. Our results showed that the level of OPA is significantly lower in comparison to non-OPA in ASD ($P < 0.001$), CP ($P < 0.001$), and ID ($P < 0.001$) groups (Table 2). Furthermore, the OPA level was significantly lower in the CP group compared to ASD and ID groups ($P < 0.001$). Also, non-OPA levels were significantly different between the three groups ($P < 0.001$). Also, in pairwise comparisons, moderate ($P < 0.001$), vigorous ($P < 0.05$), and total ($P < 0.001$) physical activity levels were significantly different between all three groups, with the values being higher in the ASD group compared to the other two.

Table 2 The amount of physical activity/organized physical activity (minutes per week) and level of physical activity in autism spectrum disorders in comparison to control intellectual disability, and cerebral palsy groups

Min/week	ASD, mean (SD)	ID, mean (SD)	CP, mean (SD)	P value
OPA				
Aerobic exercise	1.0 (8.7)	1.1 (10.2)	0.6 (6.5)	0.938
Dancing	7.3 (30.7)	14.2 (44.6)	6.9 (38.3)	< 0.001
Gymnastic	2.2 (24)	0.6 (8.1)	0.2 (3.1)	0.367
Tennis	0.4 (3.9)	2.0 (16.9)	4.7 (51.5)	0.323
Football	10.5 (59.4)	9.2 (34.4)	3.7 (28.2)	0.003
Volleyball	2.6 (29.2)	1.3 (9.4)	0.4 (4.3)	0.246
Basketball	0.8 (12.1)	2.3 (26.7)	0.3 (4.2)	0.475
Handball	0 (0)	0.1 (2.5)	0.3 (3.3)	0.132
Swimming laps	11.1 (58.2)	2.6 (17.4)	1.2 (10.2)	0.008
Rollerblading	4.2 (24.7)	3.6 (37.7)	0.2 (2.9)	0.017
Skateboarding	0.7 (8.3)	0.9 (15.4)	0.3 (4.2)	0.690
Physical education class	2.3 (14.7)	1.9 (11.5)	1.1 (8.6)	0.567
Sport class at school	16.4 (25.1)	10.5 (24.9)	6.6 (17.1)	< 0.001
Total OPA	59.5 (134.0)	50.4 (101.3)	26.6 (85.1)	< 0.001
Non-OPA (mins/week)				
Bicycling	27.4 (95.7)	11.7 (49.8)	9.4 (76.6)	< 0.001
Scooter	6.9 (37)	4.0 (29.3)	0.5 (4.6)	0.008
Skipping rope	1.6 (17.2)	0.8 (5.8)	0.3 (3.6)	0.047
Playing with the ball	0.7 (7.9)	1.7 (29.4)	0.3 (5.1)	0.377
Tag/chasey	2.1 (20.8)	3.8 (20.8)	0.6 (7.3)	< 0.001
Household chores	23.5 (70.7)	26.3 (94.8)	10.6 (53)	< 0.001
Walk for exercise	49.7 (103.5)	23.7 (55.9)	22.7 (135.6)	< 0.001
Play on playground equipment	48.2 (95.7)	22.7 (53.9)	13.6 (43.5)	< 0.001
Jogging or running	17.4 (82.6)	9.2 (35.0)	4.1 (22.1)	< 0.001
Swimming for fun	21.8 (48.6)	6.6 (25.1)	9.8 (34.5)	< 0.001
Bounce on the trampoline	4.9 (30.1)	1.5 (15.3)	0.5 (4.9)	< 0.001
Play with pet	2.3 (18.6)	3.7 (24)	5.5 (41.9)	0.471
Travel to school by walking	4.0 (21.3)	6.1 (31.9)	1.2 (9.8)	< 0.001
Travel to school by bicycling	0.2 (3.8)	0.2 (2.4)	0.1 (2.3)	0.822
Total non-OPA	210.8 (295.3)	122.1 (210.1)	79.4 (207.5)	< 0.001
Level of PA/OPA				
Moderate physical activity	198.7 (277.1)	129.4 (206.9)	79.8 (207.2)	< 0.001
Vigorous physical activity	71.5 (159.4)	43.1 (111.9)	26.1 (84.2)	< 0.001
Total physical activity	270.3 (372.9)	172.4 (275.3)	105.9 (241.8)	< 0.001

PA: Physical activity; OPA: Organized physical activity; ASD: Autism spectrum disorders; CP: Cerebral palsy; ID: Intellectual disability; SD: Standard deviation.

Table 3 The amount of sedentary behavior (minutes per week) in autism spectrum disorders in comparison to control intellectual disability, and cerebral palsy groups

Variables (mins/week)	ASD, mean (SD)	ID, mean (SD)	CP, mean (SD)	P value
Watching TV	465.8 (628.1)	709.8 (810.0)	747.3 (788.9)	< 0.001
Play station/computer games	131.7 (306.9)	96.2 (281.8)	103.1 (309.4)	0.061
Computer/internet	74.9 (215.7)	70.5 (229.9)	69.0 (270.1)	0.185
Homework	363.1 (410.6)	415.2 (489.0)	516.6 (717.0)	0.392
Play indoors with toys	136.7 (277.4)	164.1 (315.4)	193.7 (359.0)	0.742
Sitting talking	112.7 (296.5)	170.3 (400.2)	293 (757.4)	0.052
Talk on the phone	16.8 (60.0)	38.2 (175.5)	67.1 (231.9)	0.001
Listen to music	177.4 (402.3)	121.9 (258.1)	118.3 (253.2)	0.118
Playing musical instrument	7.6 (37.4)	5.1 (62.3)	2.9 (27.9)	0.005
Playing board games/cards	15.7 (88.0)	15.9 (75.9)	27.4 (129.3)	0.249
Reading	98.1 (222.4)	146.6 (294.2)	250.2 (420.4)	0.001
Art	40.2 (128.3)	44.7 (169.5)	49.1 (234.6)	0.187
Imaginary play	24.0 (115.5)	72.3 (197.2)	89.1 (279.9)	0.001
Travel by car/bus	154.7 (357.6)	105.7 (296.1)	160.3 (372.4)	0.032
Total sedentary behavior	1819.4 (1680.0)	2176.5 (2168.9)	2687.0 (2673.5)	0.008

ASD: Autism spectrum disorders; CP: Cerebral palsy; ID: Intellectual disability; SD: Standard deviation.

Table 3 represents the sedentary behaviors of participants. The mean of the total sedentary behavior duration in the ASD group (1819.4 mins/week, SD: 1680) was significantly lower than in the CP group (2687 mins/week, SD: 2673; $P = 0.007$) but not ID group (2176 mins/week, SD: 2168.9; $P = 0.525$). There was also no significant difference between children with CP and ID concerning the time spent on sedentary behavior ($P = 0.106$).

Sociodemographic contributing factors

Tables 4–6 show the details of contributing factors for moderate to vigorous physical activities (MVPA) and sedentary behaviors in the ASD, ID, and CP groups, respectively. OPA was significantly lower in females (mean = 5.6, SD = 11.1) than males (mean = 61.6, SD = 136) in children with ASD ($P = 0.045$). Also, in the ASD group, non-OPA ($P = 0.032$) and sedentary behavior ($P = 0.02$) levels were significantly different in children of mothers with various educational levels (Table 4). Males in the ID group had higher MVPA ($P < 0.001$), OPA ($P < 0.001$), and non-OPA ($P = 0.001$) levels than the females. Household status ($P = 0.018$) and age ($P = 0.004$) were associated with OPA, while the presence of musculo-skeletal disorders ($P = 0.041$) and household status ($P = 0.008$) were associated with sedentary behavior in the ID group (Table 5). Additionally, in this group, childcare status was associated with MVPA ($P = 0.021$) and non-OPA ($P = 0.023$). Gender was associated with MVPA ($P = 0.091$), OPA ($P = 0.045$), and sedentary behavior ($P = 0.002$) in children with CP. Also, household status ($P = 0.018$) and father's education ($P = 0.029$) were associated with sedentary behavior and OPA, respectively (Table 6).

DISCUSSION

Regular OPA and general PA help enhance psychosocial and health outcomes[29]. On the other hand, sedentary behaviors can indirectly increase the risk of various health conditions. It is worth noting that children and adolescents with disabilities have a lower participation rate in PA, putting them at higher risk for complications[30], which can cause significant challenges for the child, their families, and society[30]. Thus, we aimed to examine the participation rate of OPA, PA, and sedentary behaviors among children with neurodevelopmental disorders in a new sample from a developing country.

Interestingly, our findings showed that the amount of OPA is lower than non-OPA in all ASD, CP, and ID groups. Despite the known positive effects of group-based OPA in overall social functioning in children[23], it seems that the parents/caregivers of children with neurodevelopmental disorders still do not take advantage of regular OPA as a non-medical treatment for their children. Papadopoulos *et al*[31] examined parent-reported barriers to OPA, reported a lack of children's happiness and motivation during OPA as the main existing barriers to OPA among individuals with neurodevelopmental disorders. However, it seems that other hypothetical major barriers, such as the lack of appropriately adapted OPA programs and parents' unawareness of OPA's benefits, are also playing a role in developing

Table 4 Associations between contributing factors, moderate to vigorous physical activities, and sedentary behaviors in autism spectrum disorders group

Domain	Variable		MVPA (mins/week)	P value	OPA (mins/week)	P value	Non-OPA (mins/week)	P value	SB (mins/week)	P value
Individual	Gender	Male (<i>n</i> = 239)	276.7 (377.9)	0.127	61.6 (136.0)	0.045	215.1 (299.3)	0.310	1835.6 (1686.0)	0.418
		Female (<i>n</i> = 9)	100.6 (105.8)		5.6 (11.1)		95.0 (105.2)		1388.7 (1536.3)	
	Age	6-11 yr (<i>n</i> = 143)	308.1 (423.1)	0.381	64.3 (148.7)	0.484	243.8 (345.4)	0.313	1897.70 (1738.69)	0.733
		12-14 yr (<i>n</i> = 72)	200.1 (237.5)		48.5 (81.0)		151.5 (193.4)		1728.3 (1538.7)	
		15-18 yr (<i>n</i> = 33)	259.7 (319.3)		62.9 (159.4)		196.8 (218.6)		1679.1 (1747.5)	
	Musculoskeletal disorder	No (<i>n</i> = 221)	264.4 (380.2)	0.094	57.7 (136.1)	0.054	206.7 (301.6)	0.140	1774.4 (1666.3)	0.242
		Yes (<i>n</i> = 27)	318.9 (307.8)		74.6 (115.9)		244.2 (239.1)		2187.7 (1778.6)	
Familial/social	Household	Owner (<i>n</i> = 131)	252.2 (362.2)	0.897	59.1 (142.0)	0.880	193.1 (262.6)	0.985	1803.0 (1625.8)	0.986
		Tenant (<i>n</i> = 92)	288.3 (397.6)		65.7 (137.0)		222.7 (324.9)		1832.8 (1801.9)	
		Other (<i>n</i> = 15)	234.4 (223.1)		52.0 (74.8)		182.4 (206.6)		1846.0 (1729.3)	
	Child care	Two parents (<i>n</i> = 207)	285.5 (389.1)	0.258	63.8 (144.5)	0.624	221.8 (304.0)	0.325	1906.3 (1698.4)	0.493
		Single parent (<i>n</i> = 17)	202.9 (296.8)		29.4 (35.6)		173.5 (297.9)		1415.0 (1399.3)	
		Other (<i>n</i> = 1)	-		-		-		-	
	Father's education	Lower than diploma (<i>n</i> = 39)	309.3 (426.0)	0.335	58.5 (144.6)	0.060	250.8 (367.3)	0.672	1782.3 (1637.1)	0.099
		Diploma (<i>n</i> = 70)	264.2 (439.7)		62.4 (189.2)		201.8 (295.2)		1526.7 (1584.9)	
		Higher than diploma (<i>n</i> = 128)	269.0 (324.6)		60.7 (93.9)		208.3 (277.0)		2012.8 (1637.1)	
	Mother's education	Lower than diploma (<i>n</i> = 37)	229.9 (352.3)	0.076	37.8 (75.8)	0.443	192.0 (342.8)	0.032	1218.8 (1694.3)	0.020
		Diploma (<i>n</i> = 85)	323.1 (433.6)		70.0 (177.3)		253.1 (306.6)		1696.5 (1708.2)	
		Higher than diploma (<i>n</i> = 120)	251.5 (337.2)		59.9 (113.4)		191.6 (275.1)		1898.4 (1607.9)	
	Father's age	< 35 yr (<i>n</i> = 13)	204.2 (222.6)	0.484	36.9 (46.1)	0.496	167.3 (217.1)	0.538	1656.0 (2499.9)	0.223
		35-49 yr (<i>n</i> = 182)	297.0 (403.1)		64.7 (144.8)		232.3 (320.8)		1912.5 (1690.2)	
		≥ 50 yr (<i>n</i> = 40)	202.6 (244.1)		44.5 (93.9)		158.1 (190.8)		1472.0 (1329.6)	
	Mother's age	< 35 yr (<i>n</i> = 81)	327 (456.6)	0.168	71.7 (181.7)	0.544	255.4 (334.3)	0.228	1822.7 (1935.8)	0.218
		35-49 yr (<i>n</i> = 149)	258.2 (334.1)		56.3 (107.4)		202.0 (283.3)		1866.2 (1545.9)	
		≥ 50 yr (<i>n</i> = 13)	132.7 (177.1)		27.3 (53.4)		105.4 (132.2)		1123.5 (1129.0)	

OPA: Organized physical activity; SB: Sedentary behaviors MVPA: Moderate to vigorous physical activities

Table 5 Associations between contributing factors, moderate to vigorous physical activities, and sedentary behaviors in intellectual disability group

Domain	Variable		MVPA (mins/week)	P value	OPA (mins/week)	P value	Non-OPA (mins/week)	P value	SB (mins/week)	P value
Individual	Gender	Male (<i>n</i> = 219)	208.2 (295.8)	< 0.001	63.7 (114.2)	< 0.001	144.5 (224)	0.001	2183 (1916.7)	0.248
		Female (<i>n</i> = 247)	140.7 (252.1)		38.5 (86.9)		102.2 (195.2)		2170.7 (2374.1)	
	Age	6-11 yr (<i>n</i> = 176)	179.1 (276.2)	0.355	43.6 (104)	0.004	135.5 (212.8)	0.248	2200.6 (2193.2)	0.831
		12-14 yr (<i>n</i> = 147)	164.0 (299.1)		47.0 (101.6)		117.0 (237.6)		2090.5 (2149.9)	
		15-18 yr (<i>n</i> = 143)	172.9 (249.1)		62.2 (97.2)		110.7 (174.0)		2235.0 (2170.9)	
	Musculoskeletal disorder	No (<i>n</i> = 396)	171.2 (263.1)	0.676	49.4 (101.4)	0.775	121.8 (200.8)	0.421	2249.2 (2170.2)	0.041
		Yes (<i>n</i> = 70)	179.6 (338.2)		56.0 (101.2)		123.6 (258.1)		1764.9 (2130.5)	
Familial/social	Household	Owner (<i>n</i> = 239)	179.7 (250.7)	0.054	57.4 (106.3)	0.018	122.2 (185.4)	0.075	2413.6 (1994.4)	0.008
		Tenant (<i>n</i> = 178)	161.5 (295.1)		42.0 (96.9)		119.5 (225.7)		1994.7 (2415.6)	
		Other (<i>n</i> = 24)	138.6 (170.1)		39.2 (59.5)		99.4 (159.7)		2346.2 (2007.6)	
	Child care	Two parents (<i>n</i> = 350)	183.7 (286.0)	0.021	52.9 (108.3)	0.282	130.8 (216.6)	0.023	2205.3 (2121.6)	0.144
		Single parent (<i>n</i> = 48)	130.2 (216.1)		41.8 (74.0)		88.4 (172.9)		2093.1 (2189.2)	
		Other (<i>n</i> = 10)	53.6 (125.9)		20.0 (43.2)		33.6 (96.2)		1282.0 (2451.6)	
	Father's education	Lower than diploma (<i>n</i> = 217)	177.7 (298.1)	0.446	51.5 (104.6)	0.633	126.2 (231.8)	0.233	2098.5 (2151.7)	0.421
		Diploma (<i>n</i> = 134)	171.4 (237.4)		39.2 (64.7)		132.23 (194.40)		2442.4 (2266.8)	
		Higher than diploma (<i>n</i> = 96)	175.9 (286.8)		68.0 (136.5)		107.9 (185.7)		2215.7 (2104.4)	
	Mother's education	Lower than diploma (<i>n</i> = 215)	185.7 (307.1)	0.575	52.9 (112.4)	0.575	132.8 (235.9)	0.552	2175.8 (2399.6)	0.6
		Diploma (<i>n</i> = 159)	157.0 (215.0)		41.4 (74.7)		115.6 (173.2)		2215.3 (1901.2)	
		Higher than diploma (<i>n</i> = 70)	178.9 (315.7)		64.0 (124.5)		114.8 (217.4)		2256.5 (2108.8)	
	Father's age	< 35 yr (<i>n</i> = 22)	140.2 (173.3)	0.367	36.0 (53.8)	0.927	104.1 (151.5)	0.059	1894.1 (1841.9)	0.756
		35-49 yr (<i>n</i> = 289)	176.2 (256.7)		49.5 (100.2)		126.7 (198.5)		2239.32 (2106.00)	
		≥ 50 yr (<i>n</i> = 135)	179.1 (333.0)		57.1 (115.1)		122.0 (245.7)		2237.8 (2381.8)	
	Mother's age	< 35 yr (<i>n</i> = 90)	169.5 (248.4)	0.953	42.0 (80.7)	0.542	127.5 (202.5)	0.759	1863.4 (1888.8)	0.326
		35-49 yr (<i>n</i> = 297)	165.6 (252.1)		49.5 (100.0)		116.1 (191.6)		2272.5 (2211.1)	
		≥ 50 yr (<i>n</i> = 62)	218.9 (406.3)		69.4 (139.0)		149.5 (297.4)		2278.8 (2403)	

OPA: Organized physical activity; SB: Sedentary behaviors MVPA: Moderate to vigorous physical activities

Table 6 Associations between contributing factors, moderate to vigorous physical activities, and sedentary behaviors in cerebral palsy group

Domain	Variable		MVPA (mins/week)	P value	OPA (mins/week)	P value	Non-OPA (mins/week)	P value	SB (mins/week)	P value
Individual	Gender	Male (<i>n</i> = 146)	80.9 (163.5)	0.019	19.1 (53.5)	0.045	61.9 (125.1)	0.107	2236.2 (2531.7)	0.002
		Female (<i>n</i> = 160)	128.7 (294.4)		33.4 (105.7)		95.3 (260.3)		3098.2 (2740.2)	
	Age	6-11 yr (<i>n</i> = 143)	126.4 (288.0)	0.665	23.9 (70.6)	0.681	102.6 (267.5)	0.471	2250.8 (2326.4)	0.076
		12-14 yr (<i>n</i> = 82)	98.8 (229.7)		40.5 (130.7)		58.3 (137.6)		3061.3 (2850.2)	
		15-18 yr (<i>n</i> = 81)	76.9 (143.5)		17.2 (33.9)		59.7 (127.1)		3078.0 (2963.1)	
	Musculoskeletal disorder	No (<i>n</i> = 228)	113.9 (269.2)	0.907	26.8 (83.9)	0.633	87.0 (233.1)	0.976	1771.6 (2807.1)	0.623
		Yes (<i>n</i> = 78)	82.7 (131.1)		25.8 (89.1)		56.9 (98.4)		2439.5 (2235.6)	
Familial/social	Household	Owner (<i>n</i> = 108)	98.5 (203.5)	0.586	28.0 (85.8)	0.543	70.5 (173.3)	0.418	2411.4 (2769.4)	0.018
		Tenant (<i>n</i> = 141)	106.8 (248.9)		18.4 (53.4)		88.4 (241.6)		3060.0 (2509.6)	
		Other (<i>n</i> = 36)	108.1 (308)		47.1 (150.1)		61.1 (179.3)		221.3 (2841.7)	
	Child care	Two parents (<i>n</i> = 242)	115.3 (260.2)	0.828	28.7 (91.0)	0.901	88.6 (227.2)	0.972	2686.2 (2707.5)	0.429
		Single parent (<i>n</i> = 25)	60.0 (85.1)		11.6 (21.0)		48.4 (72.0)		3329.4 (2927.9)	
		Other (<i>n</i> = 4)	36.3 (66.0)		11.3 (22.5)		25.0 (43.6)		3147.5 (2116.5)	
	Father's education	Lower than diploma (<i>n</i> = 122)	114.3 (231.1)	0.182	36.5 (110.3)	0.029	77.8 (168.6)	0.257	2879.7 (2684.7)	0.261
		Diploma (<i>n</i> = 89)	127.0 (324.4)		21.1 (68.0)		105.9 (311.7)		2847.8 (3060.3)	
		Higher than diploma (<i>n</i> = 67)	60.6 (108.2)		14.8 (41.7)		45.8 (89.6)		2199.7 (2229.7)	
	Mother's education	Lower than diploma (<i>n</i> = 105)	103.0 (183.5)	0.604	34.7 (99.0)	0.059	68.2 (137.7)	0.908	2514.6 (2757.7)	0.423
		Diploma (<i>n</i> = 132)	116.2 (309.6)		22.0 (82.3)		94.2 (279.2)		2967.4 (2822.2)	
		Higher than diploma (<i>n</i> = 54)	65.5 (104.8)		17.0 (44.8)		48.5 (86.8)		2642.4 (2291.8)	
	Father's age	< 35 yr (<i>n</i> = 24)	99.8 (133.8)	0.117	45.0 (114.2)	0.33	54.8 (73.4)	0.245	2598.5 (2184.7)	0.966
		35-49 yr (<i>n</i> = 206)	106.7 (271.1)		22.7 (73.8)		84.0 (240.2)		2711.8 (2839.5)	
		≥ 50 yr (<i>n</i> = 51)	103.4 (150.2)		30.7 (108.7)		72.7 (110.4)		2593.2 (2488.7)	
	Mother's age	< 35 yr (<i>n</i> = 99)	102.8 (205.7)	0.740	27.4 (84.1)	0.978	75.3 (188.3)	0.802	2829.4 (2773.4)	0.595
		35-49 yr (<i>n</i> = 179)	108.2 (264.9)		25 (85.9)		83.1 (226.5)		2639.1 (2696.7)	
		≥ 50 yr (<i>n</i> = 16)	40.9 (56.1)		18.4 (35.3)		22.5 (32.0)		3098.4 (2400.9)	

OPA: Organized physical activity; SB: Sedentary behaviors MVPA: Moderate to vigorous physical activities

societies.

In addition, our study showed that among our participants, children with ASD had the highest level of OPA, non-OPA, and total PA, followed by children with ID and then CP. Besides, our study showed that although the pattern and specific type of sedentary behaviors were different among the three groups, children with ASD were similar to ID and better than the CP group. Moreover, regarding the intensity of PA, children with ASD demonstrated the highest levels of moderate and vigorous PA compared to CP and ID groups. Although previous investigations reported a lesser amount of MVPA in children with ASD compared to their TD peers[29,32], our study showed that among two other neurodevelopmental disorders, such as CP and ID, children with ASD would report better results. According to the world health organization (WHO), it is recommended 60 min per day (300 min per week) of MVPA to gain health benefits of PA for children[33]; thus, our study showed that all three groups of participants, on average, participated in less MVPA than what is recommended for children. However, due to the lack of a developed standard of PA or OPA participation for children and adolescents with neurodevelopmental disorders, such interpretation should be made with caution.

To our knowledge, this is one of the first reports representing the amount of OPA/non-OPA as well as sedentary behaviors in children and adolescents with ASD in comparison to other neurodevelopmental disorders such as ID and CP. This finding highlights the importance of considering the health conditions (*e.g.*, motor *vs* non-motor limitation) of children with neurodevelopmental disorders in OPA participating. For example, children with CP might have more motor limitations than children with ASD and ID. Designing adapted OPA specific for each neurodevelopment disorder is of paramount importance for increasing the rate of OPA participation in these populations. As an important limitation, previous studies only examined the general PA participation in ASD and similar disorders. For example, examining ASD with TD peers, data showed an association between lower levels of PA participation and an increase in medical complications such as obesity and chronic illness[11,34]. Recent studies have shown that the issue has worsened because of the COVID-19 pandemic, quarantine, and social distancing[35,36].

Although, according to evidence, the level of PA in children and adolescents with ASD is lower than TD ones, our study showed that, at least in part, the PA status of children and adolescents with ASD is better than other children with neurodevelopmental disorders such as children with CP and ID. It highlights the urgent need to design and develop strategies to enhance the PA and OPA levels for all children and adolescents with neurodevelopmental disorders, which might be challenging due to the lack of studies and the inefficacy of current interventions[37]. This issue warrants much more attention in developing countries which need both increase the general awareness of people and design novel strategies for enhancing adapted PA behavior in individuals with neurodevelopmental disorders. According to theories and frameworks[31], the opportunities for adapted PA/OPA must be intrinsically rewarding to encourage acquiring life skills and reassure peer relationships, parental involvement, and the sense of belonging to a bigger community[38].

Children with CP had the least PA time compared to ASD and ID, possibly related to the higher number of physical and movement incapacities. On the other side, we recruited children and adolescents with ASD from special schools; usually, children who attend these schools are high functioning and consequently do not have the limitations of children with low-functioning ASDs (comorbid with ID and other disabilities). Consequently, they may also have the potential to do more deliberate and regular activities, improving their PA level than more physically and mentally disabling disorders such as CP and ID. Given the above, it seems necessary to develop standards for PA/OPA participation rate in children and adolescents with neurodevelopmental disorders generally and specifically for each group based on the amount of physical and cognitive limitations.

In addition, regarding the contributing factors, our results suggest that gender, parent's education, and childcare status might be related to PA and sedentary behaviors. Factors contributing to enhancing the amount of PA may have an adverse effect on sedentary behaviors and vice versa[39,40]. In the general population, individuals with older age, female gender, comorbidities, the need for movement equipment, or higher BMI are more prone to engage in less PA and more sedentary behaviors[39]. In previous investigations, factors such as symptom severity, gender, having other comorbidities, using mobility equipment, and household status have been reported to contribute to PA participation rate in children with ID and CP[13,14].

The current study is unique in its sample and measures; however, it is not without limitations. The recall bias and the selection of the participants from special schools were from study limitations. In addition, we had to use cross-sectional data for physical activity behavior, and we could not scrutinize the potential effects of data changes over time. Nevertheless, the relatively sizable number of participants could be accounted as one of the important strengths of the current study. This might authenticate and increase the validity of the result in the study despite its limitation.

CONCLUSION

The current study showed that PA behavior in ASD, ID, or CP groups was lower than expected, highlighting the need to support PA/OPA opportunities by designing targeted and adapted programs to decrease unhealthy sedentary behaviors in these groups.

ARTICLE HIGHLIGHTS

Research background

There is little data on physical activity (PA), organized PA (OPA), and sedentary behaviors in children with neurodevel-

opmental disorders in developing countries.

Research motivation

In this large-scale study, we evaluated PA levels among children with neurodevelopmental disorders in the context of a developing country to help identify the groups which benefit the most from the interventions to improve PA levels, which can be a basis for future studies.

Research objectives

To examine OPA, non-OPA, and sedentary behaviors and their associated factors in children and adolescents with autism spectrum disorders (ASD), cerebral palsy (CP), and intellectual disability (ID).

Research methods

A total of 1020 children and adolescents with ASD, CP, and ID living in Tehran between 2011 and 2021 were assessed regarding the child and family information as well as the Children's Leisure Activities Study Survey.

Research results

The results showed that the OPA level was significantly lower than non-OPA in all groups. Moderate to vigorous PA levels were higher among children with ASD compared to children with CP and ID.

Research conclusions

The PA levels are lower than the recommended levels in children with neurodevelopmental disabilities living in a developing country, and there is a need for interventions to improve PA levels, especially OPA, in this group.

Research perspectives

Future studies should focus on evaluating PA levels in children with neurodevelopmental disabilities in other developing countries, and aim to design intervention to improve OPA and total PA in this group.

FOOTNOTES

Author contributions: Memari A was the guarantor; Nakhostin-Ansari A, Shayestehfar M, and Memari A designed and implemented the study; Nakhostin-Ansari A analyzed the data; Nakhostin-Ansari A, Shayestehfar M, Gorgani F, and Hasanzadeh A wrote the initial draft of the manuscript; and all authors read and approved the final version of the manuscript.

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