Association between SDQ-TR-assessed hyperactivity symptoms and step count during school activities in school-aged children

Najwa Citamajida[1,C-F], Adnan Faris Naufal[1*,A,B,E,F]

[1] Faculty of Health Science, Universitas Muhammadiyah Surakarta, Indonesia

***Corresponding author:** Adnan Faris Naufal; Faculty of Health Science, Universitas Muhammadiyah Surakarta, Indonesia; email: afn778@ums.id

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ABSTRACT

Background: Hyperactivity is a core symptom of attention-deficit/hyperactivity disorder (ADHD) and may manifest as increased motor activity. Objectively measured step count may provide information about ambulatory movement associated with hyperactivity symptoms, while developmental differences may also influence movement patterns in children.

Objective: To examine the association between hyperactivity symptom severity and step count during school activities and to compare step count and hyperactivity scores between children aged 5 and 12 years.

Methods: This cross-sectional study included 40 children (20 males and 20 females) aged 5 and 12 years from two schools in Surakarta, Indonesia, recruited using total sampling. Hyperactivity symptoms were assessed using the hyperactivity/inattention subscale of the Strengths and Difficulties Questionnaire Teacher Report (SDQ-TR), while step count was objectively measured using a Maxfit pedometer during one school day. Spearman's rank correlation, independent-samples t-tests, and Mann–Whitney U tests were used for statistical analysis.

Results: Hyperactivity scores were strongly and positively correlated with step count ($r_s = 0.918$, $p < 0.001$). Step count differed significantly between the age groups ($p = 0.041$), with higher values observed among 5-year-old children than among 12-year-old children. In contrast, hyperactivity scores did not differ significantly between the two age groups ($p = 0.701$).

Conclusion: Higher hyperactivity symptom severity was associated with greater step count during school activities. Step count differed between the two age groups, whereas hyperactivity scores did not. These findings suggest that objectively measured ambulatory movement and hyperactivity symptoms may capture related but developmentally distinct aspects of children's behaviour.

Keywords: ADHD symptoms, hyperactivity, step count.

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INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by persistent patterns of inattention, hyperactivity, and impulsivity that may interfere with children's functioning and development (Prasad & Kumminimana, 2025). The prevalence of ADHD among children varies across populations, with a global estimate of approximately 7.6% among children aged 3–12 years (Salari et al., 2023). Hyperactivity, one of the core symptoms of ADHD, is characterized by excessive or developmentally inappropriate motor activity and may manifest as difficulty remaining still and frequent movement (Gawrilow et al., 2014). Children with greater hyperactivity symptoms may therefore exhibit increased physical movement associated with difficulties in impulse control and behavioural inhibition (Diamanti et al., 2025; Earnest et al., 2020). Although physical activity is generally beneficial for health, increased movement in children with hyperactivity symptoms may also represent a behavioural manifestation of hyperactivity (Hoy et al., 2024). Objectively measured step count may therefore provide useful information about ambulatory movement associated with variation in hyperactivity symptom severity.

Developmental stage may also influence children's movement patterns. Children around 5 years of age represent a preschool developmental stage in which objectively measured step counts have been investigated, whereas 12-year-old children fall within early adolescence, a period also characterized by changes in physical activity patterns (Fang et al., 2020; Nagata et al., 2023). Longitudinal evidence indicates that daily step counts tend to decline from childhood into adolescence, suggesting that age is relevant when examining ambulatory movement across developmental stages (Guimarães et al., 2021). Comparing children aged 5 and 12 years therefore provides a developmental contrast for examining differences in step count and their relationship with hyperactivity symptoms.

Hyperactivity symptoms may also vary across development. Longitudinal evidence suggests that hyperactivity symptoms tend to decline from childhood into adolescence (Eng et al., 2023). Neurobiological maturation, particularly in prefrontal regions involved in inhibitory control, has been proposed as one mechanism that may contribute to developmental changes in the regulation of behaviour and spontaneous motor activity (Weiss & Luciana, 2022). However, developmental changes in motor activity and hyperactivity symptoms should not be assumed to follow identical trajectories. Examining both step count and hyperactivity symptom severity across distinct age groups may therefore provide additional insight into their relationship.

Previous studies have examined associations between ADHD or hyperactivity symptoms and physical activity using different assessment approaches. Villalba-Heredia et al. (2023) objectively assessed physical activity and sedentary behaviour using ActiGraph GT3X accelerometry and reported higher physical activity levels among children with ADHD than among those without ADHD, although moderate-intensity physical activity decreased with age in the ADHD group. However, that study focused primarily on ADHD status and presentation rather than the association between continuous hyperactivity symptom severity and step count. Selinus et al. (2021), using data from 3,949 Swedish children, reported that higher childhood hyperactivity/impulsivity scores were associated with a greater likelihood of physical activity during adolescence; however, physical activity was assessed by self-report rather than device-measured step count. Similarly, Brandt et al. (2021) examined objectively measured activity at age 7 in relation to ADHD symptoms and diagnosis at age 14 and found that lower sedentary behaviour was associated with more ADHD symptoms. Their activity measures, however, focused on sedentary behaviour and general activity levels rather than step count.

Collectively, these studies indicate a relationship between ADHD-related symptoms and physical activity, but differences in symptom assessment and movement measurement leave an important gap. Specifically, the association between hyperactivity symptom severity assessed as a continuous score and objectively measured step count during school activities remains less understood. Examining symptom severity continuously may preserve variation in hyperactivity symptoms, while device-measured step count provides an objective measure of ambulatory movement during the observation period. This approach may help clarify whether children with greater hyperactivity symptom severity also exhibit greater ambulatory movement in the school setting.

Therefore, this study aimed to examine the association between hyperactivity symptom severity, assessed using the continuous Strengths and Difficulties Questionnaire Teacher Report (SDQ-TR) hyperactivity/inattention score, and objectively measured step count during school activities. The study also compared step count and hyperactivity scores between children aged 5 and 12 years. By examining these outcomes together, the study sought to provide empirical evidence regarding the relationship between hyperactivity symptoms and ambulatory movement while considering differences between two distinct developmental age groups.

METHODS

Study Design and Participants

This study employed a quantitative cross-sectional design to examine the association between hyperactivity symptom severity and objectively measured step count during school activities and to compare these variables between two age groups. Participants were recruited using total sampling from two selected schools in Surakarta, Indonesia. All eligible students at the participating schools were invited to participate. The final sample consisted of 40 children, including 20 children aged 5 years and 20 children aged 12 years. The 5-year-old participants were recruited from Aisyiyah Gumpang Kindergarten, whereas the 12-year-old participants were recruited from Alkausar Kartasura Elementary School. All 40 participants provided complete data and were included in the final analysis (Figure 1).

Ethical approval statement

This study was approved by the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (Ethical Approval No. 2436/KEPK-FIK/VI/2026). All study procedures were conducted in accordance with the approved research protocol and applicable ethical principles for research involving children. Written informed consent was obtained from the participants' parents or legal guardians prior to participation.

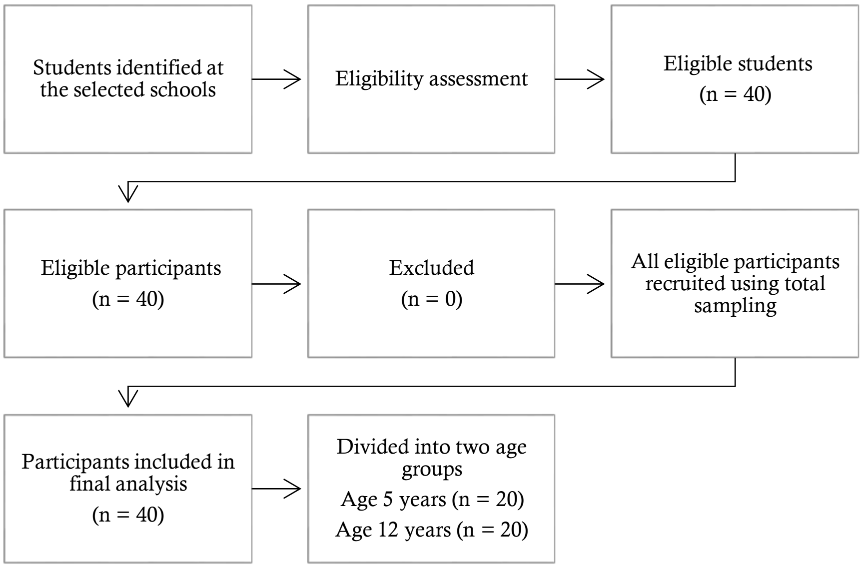

Figure 1. Flowchart of Participant Recruitment and Selection

Research Instruments

Strengths and Difficulties Questionnaire Teacher Report

Hyperactivity symptoms were assessed using the hyperactivity/inattention subscale of the Strengths and Difficulties Questionnaire Teacher Report (SDQ-TR). The SDQ-TR is a 25-item behavioural screening instrument comprising five domains: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. In the present study, only the hyperactivity/inattention subscale was used as the behavioural measure of interest. The hyperactivity/inattention score was analysed as a continuous variable without applying categorical cut-off points, thereby preserving variation in symptom severity across participants. Previous research has demonstrated good internal consistency for the hyperactivity/inattention domain (Cronbach's α = 0.86) and supported the reliability and concurrent validity of the SDQ-TR for assessing emotional and behavioural difficulties in children (van den Heuvel et al., 2017). In Indonesia, the SDQ-TR hyperactivity/inattention subscale has also been evaluated as a screening measure for hyperkinetic disorder, with reported sensitivity of 72.4% and specificity of 73.3% (Siregar & Wimbarti, 2018).

Pedometer

Step count was objectively measured using a Maxfit pedometer attached to the participant's ankle during school activities on one observation day. The total number of steps recorded during the observation period was used as an indicator of ambulatory movement during school activities. Because measurement was limited to a single school day, the recorded step count represents movement during the observed school period rather than habitual daily physical activity. Pedometer-based step counting has been used as an objective approach for assessing children's ambulatory physical activity in school settings (Hardman et al., 2009; Tudor-Locke et al., 2006).

Data Collection Procedure

Data collection consisted of behavioural assessment and objective step-count measurement. Hyperactivity symptoms were assessed using the teacher-report SDQ-

TR hyperactivity/inattention subscale. Step count was measured using a Maxfit pedometer worn at the ankle during school activities on one observation day. Following data collection, SDQ-TR hyperactivity/inattention scores and step-count records were compiled for statistical analysis. Complete data were available for all 40 participants.

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics version 25. Descriptive statistics were used to summarize participant characteristics and study variables. The normality of continuous variables was assessed using the Shapiro–Wilk test. Step-count data were normally distributed, whereas SDQ-TR hyperactivity/inattention scores were not normally distributed. Differences in mean step count between the 5- and 12-year-old groups were therefore analysed using an independent-samples t-test, with homogeneity of variance assessed using Levene's test. Differences in hyperactivity/inattention scores between the two age groups were analysed using the Mann–Whitney U test. The association between hyperactivity/inattention scores and step count was examined using Spearman's rank correlation because the hyperactivity/inattention scores were not normally distributed. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 40 children were included in the final analysis, comprising 20 children aged 5 years and 20 aged 12 years. The sample included 20 males (50.0%) and 20 females (50.0%), with no missing data. The mean BMI was 17.40 ± 1.40 kg/m². During the observation period, participants recorded a mean step count of 10,918.60 ± 680.06 steps, with values ranging from 9,786 to 11,994 steps. The mean SDQ-TR hyperactivity/inattention score was 5.58 ± 1.84, with scores ranging from 2 to 8. Participant characteristics are presented in Table 1.

Table 1. Participant Characteristics

Characteristic	Value
Sex, n (%)	
Male	20 (50.0)
Female	20 (50.0)
Age group, n (%)	
5 years	20 (50.0)
12 years	20 (50.0)
BMI (kg/m²), mean ± SD	17.40 ± 1.40
Range	15.4–19.4
BMI category, n (%)	
Underweight	28 (70.0)
Normal weight	12 (30.0)
Overweight	0 (0.0)
Obese	0 (0.0)
Step count, mean ± SD	10,918.60 ± 680.06
Median (IQR)	11,005.50 (10,450.25–11,462.50)
Range	9,786–11,994
SDQ-TR hyperactivity/inattention score, mean ± SD	5.58 ± 1.84
Median (IQR)	6.00 (4.00–7.00)
Range	2–8

Table 2. Association Between SDQ-TR Hyperactivity/Inattention Scores and Step Count

Variable	r_s	p	N
SDQ-TR hyperactivity/inattention score and step count	0.918	<0.001	40

Note. r_s *= Spearman's rank correlation coefficient.*

Spearman's rank correlation analysis showed a strong positive association between SDQ-TR hyperactivity/inattention scores and step count ($r_s = 0.918$, $p < 0.001$; N = 40). Higher hyperactivity/inattention scores were associated with greater step counts during the observed school period (Table 2 and Figure 2).

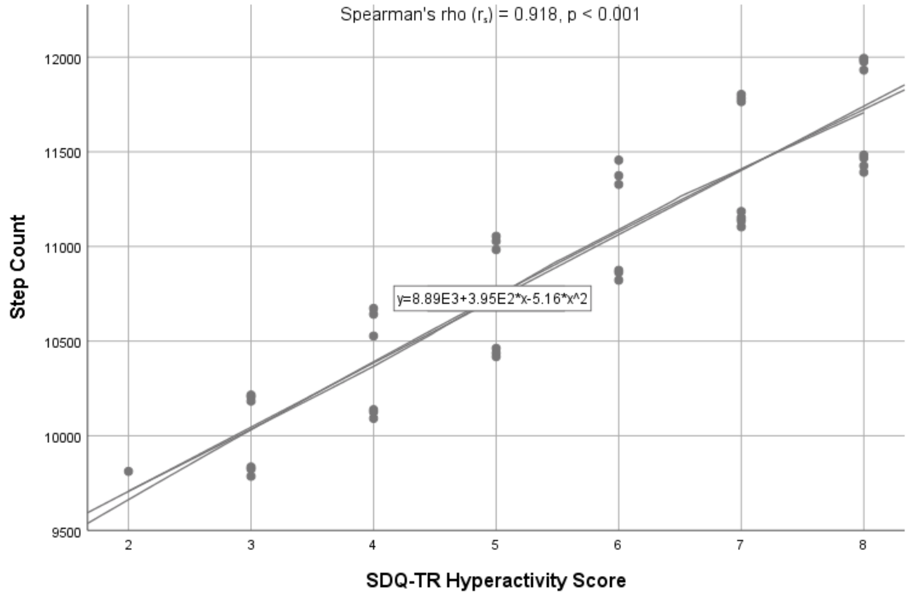

Figure 2. Scatter Plot of the Association Between SDQ-TR Hyperactivity/Inattention Scores and Step Count

Table 3. Comparison of Step Count Between Age Groups

Characteristic	Result
Age 5 years, mean ± SD	11,136.10 ± 707.16
Age 12 years, mean ± SD	10,701.10 ± 591.31
Mean difference	435.00
Levene's *F*	0.786
Levene's *p*	0.381
t(df)	2.110 (38)
p	0.041

Children aged 5 years recorded a higher mean step count (11,136.10 ± 707.16 steps) than children aged 12 years (10,701.10 ± 591.31 steps). Levene's test indicated that the homogeneity-of-variance assumption was met ($F = 0.786$, $p = 0.381$). The independent-samples t-test showed a statistically significant between-group difference, $t(38) = 2.110$, $p = 0.041$, with a mean difference of 435.00 steps (95% CI [17.73, 852.27]) (Table 3).

Table 4. Comparison of SDQ-TR Hyperactivity/Inattention Scores Between Age Groups

Characteristic	Result
Age 5 years, mean rank	19.80
Age 12 years, mean rank	21.20
Mann–Whitney *U*	186.00
Z	-0.384
p	0.701

The Mann–Whitney U test showed no statistically significant difference in SDQ-TR hyperactivity/inattention scores between children aged 5 and 12 years ($U = 186.00$, $Z = -0.384$, $p = 0.701$). The mean ranks were 19.80 for the 5-year-old group and 21.20 for the 12-year-old group (Table 4).

DISCUSSION

The present study examined the association between hyperactivity symptom severity and objectively measured step count during school activities and compared these variables between children aged 5 and 12 years. Three main findings were identified. First, SDQ-TR hyperactivity/inattention scores were strongly and positively associated with step count. Second, children aged 5 years recorded significantly higher step counts than those aged 12 years. Third, hyperactivity/inattention scores did not differ significantly between the two age groups. Together, these findings suggest that greater hyperactivity symptom severity was associated with greater ambulatory movement during the observed school period, while age-related differences were evident for step count but not for hyperactivity/inattention scores.

The strong positive association between hyperactivity/inattention scores and step count ($r_s = 0.918$, $p < 0.001$) (Table 2) indicates that children with higher teacher-rated hyperactivity/inattention symptoms tended to accumulate more steps during school activities. This finding is broadly consistent with previous evidence suggesting that children with ADHD or elevated ADHD-related symptoms may display greater levels of objectively measured movement. Villalba-Heredia et al. (2023), for example, reported higher objectively measured physical activity among children with ADHD than among children without ADHD. Similarly, Brandt et al. (2021) found associations between objectively measured activity patterns in childhood and subsequent ADHD symptoms. Although differences in study design, measurement devices, and ADHD assessment limit direct comparisons, these findings collectively support an association between ADHD-related behavioural characteristics and objectively measured motor activity.

The present findings also complement those of Selinus et al. (2021), who reported an association between childhood hyperactivity/impulsivity and later physical activity. An important distinction is that the present study assessed hyperactivity/inattention severity as a continuous score and measured ambulatory movement objectively through step count. Treating symptom severity continuously preserves individual variation that may be obscured when participants are classified into diagnostic or categorical groups. Nevertheless, step count should not be regarded as a direct or diagnostic measure of hyperactivity. Pedometers capture ambulatory movement but do not distinguish whether individual movements arise from hyperactivity symptoms, structured physical education, play, classroom transitions, environmental opportunities, or other behavioural and contextual factors. The observed association should therefore be interpreted as a relationship between teacher-rated hyperactivity/inattention symptoms and ambulatory movement during the measured school period.

A significant difference in step count was also observed between the two age groups. Children aged 5 years accumulated a mean of 11,136.10 ± 707.16 steps, compared with 10,701.10 ± 591.31 steps among children aged 12 years, corresponding to a mean difference of 435 steps (Table 3). Previous research has documented developmental changes in physical activity across childhood and adolescence. Guimarães et al. (2021) reported a decline in daily step counts from childhood into adolescence, while Fang et al. (2020) and Nagata et al. (2023) described age-related differences in physical activity patterns across developmental stages. The lower step count observed among the 12-year-old participants in the present study is therefore broadly consistent with evidence that ambulatory activity may decrease with increasing age.

However, the age-group difference observed in this study should be interpreted cautiously. The study compared two distinct age groups cross-sectionally rather than following the same children longitudinally. Consequently, the observed difference cannot be attributed directly to developmental maturation. Neurodevelopmental changes, including maturation of neural systems involved in behavioural regulation and inhibitory control, may contribute to developmental differences in motor behaviour (Weiss & Luciana, 2022), but such mechanisms were not measured in the present study. Differences in school schedules, opportunities for movement, classroom structure, play activities, and other environmental factors may also have contributed to the observed step-count difference. Therefore, neurobiological maturation should be considered only as one possible explanatory mechanism rather than a demonstrated cause of the findings.

In contrast to the difference in step count, SDQ-TR hyperactivity/inattention scores did not differ significantly between children aged 5 and 12 years ($U = 186.00$, $Z = -0.384$, $p = 0.701$) (Table 4). This finding suggests that, within the present sample, teacher-rated hyperactivity/inattention symptom severity was not statistically distinguishable between the two age groups. Previous longitudinal evidence indicates that hyperactivity symptoms may change across childhood and adolescence (Eng et al., 2023), however, the absence of a significant difference in the present study does not necessarily contradict such developmental patterns. The relatively small sample, cross-sectional design, and comparison of children from two different school settings may have limited the ability to detect age-related differences in symptom severity.

The combination of a significant age-group difference in step count and a non-significant difference in hyperactivity/inattention scores is noteworthy. It suggests that objectively measured ambulatory movement and teacher-rated hyperactivity/inattention symptoms, although strongly associated across participants, should not be considered interchangeable constructs. Step count reflects the amount of ambulatory movement occurring within a particular observation context, whereas the SDQ-TR captures behavioural symptoms based on teacher observations. The two measures may therefore provide complementary information about children's behaviour. This distinction is particularly important when interpreting objective movement data in relation to ADHD-related symptoms.

From a practical perspective, objective step-count measurement may complement behavioural assessment by providing information about children's ambulatory movement during school activities. Pedometers are relatively simple tools for quantifying movement and may be useful in research or school-based monitoring when interpreted alongside behavioural measures. However, the strong correlation observed in this study does not support the use of step count as a diagnostic tool for

ADHD or hyperactivity. Clinical or educational assessment of ADHD-related symptoms requires appropriate validated behavioural and diagnostic procedures, and step-count data should be considered supplementary rather than diagnostic information.

Limitations of the study

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design does not allow causal or developmental inferences to be drawn from the observed association between hyperactivity/inattention symptoms and step count. Second, the relatively small sample of 40 participants recruited from only two schools limits the generalizability of the findings to broader populations. In addition, the two age groups were recruited from different schools, with the 5-year-old participants attending a kindergarten and the 12-year-old participants attending an elementary school. Consequently, age and school setting were confounded, and the observed difference in step count between the age groups cannot be attributed solely to age or developmental stage. Differences in school schedules, classroom structure, opportunities for physical activity, and other environmental factors may have contributed to the findings.

Third, step count was measured using a pedometer during only one school day. Therefore, the recorded values may not represent participants' habitual daily physical activity or usual movement patterns across multiple days. Pedometers also quantify ambulatory movement without providing information about movement intensity, duration, context, or the specific behaviours contributing to the accumulated steps. Fourth, hyperactivity/inattention symptoms were assessed using teacher-reported SDQ-TR scores rather than a clinical diagnostic assessment. The findings should therefore be interpreted in terms of variation in reported symptom severity and should not be considered evidence of an ADHD diagnosis. Finally, potentially relevant factors such as differences in school activities and other contextual influences were not incorporated into the statistical analyses. Future studies should include larger and more diverse samples, recruit different age groups within comparable school environments, employ multi-day objective activity monitoring, and consider additional contextual and behavioural variables. Longitudinal designs would also be valuable for examining how the relationship between hyperactivity symptoms and objectively measured movement changes across development.

CONCLUSION

This study found a strong positive association between teacher-reported hyperactivity/inattention symptom severity and objectively measured step count during school activities, indicating that children with higher symptom scores tended to accumulate more steps during the observed school period. Children aged 5 years recorded significantly higher step counts than children aged 12 years, whereas hyperactivity/inattention scores did not differ significantly between the two groups. However, because the age groups were recruited from different school settings, the observed difference in step count cannot be attributed solely to age or developmental stage. These findings suggest that objectively measured step count may provide complementary information about ambulatory movement associated with hyperactivity/inattention symptoms, but it should not be interpreted as a diagnostic measure of ADHD. Future studies using larger and more diverse samples, comparable school environments, multi-day activity monitoring, and longitudinal designs are needed to clarify how hyperactivity symptoms and objectively measured movement are related across development.

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AI DISCLOSURE STATEMENT

During the preparation of this work, the authors used ChatGPT (OpenAI) and Grammarly to assist with language editing, grammar improvement, and manuscript organization. After using these tools, the authors carefully reviewed, revised, and verified the content and take full responsibility for the accuracy, integrity, and final content of the published article.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to participant privacy and confidentiality considerations.

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This research did not receive any external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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