12 (1) (2025) 210 - 215

Journal of Physical Education, Health and Sport

https://journal.unnes.ac.id/journals/jpehs

Relationship Between Sedentary Behavior and Cognitive Function in Children in Phase C

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History Article

Received July 2025
Approved July 2025
Published vol 12 no 1 2025

Keywords

Sedentary Behavior; Cognitive Function; Elementary School Children

Abstract

This study aimed to analyze the relationship between sedentary behavior and cognitive function in phase C elementary school students (aged 10–12 years). A quantitative approach with a correlational design was used in 291 students in Cibeunying Kidul District, Bandung City. Sedentary behavior was measured using the Adolescent Sedentary Activity Questionnaire (ASAQ), while cognitive function was measured using the Indonesian version of the Mini-Mental State Examination (MMSE). Data analysis was performed using Spearman's rho correlation test. The results showed a significant but weak negative relationship between sedentary behavior and cognitive function ($r = –0.121$; $p = 0.040$). This finding indicates that the higher the level of sedentary behavior, the lower the child's cognitive function score. Theoretically, these results support the view that physical activity plays an important role in maintaining and improving cognitive function, while sedentary behavior can hinder it. The practical implications of this study emphasize the importance of involving parents, teachers, and schools in reducing the duration of children's sedentary activities through programs that increase enjoyable physical activity and are integrated with learning activities. This study contributes to local literature regarding the impact of sedentary behavior on the cognitive development of elementary school-aged children.

How to Cite

Adelia, S., Lubay, L. H.,Nugroho, W. A., & Sumarno, G. (2025). Relationship Between Sedentary Behavior and Cognitive Function in Children in Phase C. Journal of Physical Education, Health and Sport, 12 (1), 210-215.

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p-ISSN 2354-7901
e-ISSN 2354-8231

INTRODUCTION

The rapid development of information and communication technology has brought about significant changes in the lives of elementary school-aged children. Digital devices such as smartphones, tablets, and computers are now easily accessible, shifting activity patterns to become more passive (Daulay et al., 2020; Rohana & Hartini, 2020; Widiastiti & Agustika, 2020)This phenomenon is increasingly visible in the digital age, as children spend more time on screen-based activities than on outdoor physical activities.

The elementary school years, particularly phase C (grades 5–6, ages 10–12), are crucial for cognitive development. At this stage, children begin to think logically, solve problems, and understand cause-and-effect relationships. Lack of physical activity and high levels of sedentary behavior have the potential to hinder this development (Fatimah, 2021; Mifroh, 2020).

Sedentary behavior is defined as sitting or lying down behavior with energy expenditure ≤1.5 MET, such as watching television, playing games, or reading (Setyoadi et al., 2015; Tremblay et al., 2017). High sedentary duration can reduce physical activity and have negative impacts on health, including increasing the risk of cognitive impairment (Falck et al., 2017; Wheeler et al., 2017).

Cognitive functions include the ability to think, remember, pay attention, speak, and executive functions such as planning and decision making (Diamond, 2013; Zulherma & Suryana, 2019).This process develops rapidly during childhood and requires consistent stimulation. Physical activity has been shown to provide positive stimulation for the development of cognitive function, while sedentary behavior tends to decrease it (Biddle & Asare, 2011; Wang et al., 2024).

Previous research has shown a negative relationship between sedentary behavior and cognitive function. According to Walsh et al. (2018)found that screen time of more than two hours per day was associated with decreased attention and memory. According to Falck et al. (2017) reported that increased sedentary time can accelerate cognitive decline. However, most of this research was conducted overseas and therefore does not represent the Indonesian social and cultural context.

In Indonesia, studies on sedentary behavior generally focus more on its impact on physical health, such as obesity or physical fitness (Firmansyah & Nurhayati, 2021; Nafi›ah & Hadi, 2022), while its impact on the cognitive function of elementary school children has been rarely studied. This indicates a research gap that needs to be filled to understand this phenomenon in a local context.

The novelty of this research lies in its focus on examining the relationship between sedentary behavior and cognitive function in Phase C elementary school students. This research integrates Piaget›s cognitive development perspective, which emphasizes the importance of physical activity and social interaction as brain stimulation (Fatimah, 2021; Mifroh, 2020) This approach is expected to provide a comprehensive picture of the impact of sedentary behavior on children›s cognitive development in Indonesia.

METHOD

This study used a quantitative approach with a correlational design to examine the relationship between sedentary behavior (X) and cognitive function (Y) in elementary school students. The subjects were 291 students aged 10–12 years in Cibeunying Kidul District, Bandung City, who were selected using a purposive sampling technique according to the inclusion criteria: aged 10–12 years or in phase C, actively participating in learning activities in elementary school, and willing to be respondents.

The study population was all phase C elementary school students in the sub-district. This age group was selected based on the developmental period of physical, motor, social, and cognitive functions, as well as the formation of habits that will persist into adulthood, with a relatively high level of sedentary behavior. The sample size was calculated using the Slovin formula.

The research instrument consisted of the Adolescent Sedentary Activity Questionnaire (ASAQ) to measure sedentary behavior, which contains 23 questions related to screen-based activities, screen-based learning, and other sedentary activities during the last seven days, with a reliability of 0.57–0.86.(Hardy et al., 2007), as well as low (<2 hours/day), moderate (2–5 hours/day), and high (>5 hours/day) categories. Cognitive function was measured using the Indonesian version of the Mini-Mental State Examination (MMSE), with a sensitivity of 87% and a specificity of 82% (Tarigan et al., 2017), as well as the normal score categories (24–30), mild impairment (18–23), and severe impairment (0–17). Data collection was conducted at the school by directly completing questionnaires. Data analysis

used IBM SPSS Statistics version 29 (Fadluloh et al., 2024), including descriptive analysis to describe data characteristics, the Shapiro–Wilk normality test, and a linearity test using ANOVA. Correlation tests were performed using Pearson for normally distributed data, or Spearman/Kendall for non-normal data. Hypotheses were tested at a 5% significance level ($p < 0.05$).

RESULTS AND DISCUSSION

The results of descriptive statistical analysis, it is known that the number of respondents (N) is 291 students. The average value (mean) of the ASAQ score is 4.7761 with a standard deviation of 2.15614, while the average value of the MMSE is 24.88 with a standard deviation of 2.455. The minimum and maximum values of the ASAQ variable are 0.15 to 8.83, while the MMSE ranges from 14 to 30. This shows that there is a diversity of scores on both variables measured in this study.

Table 1. ASAQ Category

Criteria	Number
Low (< 2 Hours)	46
Moderate (< 5 Hours)	83
High (> 5 Hours)	162
Total	291

Table 1 shows that out of a total of 291 students, 46 students (low category, ≤ 2 hours per day) had relatively little sedentary activity. A total of 83 students were in the moderate category (≤ 5 hours per day), while the majority of students, 162 students, were in the high category (≥ 5 hours per day). These findings indicate that most respondents have a high duration of sedentary activity, while only a small portion fall into the low category. This condition suggests a tendency toward physically inactive behavior among most students, which could potentially have negative impacts on their health and fitness if it continues over the long term.

Table 2. MMSE Category

Criteria	Score	Number
Abnormal	0-23	79
Abnormal (Severe)	0-17	0
Abnormal (Moderate)	18-23	79
Normal	24-30	212
Total		**291**

Table 2 shows that 79 students were in the abnormal category (score 0–23), with 79 students specifically classified as having moderate abnormality (score 18–23). Meanwhile, the majority of respondents, namely 212 students, were in the normal category (score 24–30). These findings indicate that most students have normal cognitive function; however, there remains a considerable proportion whose results fall below the normal category. This condition highlights the need for special attention for students with low scores so that they can receive appropriate interventions or support to improve their cognitive function.

The significance value for the ASAQ variable is 0.000, and for the MMSE variable, it is also 0.000. Because the significance values for both variables are less than 0.05, it can be concluded that the data are not normally distributed. Therefore, this study used a non-parametric correlation test, namely Spearman's rho.

The significance value in the Deviation from Linearity row is 0.779, which is greater than 0.05. This indicates that there is no significant deviation from linearity. Therefore, it can be concluded that the relationship between the MMSE and ASAQ variables is linear, thus fulfilling the requirements for further analysis using a linear regression model.

The results of the Spearman correlation test, which shows a negative relationship between the ASAQ and MMSE variables, with a correlation coefficient of -0.121 and a significance level of 0.040 ($p < 0.05$). This indicates a statistically significant but weak and negative relationship between sedentary behavior and cognitive function. In other words, higher levels of sedentary behavior tend to be followed by a decrease in children's cognitive function score

The results of this study indicate a significant negative relationship between sedentary behavior and cognitive function in fifth-grade elementary school students. This finding indicates that increased duration of sedentary activity tends to correlate with decreased cognitive function in children, although the strength of the relationship is relatively weak. Theoretically, these results align with the understanding that sedentary behavior can hinder the cognitive development of school-age children, who are at a crucial phase in brain development and thinking skills.

In the context of child development, the 10–12 year age phase is a critical period in the development of executive functions, working memory, attention, and problem-solving abilities Diamond (2013)These executive functions are greatly influenced by physical activity and a

stimulating environment. When children spend more time sitting, staring at screens, or engaging in other passive activities, their brains receive less stimulation, resulting in lower cognitive achievement.

High levels of sedentary behavior—measured using the Adolescent Sedentary Activity Questionnaire (ASAQ)—represent the frequency and duration of activities children engage in that involve little physical movement. Activities such as watching television, playing with gadgets, or sitting for extended periods of time for non-academic activities are key contributors to this behavior. The results of this study corroborate findings from (Tremblay & others, 2016)which states that long periods of sedentary behavior are closely related to decreased cognitive scores in children and adolescents. In the long term, this sedentary lifestyle risks disrupting not only cognitive aspects but also children's mental and emotional health.

Furthermore, these results also strengthen the results of a study conducted by (Carson & others, 2016), which concluded that excessive screen media exposure is negatively associated with children's cognitive performance, particularly in attention and short-term memory. While not all sedentary activities are detrimental, children's tendency to choose passive over active activities tends to have a cumulative impact on brain function.

In this study, cognitive function was measured using the Mini-Mental State Examination (MMSE) instrument, modified to suit the age context of elementary school children. The range of scores obtained from respondents showed that most children had good cognitive function, but there were also children with lower scores, which could be interpreted as an indication of delayed or impaired cognitive development. These results clearly reflect that variations in children's daily behavior contribute to shaping their cognitive profiles.

According to the theory of neuroplasticity, the brains of elementary school-aged children are highly adaptive to daily experiences and activities. Therefore, adequate and varied physical activity will help strengthen neuronal connections and support the growth of brain areas involved in decision-making, concentration, and emotional control (Ratey & Hagerman, 2008) Conversely, a lack of stimulation due to sedentary behavior will hinder this process, preventing the child's intellectual potential from developing optimally.

The findings of this study indicate a significant negative relationship between sedentary behavior and cognitive function in elementary school students, which is in line with various contemporary studies (Zahran, 2024), in their longitudinal study, stated that the combination of sleep time, physical activity level, and duration of sedentary behavior collectively play a significant role in influencing children's cognitive development, particularly from preschool through early elementary school. Excessive sedentary time was identified as a contributing factor to declining cognitive performance.

Other research published in (Wu, 2023), showed that high sedentary time in preschool children correlated with improved conceptual skills in boys upon entering elementary school. However, this trend was sex-specific and cannot be generalized as a universal influence on cognitive function. This indicates that the relationship between sedentary time and cognitive function is complex and influenced by various demographic factors and the context of children's activities.

Further support comes from a scoping review study by (Wu, 2023), involving more than 30,000 children under 12 years old using a neuroimaging approach. The findings indicate that excessive screen exposure is associated with structural and functional changes in the brain, particularly in the prefrontal cortex region that regulates working memory, attention, planning abilities, and other executive functions. The implications of these findings confirm that high levels of sedentary behavior, especially those related to screen use, can have long-term impacts on children's neurodevelopment and cognitive capacity.

From a developmental neuroscience perspective, the findings from this large project (Consortium, 2023), revealed that high screen time is associated with weakened connectivity between the fronto-striatal areas of the brain, which play a key role in impulse control and decision-making. This leads to a tendency to respond more readily to instant rewards and a decline in self-regulation. Thus, sedentary time not only impacts basic cognitive aspects but also executive control and behavior.

Contextually (Panjeti-Madan & Ranganathan, 2023), highlights that screen use in early childhood impacts various developmental domains, including cognitive, motor, language, and socio-emotional. These impacts are influenced not only by duration but also by the type of content consumed and the quality of interactions during digital device use. Therefore, a comprehensive understanding is needed to understand that the quality and context of sedentary time play a

crucial role in determining its impact on child development.

Decreased physical activity and increased sedentary behavior can affect emotional and stress regulation, ultimately impacting children's thinking and learning abilities. Furthermore, excessive screen time, especially without parental supervision, can disrupt children's sleep, which is also a crucial factor in memory recovery and consolidation (Biddle & Asare, 2011).

From an educational perspective, these findings highlight the crucial role of schools and families in creating an environment that encourages active movement. An overly dense curriculum without breaks for physical activity can actually hinder students' readiness to learn. Therefore, integrating physical activity into daily learning should be considered as a strategy to maintain and enhance children's cognitive capacity.

Although the relationship found in this study was weak, statistical significance suggests a consistent pattern between sedentary behavior and cognitive decline. This could be an early indicator for educators and parents to be more vigilant about children's tendency to engage in passive activities for too long. This weak relationship may be influenced by external factors such as nutrition, sleep patterns, stress, and socioeconomic background, which were not included in this study.

Thus, this study not only provides a theoretical contribution to the literature on elementary school children's lifestyles but also opens up opportunities for practical interventions. Systematic and enjoyable physical activity programs in elementary schools need to be developed to minimize the negative impacts of sedentary behavior. Future research is recommended to explore the interactions between sedentary behavior, physical activity, and other factors such as nutrition and social aspects to gain a more comprehensive understanding of their effects on children's cognitive function.

CONCLUSION

This study shows a significant but weak negative relationship between sedentary behavior and cognitive function in elementary school students in phase C, where high duration of sedentary activity tends to decrease concentration, memory, and problem-solving abilities. These findings emphasize the importance of regular physical activity as brain stimulation and support for the learning process. Therefore, teachers, schools, and parents are expected to play an active role in limiting sedentary time and providing opportunities for children to engage in enjoyable and structured physical activities, both at school and at home, so that children's cognitive development and health can be optimally maintained.

The results of this study are expected to provide scientific and practical contributions for teachers, parents, and policy makers, to design strategies that balance the use of technology with physical activity, so that children can grow with optimal physical and cognitive health.

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