Physical Activity in Children
ISSN: 2783-5391

Original Article

The Relationship between Self-reported and Device-measured Physical Activity among Children with ADHD

Tayebeh Baniasadi *

College of Human Science& Education, School of Kinesiology, Baton Rouge, LA.

*Corresponding Author: Tayebeh Baniasadi, College of Human Science& Education, School of Kinesiology, Baton Rouge, LA. Email: tbania1@lsu.edu

Received: 10 August, 2023; **Revised:** 07 November, 2023; **Accepted:** 02 December, 2023; **Published**: 17 June, 2024.

Abstract

Introduction: There are contradictory results regarding the levels of physical activity (PA) among children with ADHD, which may be due to the use of subjective and objective tools.
Objectives: The purpose of the current study was to compare the self-reported and device-measured PA among children with ADHD.
Methods: This study used a comparative-correlational method. Seventy-five children with ADHD (36 girls) attending a special school (Mage: 10.61 ± 1.28 years) selected based on a convenience sampling method. The short form of the International Physical Activity Questionnaire (IPAQ-SF) was used to measure self-reported PA. Moreover, modern accelerometers were used to measured device-based PA. Data was analyzed using independent sample t test and Spearman correlation test by SPSS version 26.
Results: The results showed that children with ADHD, particularly girls, do not meet the WHO guidelines for at least 60 minutes of moderate-to-vigorous PA (MVPA) per day. In addition, the children tended to report significantly different PA pattern than their accelerometer-based PA pattern is ($p<0.05$), where they reported higher vigorous PA and lower moderate and light PA ($p<0.05$).
Conclusions: These results show great differences between PA patterns of children with ADHD as measured by questionnaires and accelerometers, indicating that type of tools for measuring PA is a crucial aspect in the practice of PA and health promotion and rehabilitation.

Keywords: Exercise, ADHD, Questionnaire, Instrumentation, Child

How to Cite: Baniasadi T, The Relationship between Self-reported and Device-measured Physical Activity among Children with ADHD. Phys. Act. Child. 2024;1(1):1-5. doi: 10.61186/PACH.195747

1. Introduction

Physical activity (PA) refers to any activity or movement of the body that is caused by the contraction and expansion of skeletal muscles and requires energy (1). PA can include fast walking, light weight lifting, collecting leaves from the ground, car washing, house cleaning or even gardening (1). Research showed that PA and sports have many benefits across different age-categories including children including enhanced physical fitness, brain health, weight management, proper bones and muscles, and reducing the risk of disease (2-9). Thus, sports and targeted PA are one of the important parts of children' lives. Based on numerous benefits of regular PA, world health organization (WHO) recommended that children and adolescents aged 5-17 years should have PA for 180 minutes, of which more than 60 minutes should be of moderate to vigorous intensity (10). As well, their sedentary behaviors, such as sitting in one place for more than 60 minutes, should be low, otherwise they will be far from the global standards of the WHO (10). Nevertheless, previous studies showed that children and adolescents worldwide do not meet the WHO guidelines of participating in 60 minutes of moderate to vigorous PA (MVPA) per day (8-10). In addition, girls were less physically active than boys (8-10).

Pattern of PA in children is more complex and less structured. This makes measuring PA in children challenging. To date, the use of questionnaires to measure PA in children has been mostly common. Numerous studies have also used questionnaires to measure PA in children (11-17). However, the questionnaire is a self-reporting tool and has disadvantages such as measurement bias (18-24). Therefore, the use of modern technologies such as accelerometer tools to measure PA in children has been emphasized. Accelerometers are modern devices to measure PA pattern continuously with high-resolution (19-21). In this regard, some studies have shown that there is a difference between the amount and intensity PA measured by questionnaires and accelerometers (11-13, 21, 24). These researches have indicated that the self-reported measures overestimate the amount and intensity of PA (11-13). However, few researches have examined the differences in using questionnaires and accelerometers in measuring PA in children of special groups such as children with attention deficit hyperactivity disorder (ADHD).

ADHD is a developmental behavioral disorder in which the child does not have the ability to pay attention and focus on one subject, is slow to learn and has unusual and in some cases very high physical activity (25). This disorder is associated with attention

deficit, hyperactivity, impulsive behaviors, or a combination of these symptoms (26). It is estimated that in 2010, 9.5% of American boys and 4.4% of American adults have ADHD. In addition, boys are three times more likely to suffer from this disorder than girls (25). Regarding PA, research showed that children with ADHD have less PA than normally developing children (27). On the other hand, research showed that children with ADHD have more PA than normally developing children (28). These contradictory results may be due to the use of different tools in measuring the amount and intensity of PA among children with ADHD. This makes it necessary to investigate the differences between the measurement of PA using questionnaire and accelerometer in children with ADHD. The results of this study can clarify the existing knowledge in the field of PA of children with ADHD. Therefore, the purpose of this study is to compare the self-reported and device-measured PA among children with ADHD.

2. Methods

The current study used a comparative-correlational method.

2.1. Participants

Statistical sample of this study included all children with ADHD who attended in special schools. Of them, seventy-five children with ADHD (36 girls) attending a special school (Mage: 10.61 ± 1.28 years) selected based on a convenience sampling method. Inclusion criteria was included 1) s 2) not having any physical disability (such as amputation) that would interfere with wearing the accelerometer. Exclusion criteria were included 1) not completing the consent form and 2) not completing the accelerometer protocol. The protocol of this study approved by university ethical board.

2.2. Measures

2.2.1. Questionnaire

The short form of the International Physical Activity Questionnaire (IPAQ-SF) (29) was used to measure self-reported PA. IPAQ-SF is a self-report seven-days recall measure of PA consisted of seven questions measuring frequency and duration of vigorous PA, moderate PA, walking, and sedentary activities (7). In addition, participants were asked to record the amount of time during which they were sedentary. The outcomes moderate PA and vigorous PA were recorded as total minutes per week. We measured the reliability of this questionnaire where its Cronbach alpha was 0.88.

2.2.2. Accelerometer

Highly validated ActiGraph wGT3X-BT accelerometer (ActiGraph LLC, Pensacola, FL, USA) was used to measure objectively intensity (light PA, moderate PA, vigorous PA, and MVPA) and duration of PA and sedentary time (30). Children installed the device during a week on their right hip and the related software was used to analyze the data. The cutoff points (i.e., counts per minute [CPM]) for defining intensities of PA were 101 CPM to 2,799 CPM for light PA, 2,800 CPM to 3,999 CPM for moderate PA, and ≥ 4,000 CPM for vigorous PA (31,32).

2.3. Statistical analysis

Data was analyzed using SPSS version 26. The mean and standard deviation were used for descriptive statistical analyses. Gender differences were examined by independent sample t test. Differences between self-reported and device-measured PA were examined by independent sample t test, because we assumed each item as a group. Pearson correlation was calculated to analyze the relation between self-reported and accelerometer-based PA The significance level was set at $p < .05$.

3. Results

3.1. Demographic data

The mean and standard deviation of age of the boys and girls were 10.78 ± 1.51 and 10.52 ± 1.37 years, respectively. Also, height of the boys and girls were 147.82 ± 8.15 and 149.66 ± 9.71 cm, respectively. Finally, weight of the boys and girls were 50.76 ± 6.77 and 49.19 ± 8.27 kg, respectively.

3.2. Self-reported physical activity

Overall, four children (5%) reported to have no PA during the week. Moreover, 30 (40%) children had PA on two days per week. In addition, 33 (44%) children reported being active on three days per week. Finally, 8 (11%) reported to be active on every day. Furthermore, Table 1 shows the total minutes of self-reported PA across gender. Accordingly, boys had 60.92±55.71 minutes vigorous, 120.94±210.84 minutes moderate, and 350.82±290.64 minutes light PA per week. In addition, they reported to spend 2501.54±1251.09 minutes in sedentary per week. Concerning girls, the results showed that they had 45.94±45.33 minutes vigorous, 80.97±110.93 minutes moderate, and 308.66±187.80 minutes light PA per week. In addition, they reported to spend 2938.40±1582.46 minutes in sedentary per week. Regarding gender differences, we found that boys had significantly higher vigorous, moderate, and light PA than girls (all $p<0.001$). However, girls had significantly higher sedentary time than boys ($p<0.001$).

Table 1. Mean and SD of Self-Reported PA Across Gender (Total Minute per Week).

Variable	Overall (N=75)		Boys (N=39)		Girls (N=36)		Comparison
	M	SD	M	SD	M	SD	
Light PA	320.80	239.12	350.82	290.64	308.66	187.80	t=24.82 p<0.001
Moderate PA	98.17	158.97	120.94	210.84	80.97	110.93	t=-33.94 p<0.001
Vigorous PA	52.87	51.83	60.92	55.71	45.94	45.33	t=13.55 p<0.001
Sedentary	2758.92	1365.33	2501.54	1251.09	2938.40	1582.46	t=19.70 p<0.001

3.3. Device-based PA

Table 2 shows the total minutes of accelerometer-measured PA across gender. Accordingly, boys had 34.39±20.17 minutes vigorous, 161.96±64.85 minutes moderate, and 628.41±293.74 minutes light PA per week. In addition, they reported to spend 4638.99±693.48 minutes in sedentary per week. Concerning girls, the results showed that they had 30.68±24.18 minutes vigorous, 144.63±84.73 minutes moderate, and 455.77±147.98 minutes light PA per week. In addition, they reported to spend 4955.57±547.11 minutes in sedentary per week. Regarding gender differences, we found that boys had significantly higher vigorous, moderate, and light PA than girls (all p<0.001). However, girls had significantly higher sedentary time than boys (p<0.001).

Table 2. Mean and SD of Device-Measured PA Across Gender (Total Minute per Week).

Variable	Overall (N=75)		Boys (N=39)		Girls (N=36)		Comparison
	Mean	SD	Mean	SD	Mean	SD	
Light PA	528.69	220.74	628.41	293.74	455.77	147.98	t=-69.47 p<0.001
Moderate PA	153.64	75.55	161.96	64.85	144.63	84.73	t=-55.28 p<0.001
Vigorous PA	28.50	33.69	34.39	30.68	24.18	34.85	t=19.57 p<0.001
Sedentary	4782.60	628.44	4638.99	693.48	4955.57	547.11	t=10.47 p<0.001

3.4. Comparison of self-reported and device-based PA

Table 1 and Table 2 show the total minutes of self-reported and accelerometer-measured PA. Accordingly, children reported to have 52.87±51.83 minutes vigorous, 98.17±158.97 minutes moderate, and 320.80±239.12 minutes light PA per week. In addition, they reported to spend 2758.92±1365.33 minutes in sedentary per week. Concerning accelerometer-based PA, the results showed that children had 28.50±33.69 minutes vigorous, 153.64±75.55 minutes moderate, and 528.69±220.74 minutes light PA per week. In addition, they reported to spend 4782.60±628.44 minutes in sedentary per week. Results of independent t tests showed that the amount of self-reported vigorous PA was significantly higher than accelerometer-measured vigorous PA (t=57.85, p<0.001). However, accelerometer-measured moderate and light PA were significantly higher than self-reported moderate and light PA (t=-96.48, p<0.001 and t=-74.54, p<0.001, respectively for moderate and light PA). Finally, accelerometer-measured sedentary time was significantly higher than self-reported sedentary time (t=105.47, p<0.001).

3.5. Relation between self-reported and device-measured PA

The results of Pearson correlation test regarding the correlation between the self-reported and device-measured PA showed relatively significant but weak correlations between vigorous PA (r=0.158, p<0.01), moderate physical activity (r=0.224, p<0.001), light PA (r=0.210, p<0.001), and sedentary time (r=0.140, p<0.01).

4. Discussion

This study compared the self-reported and device-measured PA among children with ADHD. According to previous studies (27,28), PA of children with ADHD is not sufficient when compared with the WHO guidelines. In the present study, the accelerometer-based findings further showed that children with ADHD do not meet the WHO guidelines for at least 60 minutes of MVPA per day. The lower PA in children with ADHD may be related to their social, motor and physical barriers (25,26). However, due to the numerous benefits of regular PA for the physical and mental health of children (2-9), it seems necessary to implement strategies to improve the level of PA in children with ADHD. Specifically, our findings showed that girls have significantly lower PA than boys. These findings are in accordance with those of previous studies (33-36), indicating that strategies to promote PA among children with ADHD should include special emphasis on PA for girls. Lower physical activity for girls than boys may be explained through fewer opportunities for PA and sport at school, parental support, lower participation in organized sports activities, and gender-specific socialization in terms of sports and movement (33-36).

Concerning comparison of self-reported and device-measured PA, we found that the children in this study tended to report significantly different PA pattern than their accelerometer-based PA pattern is. Accordingly, the children reported to have 52.87±51.83 minutes vigorous PA during the week, while accelerometer data showed that children had only 28.50±33.69 minutes vigorous PA during the week. On the contrary, the children reported to have 98.17±158.97 minutes moderate PA during the week, while accelerometer data showed that they had 153.64±75.55 minutes moderate PA during the week. Similarly, the children reported 320.80±239.12 minutes light PA during the week, while accelerometer data showed that they had 528.69±220.74 minutes light PA during the week. Finally, the children reported to spend 2758.92±1365.33 minutes in sedentary during the week, accelerometer data showed that they spend 4782.60±628.44 minutes in sedentary during the week. These findings are in line with studies showing that most people tend to report different PA than their accelerometer-based PA is (11-13, 21, 24). Regarding the pattern of PA, it should be noted that children reported more vigorous PA, while they reported less moderate and light PA compared to accelerometer data. In addition, they reported lower sedentary time than accelerometer-measured data. These results show great differences between PA patterns of children with ADHD as measured by questionnaires and accelerometers.

The strength of the current study is we examined, for the first time, the difference in the pattern of PA of children with ADHD measured by questionnaire and accelerometer. The results of the present study can be added to the results of previous studies on typically

developing children. However, this study has some limitations. For example, some sport or PA such as water activities (e.g., swimming) could not be assessed by accelerometer because the it could not be worn in the water. Furthermore, while accelerometers are valid tools for measuring PA among children (30-32), they are not able to accurately detect some activities such as cycling, and thus, the children's actual PA levels could be underestimated.

4.1. Conclusions

First of all, it should be noted that children with ADHD, particularly girls, do not meet WHO guidelines for at least 60 minutes of MVPA per day. This makes it necessary to implement strategies to improve the level of PA in children with ADHD, with a special attention to girls. In addition, the children in this study tended to report significantly different PA pattern than their accelerometer-based PA pattern is, where they reported higher vigorous PA and lower moderate and light PA. These results show great differences between PA patterns of children with ADHD as measured by questionnaires and accelerometers, indicating that type of tools for measuring PA is a crucial aspect in the practice of PA and health promotion and rehabilitation.

Acknowledgments

The author is grateful to all the participants who participated in this research.

Footnotes

Authors' Contribution: This study was carried out solely by the corresponding author.

Conflict of Interests: The researcher confirms that there is no conflict of interests in this study with any participant.

Data Availability: The data that support the findings of this study are openly available upon request from the corresponding author.

Ethical Approval: Approval for this study was obtained from the university. The author confirms that all steps . The requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

Funding/Support: This research received no external funding.

Informed Consent: Informed written consent was obtained from all participants.

Supplementary information accompanies this paper at doi: 10.61186/PACH.195747

ORCID iD

Tayebeh Baniasadi https://orcid.org/0000-0002-6194-4465

References

1. Södergren M, Sundquist J, Johansson SE, Sundquist K. Physical activity, exercise and self-rated health: a population-based study from Sweden. BMC Public Health. 2008;**8**:352. [PubMed ID: 18840294]. [PMCID: PMC2576235]. https://doi.org/10.1186/1471-2458-8-352
2. Roychowdhury D. Using Physical Activity to Enhance Health Outcomes Across the Life Span. J Funct Morphol Kinesiol. 2020;**5**(1):2. [PubMed ID: 33467218]. [PubMed Central ID: PMC7739320]. https://doi.org/10.3390/jfmk5010002
3. Liu M, Wu L, Ming Q. How Does Physical Activity Intervention Improve Self-Esteem and Self-Concept in Children and Adolescents? Evidence from a Meta-Analysis. PLoS One. 2015;**10**(8):e0134804. [PubMed ID: 26241879]. [PubMed Central ID: PMC4524727]. https://doi.org/10.1371/journal.pone.0134804
4. Lahart I, Darcy P, Gidlow C, Calogiuri G. The Effects of Green Exercise on Physical and Mental Wellbeing: A Systematic Review. Int J Env Res Pub He.2019;**16**(8):1352. [PubMed ID: 30991724]. [PubMed Central ID: PMC6518264]. https://doi.org/10.3390/ijerph16081352
5. Telama R. Tracking of physical activity from childhood to adulthood: a review. Obes Facts. 2009;**2**(3):187-95. [PubMed ID: 20054224]. [PubMed Central ID: PMC6516203]. https://doi.org/10.1159/000222244
6. Aira T, Vasankari T, Heinonen OJ, Korpelainen R, Kotkajuuri J, Parkkari J, Savonen K, Uusitalo A, Valtonen M, Villberg J, Vähä-Ypyä H, Kokko SP. Physical activity from adolescence to young adulthood: patterns of change, and their associations with activity domains and sedentary time. Int J Behav Nutr Phys Act. 2021;**18**(1):85. [PubMed ID: 34193150]. [PubMed Central ID: PMC8246658]. https://doi.org/10.1186/s12966-021-01130-x
7. Rauner A, Jekauc D, Mess F, Schmidt S, Woll A. Tracking physical activity in different settings from late childhood to early adulthood in Germany: the MoMo longitudinal study. BMC Public Health. 2015;**15**:391. Erratum in: BMC Public Health. 2018;**18**(1):217. [PubMed ID: 25887314]. [PubMed Central ID: PMC4407713]. https://doi.org/10.1186/s12889-015-1731-4
8. Guthold R, Stevens GA, Riley LM, Bull FC. Global Trends in Insufficient Physical Activity among Adolescents: A Pooled Analysis of 298 Population-Based Surveys with 1.6 million Participants. Lancet Child Adolesc Health. 2020;**4**:23-35. [PubMed ID: 31761562]. [PubMed Central ID: PMC6919336]. https://doi.org/10.1016/s2352-4642(19)30323-2
9. Ferreira Silva RM, Fonseca Terra L, da Silva Valadão Fernandes M, Noll PRES, de Almeida AA, Noll M. Physical Activity and Sedentary Behavior in High School Students: A Quasi Experimental Study via Smartphone during the COVID-19 Pandemic. Children (Basel). 2023;**10**(3):479. [PubMed ID: 36980037]. [PubMed Central ID: PMC10047413]. https://doi.org/10.3390/children10030479
10. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, Carty C, Chaput JP, Chastin S, Chou R, Dempsey PC, DiPietro L, Ekelund U, Firth J, Friedenreich CM, Garcia L, Gichu M, Jago R, Katzmarzyk PT, Lambert E, Leitzmann M, Milton K, Ortega FB, Ranasinghe C, Stamatakis E, Tiedemann A, Troiano RP, van der Ploeg HP, Wari V, & Willumsen JF. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. British journal of sports medicine, 2020;**54**(24):1451-1462. [PubMed ID: 33239350]. [PubMed Central ID: PMC7719906]. https://doi.org/10.1136%2Fbjsports-2020-102955
11. O'Neill B, McDonough SM, Wilson JJ, Bradbury I, Hayes K, Kirk A, Kent L, Cosgrove D, Bradley JM, Tully MA. Comparing accelerometer, pedometer and a questionnaire for measuring physical activity in bronchiectasis: a validity and feasibility study? Respir Res. 2017;**18**(1):16. [PubMed ID: 28088206]. [PubMed Central ID: PMC5237513]. https://doi.org/10.1186%2Fs12931-016-0497-2
12. Skender S, Ose J, Chang-Claude J, Paskow M, Brühmann B, Siegel EM, Steindorf K & Ulrich CM. Accelerometry and physical activity questionnaires-a systematic review. BMC public health, 2016;**16**(1):515. [PubMed ID: 27306667]. [PubMed Central ID: PMC4910242]. https://doi.org/10.1186%2Fs12889-016-3172-0
13. Yu, C. A., Rouse, P. C., Van Zanten, J. J. V., Ntoumanis, N., Kitas, G. D., Duda, J. L., & Metsios, G. S. Subjective and objective levels of physical activity and their association with cardiorespiratory fitness in rheumatoid arthritis patients. Arthritis research & therapy, 2015;**17**(1):1-7. [PubMed ID: 25885649]. [PubMed Central ID: PMC4384324]. https://doi.org/10.1186%2Fs13075-015-0584-7
14. Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the global physical activity questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. BMC Public Health. 2014;**14**:1255. [PubMed ID: 25492375]. [PubMed Central ID: PMC4295403]. https://doi.org/10.1186/1471-2458-14-1255
15. Kurtze N, Rangul V, Hustvedt BE. Reliability and validity of the international physical activity questionnaire in the Nord-Trøndelag health study (HUNT) population of men. BMC Med Res Methodol. 2008;**8**:63. [PubMed ID: 18844976]. [PubMed Central ID: PMC2577099]. https://doi.org/10.1186/1471-2288-8-63

16. Keating XD, Zhou K, Liu X, Hodges M, Liu J, Guan J, Phelps A, Castro-Piñero J. Reliability and Concurrent Validity of Global Physical Activity Questionnaire (GPAQ): A Systematic Review. Int J Environ Res Public Health. 2019;**16**(21):4128. [PubMed ID: 31717742]. [PubMed Central ID: PMC6862218]. https://doi.org/10.3390/ijerph16214128
17. Sattler MC, Ainsworth BE, Andersen LB, Foster C, Hagströmer M, Jaunig J, Kelly P, Kohl HW, Matthews CE, Oja P, et al. Physical activity self-reports: Past or future? Br. J. Sports Med. 2021. [PubMed ID: 33536193]. [PubMed Central ID: PMC8477753]. https://doi.org/10.1136%2Fbjsports-2020-103595
18. Reichert M, Giurgiu M, Koch E, Wieland LM, Lautenbach S, Neubauer AB, von Haaren-Mack B, Schilling R, Timm I, Notthoff N, Marzi I, Hill H, Brüßler S, Eckert T, Fiedler J, Burchartz A, Anedda B, Wunsch K, Gerber M, Jekauc D, Woll A, Dunton GF, Kanning M, Nigg CR, Ebner-Priemer U, Liao Y. Ambulatory Assessment for Physical Activity Research: State of the Science, Best Practices and Future Directions. Psychol Sport Exerc. 2020;**50**:101742. [PubMed ID: 32831643]. [PubMed Central ID: PMC7430559]. https://doi.org/10.1016%2Fj.psychsport.2020.101742
19. Feehan LM, Geldman J, Sayre EC, Park C, Ezzat AM, Yoo JY, Hamilton CB, Li LC. Accuracy of Fitbit Devices: SystematicReview and Narrative Syntheses of Quantitative Data. JMIR Mhealth Uhealth 2018;**6**:e10527. [PubMed ID: 30093371]. [PubMed Central ID: PMC6107736]. https://doi.org/10.2196/10527
20. Skinner AM, Rowlands AV, Vlachopoulos D, Barker AR, Janz KF, Moore SA. The Influence of Accelerometer Epoch Length on Associations of Physical Activity Intensity and Volume with Bone Outcomes. J Sports Sci Med. 2023;**22**(1):117-132. [PubMed ID: 36876186]. [PubMed Central ID: PMC9982530]. https://doi.org/10.52082/jssm.2023.117
21. Slootmaker SM, Schuit AJ, Chinapaw MJ, Seidell JC, van Mechelen, W. Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. Int. J. Behav. Nutr. Phys. Act. 2009;**6**:17. [PubMed ID: 19320985]. [PubMed Central ID: PMC2670257]. https://doi.org/10.1186%2F1479-5868-6-17
22. Jess L, Jarfelt M, Bäck M. Reliability and validity of self-report questions for assessing levels of physical activity and sedentary time in adult childhood cancer survivors. BMC Sports Sci Med Rehabil. 2024;**16**(1):66. [PubMed ID: 38448950]. [PubMed Central ID: PMC10916125]. https://doi.org/10.1186/s13102-024-00851-3
23. Fiedler J, Eckert T, Burchartz A, Woll A, Wunsch K. Comparison of Self-Reported and Device-Based Measured Physical Activity Using Measures of Stability, Reliability, and Validity in Adults and Children. Sensors (Basel). 2021;**21**(8):2672. [PubMed ID: 33920145]. [PubMed Central ID: PMC8069485]. https://doi.org/10.3390/s21082672
24. Wunsch K, Nigg CR, Weyland S, Jekauc D, Niessner C, Burchartz A, Schmidt S, Meyrose AK, Manz K, Baumgarten F, Woll A. The relationship of self-reported and device-based measures of physical activity and health-related quality of life in adolescents. Health Qual Life Outcomes. 2021;**19**(1):67. [PubMed ID: 33648492]. [PubMed Central ID: PMC7923541]. https://doi.org/10.1186/s12955-021-01682-3
25. Español-Martín G, Pagerols M, Prat R, Rivas C, Ramos-Quiroga JA, Casas M, Bosch R. The impact of attention-deficit/hyperactivity disorder and specific learning disorders on academic performance in Spanish children from a low-middle- and a high-income population. Front Psychiatry. 2023;**14**:1136994. [PubMed ID: 37124266]. [PubMed Central ID: PMC10130398]. https://doi.org/10.3389/fpsyt.2023.1136994
26. Mokobane M, Pillay BJ, Meyer A. Fine motor deficits and attention deficit hyperactivity disorder in primary school children. S Afr J Psychiatr. 2019;**25**:1232. [PubMed ID: 30899581]. [PubMed Central ID: PMC6424539]. https://doi.org/10.4102%2Fsajpsychiatry.v25i0.1232
27. Gallego-Méndez J, Perez-Gomez J, Calzada-Rodríguez JI, Denche-Zamorano ÁM, Mendoza-Muñoz M, Carlos-Vivas J, Garcia-Gordillo MÁ, Adsuar JC. Relationship between Health-Related Quality of Life and Physical Activity in Children with Hyperactivity. Int J Environ Res Public Health. 2020;**17**(8):2804. [PubMed ID: 32325730]. [PubMed Central ID: PMC7216053]. https://doi.org/10.3390/ijerph17082804
28. Li R, Liang X, Liu F, Zhou Z, Zhang Z, Lu Y, Wang P, Yang B. Mediating Effect of Motor Competence on the Relationship between Physical Activity and Quality of Life in Children with Attention Deficit Hyperactivity Disorder. Biomed Res Int. 2021;**24**:4814250. [PubMed ID: 34980998]. [PubMed Central ID: PMC8720293]. https://doi.org/10.1155/2021/4814250
29. Lee PH, Macfarlane DJ, Lam, T. et al. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. Int J Behav Nutr Phys Act, 2011; **8**:115. [PubMed ID: 22018588]. [PubMed Central ID: PMC3214824]. https://doi.org/10.1186/1479-5868-8-115
30. Wijndaele K, Westgate K, Stephens SK, Blair SN, Bull FC, Chastin SF, Dunstan DW, Ekelund U, Esliger DW, Freedson PS, Granat MH, Matthews CE, Owen N, Rowland AV, Sherar LB, Tremblay MS, Troiano RP, Brage S, Healy GN. Utilization and harmonization of adult accelerometry data: review and expert consensus. Medicine and science in sports and exercise, 2015;**47**(10):2129. [PubMed ID: 25785929]. [PubMed Central ID: PMC4731236]. https://doi.org/10.1249/mss.0000000000000661
31. Marasso D, Lupo C, Collura S, Rainoldi A, Brustio PR. Subjective versus Objective Measure of Physical Activity: A Systematic Review and Meta-Analysis of the Convergent Validity of the Physical Activity Questionnaire for Children (PAQ-C). Int J Environ Res Public Health. 2021;**18**(7):3413. [PubMed ID: 33806106]. [PubMed Central ID: PMC8036389]. https://doi.org/10.3390/ijerph18073413
32. Choi L, Liu Z, Matthews CE, Buchowski MS. Validation of accelerometer wear and non-wear time classification algorithm. Medicine and science in sports and exercise, 2011;**43**(2):357–364. [PubMed ID: 20581716]. [PubMed Central ID: PMC3184184]. https://doi.org/10.1249/mss.0b013e3181ed61a3
33. Ishii K, Shibata A, Adachi M, et al. Gender and grade differences in objectively measured physical activity and sedentary behavior patterns among Japanese children and adolescents: a cross-sectional study. *BMC Public Health*. 2015;**15**:1254. [PubMed ID: 26679503]. [PubMed Central ID: PMC4683705]. https://doi.org/10.1186/s12889-015-2607-3
34. Kretschmer L, Salali GD, Andersen LB, Hallal PC, Northstone K, Sardinha LB, Dyble M, Bann D; International Children's Accelerometry Database (ICAD) Collaborators. Gender differences in the distribution of children's physical activity: evidence from nine countries. Int J Behav Nutr Phys Act. 2023;**20**(1):103. [PubMed ID: 37667391]. [PubMed Central ID: PMC10478357]. https://doi.org/10.1186/s12966-023-01496-0
35. Lawman HG, Wilson DK, Van Horn ML, Resnicow K, Kitzman-Ulrich H. The relationship between psychosocial correlates and physical activity in underserved adolescent boys and girls in the ACT trial. J Phys Act Health. 2011;**8**(2):253-61. [PubMed ID: 21359129]. [PubMed Central ID: PMC3045031]. https://doi.org/10.1123%2Fjpah.8.2.253
36. Brazo-Sayavera J, Aubert S, Barnes JD, González SA, Tremblay MS. Gender differences in physical activity and sedentary behavior: Results from over 200,000 Latin-American children and adolescents. PLoS One. 2021;**16**(8):e0255353. [PubMed ID: 34383803]. [PubMed Central ID: PMC8360534]. https://doi.org/10.1371/journal.pone.0255353