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Objective Measurement of Physical Activity with Accelerometers in Autism Spectrum Disorder

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Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that can affect children's involvement in physical activity. Low physical activity and high sedentary behavior have the potential to negatively impact the health and fitness of children with ASD. This study aims to describe the level of activity patterns and sedentary behavior of children with ASD, measured objectively using an accelerometer.. Penelitian ini menggunakan observasional deskriptif dengan pendekatan potong lintang (cross-sectional). The subjects of this study were nine children with ASD aged 6-18 years who were recruited purposively at the YPAC Bandung Special School (SLB-D). Activity was measured using an accelerometer worn for seven consecutive days. The data were analyzed descriptively, including energy expenditure, Metabolic Equivalent of Task (METs) values, sedentary behavior (sedentary bouts and sedentary breaks), and daily step count. The results showed that the average energy expenditure was 997.54 kcal with an average METs value of 1.038, indicating a predominance of very light-intensity activities. Children with ASD spend most of their time being sedentary, with long periods of sedentary behavior. Although there are variations in the number of daily steps between individuals, the intensity of physical activity remains relatively low. The conclusion of this study shows that children with ASD have low physical activity and are dominated by sedentary behavior. These findings emphasize the importance of developing structured and inclusive physical activity programs to increase physical activity intensity and reduce sedentary time in children with ASD.

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurological developmental disorder characterized by difficulties in social interaction and communication, as well as restricted and repetitive patterns of behavior (Li et al., 2023). This condition affects an individual's ability to perform daily activities optimally, including participation in physical activities. Physical activity plays an important role in supporting motor development, cardiovascular health, and cognitive function in children and adolescents, including those on the autism spectrum (Nurhidayah et al., 2022)

A number of global studies show that most children and adolescents with ASD do not meet the daily physical activity recommendations set by international guidelines, which is a minimum of 60 minutes of moderate to vigorous physical activity every day (Liang et al., 2020). This tendency toward low involvement in physical activity is accompanied by a high amount of time spent on sedentary activities, such as sitting or playing with electronic devices (Wang et al., 2024). Various factors contribute to low physical activity among individuals with ASD, including age, gender, motor limitations, lack of environmental support, and lack of access to inclusive sports programs. Objective measurement of physical activity using accelerometers has become a valid and reliable approach to evaluating the level and pattern of physical activity. Accelerometers enable detailed recording of physical activity data based on intensity (light, moderate, to heavy) and duration of movement throughout the day (Science & Jolla, n.d.). Unlike subjective methods such as questionnaires or observation, the use of accelerometers reduces the potential for bias and reporting errors, resulting in more accurate data that can be used for evidence-based decision making (Alhowikan et al., 2023).

In addition to describing physical activity in general, objective measurement of physical activity allows for the identification of patterns of physical activity intensity (light, moderate, to heavy) and specific sedentary behaviors in children and adolescents with Autism Spectrum Disorder (ASD) (Li et al., 2023)

Although this approach has been widely used in various studies in developed countries, similar studies in the Indonesian context, especially those involving individuals with ASD, are still very limited. To date, there have been few studies in Indonesia that use accelerometers to objectively assess the physical activity of children or adolescents with ASD (Arimbi et al., 2025). This situation indicates an urgent need for local studies that not only describe the level of physical activity, but also pay attention to the factors that influence it.

Therefore, this study aims to describe the levels and patterns of physical activity (light, moderate, and vigorous) and sedentary behavior measured objectively using accelerometers in children and adolescents with Autism Spectrum Disorder (ASD) in Indonesia. The results of this study are expected to provide an accurate empirical picture of the physical activity behavior of this population, which in turn can form the basis for the development of inclusive and contextual exercise interventions or programs.

METHODS

This study is a quantitative observational study with a descriptive design using a cross-sectional method(Abduh et al., 2023). This design is used to describe the level and pattern of physical activity in children and adolescents with Autism Spectrum Disorder (ASD) based on objective measurements over a specific period of time. The study was conducted at the YPAC Bandung Special School (SLB-D) in West Java. The subject recruitment process, physical activity data collection, and data verification took place from September to October 2025.

The research subjects were children and adolescents with ASD aged 6-18 years who were recruited using purposive sampling techniques. Inclusion criteria included having a diagnosis of ASD confirmed by a professional, being able to follow procedures using an accelerometer, and obtaining written consent from parents or guardians. Subjects with severe physical impairments that limited movement or whose accelerometer data did not meet validity criteria were excluded from the analysis. The sample size was determined based on the number of subjects who met the inclusion criteria and were willing to participate in the entire series of measurements during the research period, taking into account the limitations of the population at the research location and the descriptive exploratory nature of the research.

Physical activity was measured objectively using an accelerometer worn on the subject's waist for seven consecutive days during waking hours and overnight sleep, except during bathing or swimming. Data is considered valid if the device is used for at least 10 hours per day for at least four measurement days, including one weekend day. Non-wear time is defined as a period of ≥60

minutes without detected activity. Accelerometer data was processed using built-in software with a 10-second epoch and classified into sedentary behavior, light, moderate, and vigorous physical activity based on the cut-off points proposed by (Evenson et al., 2008).

The variables analyzed included energy expenditure (kilocalories), Metabolic Equivalent of Task (METs) values, sedentary behavior including sedentary bouts and sedentary breaks, and daily step count. To minimize potential measurement bias, this study used objective measuring instruments and applied strict validity criteria for accelerometer use (Bourke et al., 2023).

RESULTS AND DISCUSSION

This section of the research presents a descriptive overview of the level of physical activity among children with Autism Spectrum Disorder (ASD) based on objective measurements using an accelerometer. The analysis focused on several key indicators, including energy expenditure, the intensity level of physical activity represented by the Metabolic Equivalent of Task (METs) value, sedentary behavior characteristics, and the number of daily steps. All results are presented in descriptive statistics to provide a comprehensive understanding of the physical activity patterns of children with ASD during the measurement period

Table 1. Analysis calorie requirements and expenditure

Kcals	n	min	max	mean	Std.d
calories	9	29.718	1759.682	997.54	511.036
Calories a day	9	3.715	219.96	122.03	60.463
calories a day	9	0.155	9.165	5.08	2.519

The **Table 1** shows the analysis of calorie requirements and expenditure in children with Autism Spectrum Disorder (ASD) (n = 9). The average total energy expenditure was 997.54 kcal with a standard deviation of 511.04 kcal, indicating considerable variation between individuals. Calorie expenditure per day was recorded at an average of 122.03 kcal/day (SD = 60.46 kcal), with a wide range of values, indicating differences in physical activity levels between subjects. Meanwhile, calorie expenditure per hour averaged 5.08 kcal/hour (SD = 2.52 kcal), reflecting the overall dominance of low-intensity activities.

Table 2. analysis METs Metabolic Equivalent of Task child Autism Spectrum Disorder (ASD)

METs	n	Min	max	mean	Std.d
Metabolic Equivalent of Task	9	1.002	1.086	1.038	0.023

The **Table 2** presents the results of the Metabolic Equivalent of Task (METs) analysis in children with Autism Spectrum Disorder (ASD) with a total of nine subjects (n = 9). The average METs value was 1.038 with a standard deviation of 0.023, and a minimum value range of 1.002 and a maximum value range of 1.086. The low METs values and small interindividual variation indicate that the activities performed by children with ASD during the measurement period were dominated by very light intensity or sedentary activities

Tabel 3. Analysis Sedentary Autism Spectrum Disorder (ASD)

Sedentary	n	min	max	mean	Std.d
Sedentary bouts	9	13	242	149.55	63.44
Time in Sedentary bouts	9	3341.8	11489.7	6113.8	2369.96
Average length in Sedentary bouts	9	24	883.8	130.1	267.01
Max. length in Sedentary bouts	9	88.5	5085.2	958.366	1511.17
Min. length in Sedentary bouts	9	10	16.7	10.744	2.10
Daily average in Sedentary bouts	9	417.7	1436.2	751.844	288.185
Sedentary breaks	9	12	241	148.555	63.447
Time in Sedentary brekas	9	28.3	8158.7	5540.03	2266.039
Average length in Sedentary breaks	9	2.4	59.6	35.588	15.709
Max. length in Sedentary breaks	9	11	891.8	433.522	235.120
Min. length in Sedentary breaks	9	0.2	0.2	0,2	2.77
Daily average in Sedentary breaks	9	3.5	1019.8	684.9	286.12

The **Tabel 3** describes the characteristics of sedentary behavior in children with Autism Spectrum Disorder (ASD) based on an analysis of sedentary bouts and sedentary breaks (n = 9). The average number of sedentary bouts was recorded at 149.55 times with a standard deviation of 63.44, indicating a high frequency of sedentary behavior throughout the measurement period. The total time spent in sedentary bouts had an average value of 6,113.8 minutes, indicating a fairly long duration of sedentary behavior.

The average duration of each sedentary bout was 130.1 minutes, with a maximum duration of 958.37 minutes, reflecting prolonged periods of sedentary behavior in some subjects. Meanwhile, the minimum duration of sedentary bouts was relatively short, with an average of 10.74 minutes, indicating variations in sedentary patterns between individuals.

Analysis of sedentary breaks showed an average of 148.56 times, with a total average time of 5,540.03 minutes. The average duration of sedentary breaks was 35.59 minutes, with a maximum duration of 433.52 minutes, indicating that despite interruptions to sedentary behavior, most activity breaks still lasted for relatively long periods of time. The daily average of sedentary bouts and sedentary breaks was 751.84 minutes and 684.90 minutes, respectively, confirming the dominance of sedentary behavior in the daily activities of children with ASD.

Overall, these findings indicate that children with ASD spend most of their time in sedentary conditions with long durations and limited frequency of activity breaks, which could potentially have a negative impact on their health and physical fitness.

Tabel 4. Analysis Steps Autism Spectrum Disorder (ASD)

Steps	n	min	max	mean	Std.d
Steps couts	9	168	47564	30505	13272.02
Steps per minute	9	1	4.1	2.733	0.932

The **Tabel 4** presents the results of the analysis of the number of steps in children with Autism Spectrum Disorder (ASD) with a total of nine subjects (n = 9). The average daily number of steps recorded was 30,505 steps with a standard deviation of 13,272.02, indicating considerable variation in physical activity levels between individuals, with a minimum value of 168 steps and a maximum of 47,564 steps.

In addition, the average steps per minute was 2.73 steps/minute with a standard deviation of 0.93, reflecting a relatively low overall level of movement. These findings indicate that despite differences in activity between subjects, children with ASD generally exhibit inconsistent patterns of physical activity that tend to be dominated by low-intensity activities. This study shows that children with Autism Spectrum Disorder (ASD) have low levels of physical activity and are dominated by sedentary behavior. This is reflected in low energy expenditure values, Metabolic Equivalent of Task (METs) values close to one, and high duration and frequency of sedentary bouts. These findings indicate that the daily activity levels of children with ASD are mostly very low and do not meet the physical activity recommendations for children and adolescents, as recommended in global physical activity guidelines (Dixon et al., 2023).

The average METs value of 1.038 indicates a predominance of sedentary or light activity. These results are consistent with previous accelerometer-based studies reporting that children and adolescents with ASD consistently show lower levels of physical activity compared to typically developing children. The characteristic features of ASD, such as limited motor skills, difficulties in social interaction, and a preference for individual and repetitive activities, are thought to contribute to low levels of physical activity. These factors can limit the involvement of children with ASD in structured physical activities and activities of moderate to high intensity.

Analysis of sedentary behavior shows that children with ASD spend most of their time in long bouts of sedentary activity. This persistent sedentary pattern indicates long periods of inactivity without adequate interruption. These findings are consistent with previous reports that children with ASD tend to have longer periods of sedentary activity than typically developing children (Pan et al., 2021) High levels of sedentary time can potentially have a negative impact on cardiorespiratory fitness and metabolic health, even in children and adolescents, thereby increasing the risk of long-term health problems (María et al., 2024)

Although the frequency of sedentary breaks was relatively high, the duration of activity breaks was still long, indicating that interruptions to sedentary behavior were not yet effective enough to significantly increase physical activity intensity. This indicates that even though children with ASD move from a sedentary position, the replacement activities they engage in are still dominated by low intensity. These findings confirm that increased physical activity de-

pends not only on the frequency of movement, but also on the quality and intensity of the activities performed. Previous studies have shown that sedentary breaks that are not followed by adequate intensity activities have limited impact on increasing physical activity (Zhang et al., 2025) The number of daily steps shows considerable variation between individuals, but the low number of steps per minute indicates that most steps are taken at a low intensity. This shows that a relatively high number of steps does not always reflect engagement in moderate to vigorous physical activity. Unstructured and inconsistent movement patterns are common characteristics found in children with ASD, where activities are often performed in short, repetitive bursts without a significant increase in physiological load (Pan et al., 2021) Therefore, evaluation of physical activity in the ASD population needs to consider not only the number of steps, but also indicators of activity intensity.

In the Indonesian context, the low level of physical activity among children with ASD may also be influenced by the limited availability of inclusive sports programs, the lack of facilities that are accessible to those with special needs, and the lack of trained support staff. Although various studies have shown that structured physical activity can improve motor skills, fitness, and social skills in children with ASD, the implementation of such programs remains limited in educational and community settings. These findings provide an empirical basis for the development of physical activity interventions that are more contextual, structured, and inclusive, in line with the characteristics of children with ASD in Indonesia.

This study has several limitations that need to be considered in interpreting the results. The relatively small sample size and the limited location of the study to one institution restrict the generalizability of the findings. In addition, the cross-sectional design does not allow causal conclusions to be drawn between physical activity and sedentary behavior. However, the use of accelerometers as objective measuring instruments is the main strength of this study because they can provide an accurate picture of the intensity, duration, and patterns of physical activity in children with ASD.

CONCLUSION

This study shows that children with Autism Spectrum Disorder (ASD) have low levels of physical activity and are dominated by sedentary behavior. The daily activities of children with ASD are mostly of very light intensity, as reflected in their low energy expenditure, low Metabolic Equivalent of Task (METs) values, and high duration and frequency of sedentary bouts.

Although there are variations in the number of daily steps between individuals, the intensity of physical activity is still relatively low and inconsistent. Sedentary breaks are not yet effective in reducing sedentary behavior because the duration of activity breaks is still long.

These findings emphasize the importance of developing structured, inclusive physical activity programs tailored to the characteristics of children with ASD, particularly in efforts to increase physical activity intensity and reduce sedentary time. Further research involving larger sample sizes and longitudinal or intervention designs is recommended to gain a more comprehensive understanding of physical activity in children with ASD.

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