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Physical Activity: Relationship to Gadget Use and Sleep Quality in Junior High School Students

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Abstract

Low physical activity and increasing gadget use among adolescents are concerns for physical education. This study aimed to analyze the relationship of gadget use and sleep quality with physical activity among students of SMP Negeri 1 Barat, Magetan Regency, Indonesia. A quantitative, non-experimental, cross-sectional correlational design was used. Participants were 119 seventh-grade students from four classes selected by cluster random sampling. Data were collected online using a researcher-developed gadget-use questionnaire, a sleep quality questionnaire adapted from the Pittsburgh Sleep Quality Index (PSQI), and the Physical Activity Questionnaire for Adolescents (PAQ-A). Data were analyzed using Spearman's correlation and multiple linear regression ($\alpha = 0.05$). Gadget use was negatively and significantly correlated with physical activity ($\rho = -0.352$, $p < 0.001$), as was poorer sleep quality ($\rho = -0.261$, $p = 0.005$, $n = 116$). Jointly, both variables were significantly related to physical activity ($R = 0.411$, $R^2 = 0.169$, $F(2, 113) = 11.463$, $p < 0.001$), but only gadget use remained significant in the partial test ($\beta = -0.325$, $p = 0.001$; sleep quality: $\beta = -0.148$, $p = 0.123$). The gadget-use association remained significant after adjustment for sex, age, and class. Because the design is correlational, the findings do not indicate causality, and the low reliability of the two researcher-adapted questionnaires calls for cautious interpretation. Physical education teachers and schools may consider managing students' gadget habits as part of efforts to promote an active lifestyle.

Keywords: *Gadge; Sleep Quality; Physical Activity; Junior High School Students; PAQ-A*

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INTRODUCTION

Physical activity is a key component of children's and adolescents' growth and development. It supports bone health, a healthy body weight, and cognitive function (Kementerian Kesehatan Republik Indonesia, 2026), and, together with sleep and limited screen time, it forms the 24-hour movement behaviours that have been linked to health indicators in children and adolescents (Zhao, Wu, Haapala, & Gao, 2024). Indonesian guidance recommends that adolescents aged 10–17 years accumulate an average of at least 60 minutes of moderate-to-vigorous physical activity per day (Kementerian Kesehatan Republik Indonesia, 2026). However, many do not reach this level: the World Health Organization Regional Office for South-East Asia (2024) reported that 58% of Indonesian adolescents aged 10–14 years and 50.4% of those aged 15–19 years were insufficiently active. In Magetan Regency, studies of students' physical condition have focused on physical fitness (Prakosa & Hartati, 2022), whereas the role of adolescents' digital lifestyle has not been examined.

Adolescents' daily routines have also changed as gadget use has increased. Reviews of studies in adolescents indicate that overuse and problematic use of electronic devices, and screen use before bedtime, are associated with poorer sleep quality and shorter sleep (Dibben et al., 2023; Silva et al., 2022), and Utari and Indawati (2025) linked night-time gadget habits, including sleeping close to a device whose notifications disturb sleep, to poor sleep quality among adolescents. Poor sleep may in turn reduce energy and the motivation to be physically active the next day, and studies in adolescents have related sleep to physical activity (Cruz et al., 2024; Grasaas, Hysing, & Sandbakk, 2024).

Studies of gadget use and physical activity in young people have produced mixed results. A strong association between gadget use and physical activity was reported among elementary school students in Sleman (Rayhan, 2026), and problematic smartphone use was negatively related to adequate physical activity among Korean adolescents (Jeong et al., 2023). In contrast, objectively measured smartphone screen time was not associated with physical activity among Swedish children and adolescents (Dahlgren, Sjöblom, Eke, Bonn, & Trolle Lagerros, 2021), nor was gadget use among senior high school students in Surabaya (Lesmana, Ridwan, & Prihanto, 2026). Studies in Indonesian junior high school students have generally treated gadget use as a single factor or related it to nutritional status (Nusi, Kadir, & Aulia, 2025), rather than examining

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it together with sleep quality as correlates of physical activity.

The novelty of this study lies in examining gadget use and sleep quality together, rather than separately, as correlates of physical activity among junior high school students, using an established adolescent physical activity questionnaire (PAQ-A) and a sleep quality measure adapted from the Pittsburgh Sleep Quality Index. To our knowledge, such evidence is scarce for Indonesian early adolescents and is not yet available for Magetan Regency. It matters for physical education (PE) teachers, who design learning that encourages students' active participation.

This study therefore aimed to analyze the relationship of (a) gadget use with physical activity, (b) sleep quality with physical activity, and (c) gadget use and sleep quality together with physical activity among students of SMP Negeri 1 Barat.

METHOD

This study used a quantitative, non-experimental, cross-sectional correlational design, in which the relationships among variables were examined without giving any treatment to the participants. It was carried out at SMP Negeri 1 Barat, Magetan Regency, East Java, Indonesia, in collaboration with the school as the partner institution. Data were collected on 24–25 September 2026.

The population was all seventh-grade students of SMP Negeri 1 Barat (256 students in eight classes). Four classes (VII-D, VII-E, VII-G, and VII-H) were selected using cluster random sampling. A total of 122 responses were received from the 128 students in these four classes (32 per class; response rate 95.3%). Three students completed the questionnaire twice, and only their first submission was analyzed, so the final sample was 119 students. This number exceeds the minimum of $N \geq 104 + m = 106$ recommended by Green (1991) for multiple regression with two predictors ($m = 2$).

Gadget use (X1) was measured with a questionnaire developed by the researchers on the basis of the literature. It contains five items rated on a 1–4 scale: daily duration of mobile phone use, playing on the phone in the hour before sleep, choosing the phone over playing or exercising outdoors, difficulty in stopping phone use, and active phone notifications during sleep. Total scores range from 5 to 20, with higher scores indicating higher gadget use. Because this is not a standardized instrument, its content was reviewed through expert judgment by the supervising lecturer before use, and its

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reliability and item validity were then tested using the study data.

Sleep quality (X2) was measured with a simplified questionnaire adapted from the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and modified for junior high school students. Five components were scored following the PSQI pattern: sleep duration (calculated from bedtime and wake-up time; > 7 hours = 0, 6–7 hours = 1, 5 to < 6 hours = 2, < 5 hours = 3), sleep latency (0–3), night-time awakenings (0–3), subjective sleep quality (0–3), and freshness on waking (0–2). Total scores range from 0 to 14, and higher scores indicate poorer sleep quality. The duration component follows the original PSQI cut-offs; because age-specific scoring has been proposed for adolescents (Sancho-Domingo, Carballo, Coloma-Carmona, & Buysse, 2024), an adolescent-oriented scoring was examined in a sensitivity analysis.

Physical activity (Y) was measured with the Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski, Crocker, & Donen, 2004), which assesses activity over the previous seven days. The Indonesian version was translated by the researchers and the supervising lecturer, and its reliability and item validity were tested using the study data. The final score is the mean of eight items (leisure-time activities, school breaks, physical education classes, after school, evenings, weekends, self-description of activity, and daily activity pattern) and ranges from 1 to 5; higher scores indicate higher physical activity. The leisure-time item is scored as the mean frequency of 16 activities, from 1 (never) to 5 (seven times or more). The item on barriers to activity is not scored.

The three instruments were combined into one Google Form and completed by students simultaneously on 24–25 September 2026. The study was conducted with the school's permission, and homeroom teachers or parents were notified through the seventh-grade PE teacher. Respondents' identities were kept confidential, no sensitive information was collected, and participation was voluntary. Before analysis, bedtimes written as 08.00–11.59 were interpreted as night-time (for example, 09.30 was read as 21.30). Three respondents with implausible bedtime–wake-up patterns (sleep duration of less than 3 hours) were excluded from the analyses involving sleep quality.

Analyses comprised descriptive statistics, reliability (Cronbach's alpha) and item validity (corrected item–total correlation), normality tests, a linearity test, and a multicollinearity test (variance inflation factor, VIF). Because X1 and X2 scores were not normally distributed, the relationships of X1 and X2 with Y were tested using Spearman's

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correlation, and the joint relationship was tested using multiple linear regression. The significance level was set at α = 0.05. All analyses were performed in IBM SPSS Statistics version 26. Sensitivity analyses repeated the regression (a) with sex and age added, (b) with sex, age, and class (as dummy variables) added, (c) after excluding three records with unusual but possible bedtime–wake-up patterns, and (d) with an alternative scoring of sleep duration suited to adolescents (≥ 8 hours = 0, 7 to < 8 hours = 1, 6 to < 7 hours = 2, < 6 hours = 3). The intraclass correlation coefficient (ICC) was used to describe differences among classes. Differences between boys and girls in the study variables were tested with Mann–Whitney *U* tests.

RESULT

The 119 respondents comprised 58 boys (48.7%) and 61 girls (51.3%) aged 12–14 years (*M* = 12.73, *SD* = 0.50). Table 1 compares boys and girls: they did not differ significantly in age, gadget use, sleep quality, or physical activity, although boys reported slightly longer sleep (7.80 vs. 7.44 hours, *p* = 0.039; exploratory, not adjusted for multiple comparisons). As shown in Figure 1, almost half of the students (48.7%) used a mobile phone for 2–4 hours per day, and the phone was most often used for study or assignments (42.0%), followed by social media (38.7%). Mean sleep duration was 7.61 hours (*SD* = 1.02, *n* = 116), and 70 students (60.3%) slept less than 8 hours per night.

Table 1. Characteristics of respondents by sex (*N* = 119)

Variable	All (*N* = 119)	Boys (*n* = 58)	Girls (*n* = 61)	*p*
Sample size, *n* (%)	119 (100)	58 (48.7)	61 (51.3)	–
Age (years)	12.73 (0.50)	12.74 (0.52)	12.71 (0.49)	0.770
Gadget use (X1)	9.76 (2.34)	9.41 (1.95)	10.10 (2.62)	0.162
Sleep quality (X2)†	3.27 (2.09)	2.89 (1.57)	3.61 (2.42)	0.183
Sleep duration (hours)	7.61 (1.02)	7.80 (1.07)	7.44 (0.95)	0.039
Physical activity, PAQ-A (Y)	3.36 (0.63)	3.44 (0.55)	3.28 (0.69)	0.160

Note. Values are *M* (*SD*) unless stated otherwise. *p*-values are from Mann–Whitney *U* tests and are not adjusted for multiple comparisons; the sleep-duration difference should be treated as exploratory. † Higher scores indicate poorer sleep quality (*n* = 116: 55 boys and 61 girls); sleep duration is based on the same 116 students.

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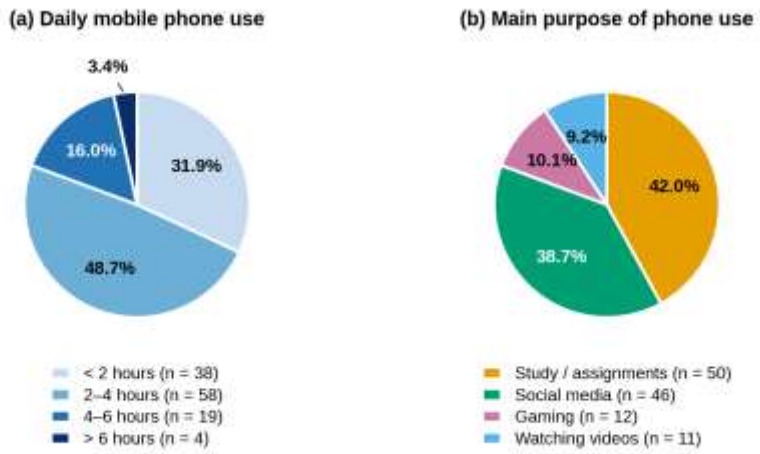


Figure 1. Distribution of respondents by daily mobile phone use (a) and main purpose of phone use (b) (N = 119).

Descriptive statistics and normality tests are presented in Table 2. Gadget-use and sleep-quality scores were not normally distributed ($p < 0.05$), whereas physical activity scores were ($p = 0.270$). The Kolmogorov–Smirnov test with Lilliefors correction led to the same conclusions (X1 and X2, $p < 0.001$; Y, $p = 0.200$). Cronbach's alpha was 0.582 for the gadget-use questionnaire (5 items), 0.626 for the sleep quality questionnaire (5 items), and 0.782 for the PAQ-A (8 items). All items had corrected item–total correlations between 0.280 and 0.614, above the critical r value (≈ 0.18; α = 0.05, n = 119), and were therefore considered valid. The reliability of the first two questionnaires was below the conventional 0.70 threshold (Nunnally & Bernstein, 1994), which should be taken into account when interpreting the results.

Table 2. Descriptive statistics and normality tests

Variable	*n*	Range	*M*	*SD*	Shapiro–Wilk *p*
Gadget use (X1)	119	5–17	9.76	2.34	0.005
Sleep quality (X2)†	116	0–10	3.27	2.09	< 0.001
Physical activity, PAQ-A (Y)	119	1.64–4.80	3.36	0.63	0.270

Note. †Higher X2 scores indicate poorer sleep quality.

The linearity test showed linear relationships (deviation from linearity: $p = 0.376$ for X1–Y and $p = 0.083$ for X2–Y). The VIF was 1.23 (tolerance = 0.813), indicating no multicollinearity. The regression residuals were normally distributed (Kolmogorov–Smirnov $p = 0.200$; Shapiro–Wilk $p = 0.852$), and the Durbin–Watson value was 1.55.

Spearman's correlations are presented in Table 3. Gadget use was negatively

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and significantly correlated with physical activity (ρ = −0.352, $p < 0.001$, $n = 119$), and poorer sleep quality was also negatively and significantly correlated with physical activity (ρ = −0.261, $p = 0.005$, $n = 116$). In other words, students with higher gadget use and poorer sleep quality tended to have lower physical activity scores. The two predictors were positively correlated with each other (ρ = 0.435, $p < 0.001$). The scatter plots are shown in Figure 2. By Cohen's (1988) conventions, the relationship of X1 with Y was of moderate size and that of X2 with Y was small to moderate.

Table 3. Spearman's correlations among variables

Relationship	*n*	ρ	*p*
Gadget use (X1) – Physical activity (Y)	119	−0.352	< 0.001
Sleep quality (X2) – Physical activity (Y)	116	−0.261	0.005
Gadget use (X1) – Sleep quality (X2)	116	0.435	< 0.001

Note. Pearson's correlations showed the same pattern (X1–Y $r = -0.354$; X2–Y $r = -0.288$). When X1–Y was computed with $n = 116$, ρ = −0.387.

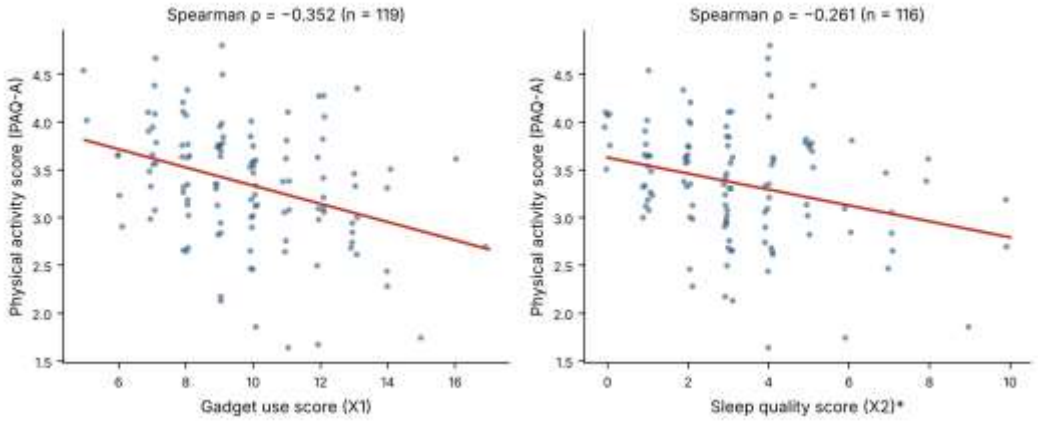


Figure 2. Scatter plots of gadget use (left; $n = 119$) and sleep quality (right; $n = 116$) against physical activity, with linear regression lines. *Higher scores indicate poorer sleep quality. Points are jittered slightly to reduce overlap.

Together, gadget use and sleep quality were significantly related to physical activity ($R = 0.411$, $R^2 = 0.169$, adjusted $R^2 = 0.154$, $F(2, 113) = 11.463$, $p < 0.001$); that is, the two variables jointly accounted for about 16.9% of the variance in physical activity scores. In the partial tests (Table 4), gadget use remained significant (β = −0.325, $p = 0.001$), whereas sleep quality was not significant after gadget use was controlled (β = −0.148, $p = 0.123$).

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Table 4. Multiple linear regression results (dependent variable: physical activity; *n* = 116)

Predictor	*B*	95% CI	*SE*	β	*t*	*p*
Constant	4.313	[3.872, 4.754]	0.223	–	19.380	< 0.001
Gadget use (X1)	−0.084	[−0.133, −0.035]	0.025	−0.325	−3.412	0.001
Sleep quality (X2)	−0.043	[−0.097, 0.012]	0.028	−0.148	−1.554	0.123

Note. $R = 0.411$; $R^2 = 0.169$; $F(2, 113) = 11.463$; $p < 0.001$. CI = confidence interval for *B*.

The main conclusion was robust in sensitivity analyses. With sex and age added to the model ($n = 116$), gadget use remained significant (β = −0.323, $p = 0.001$) and sleep quality did not (β = −0.131, $p = 0.175$); neither sex ($p = 0.517$) nor age ($p = 0.116$) was significant. Physical activity differed among classes (class means of 3.70, 3.21, 3.14, and 3.39 for VII-D, VII-E, VII-G, and VII-H; ICC = 0.12), and gadget use also showed some clustering (ICC = 0.11). When sex, age, and class were all included ($n = 115$; one respondent did not report a class), gadget use remained significant but weaker (β = −0.253, $p = 0.009$), and sleep quality remained non-significant (β = −0.104, $p = 0.264$). Excluding three records with unusual but possible bedtime–wake-up patterns changed the results little (gadget use $p = 0.001$; sleep quality $p = 0.112$; $R^2 = 0.163$). When sleep duration was scored with an adolescent-oriented cut-off (≥ 8 hours = 0; 7 to < 8 hours = 1; 6 to < 7 hours = 2; < 6 hours = 3), gadget use remained significant ($p < 0.001$), and sleep quality approached but did not reach significance (β = −0.180, $p = 0.054$). Among girls, gadget use and physical activity were correlated at ρ = −0.437 ($p < 0.001$, $n = 61$), and among boys at ρ = −0.180 ($p = 0.176$, $n = 58$); however, the sex × gadget-use interaction was not significant ($p = 0.622$).

DISCUSSION

The main finding of this study is that students who used gadgets more tended to be less physically active, and the relationship was of moderate size. This direction agrees with a study of elementary school students in Sleman (Rayhan, 2026) and with a large survey of Korean adolescents, in which problematic smartphone use was negatively associated with adequate physical activity (Jeong et al., 2023), although these studies used different indicators and contexts. A plausible explanation, which was not tested here, is that time spent on gadgets displaces time for movement. This is in line with national guidance for Indonesian adolescents, which advises limiting recreational screen time to a maximum of two hours per day (Kementerian Kesehatan Republik Indonesia,

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2026).

The evidence is not entirely consistent, however. Objectively measured smartphone screen time was not associated with physical activity among Swedish children and adolescents aged 10–15 years (Dahlgren et al., 2021), and a small study of senior high school students in Surabaya found no significant association between gadget use and physical activity (Lesmana et al., 2026). Differences in how gadget use and physical activity are measured (self-report or device-based), in sample size and age, and in the purposes for which gadgets are used may explain these differences. Gadget use for study or information-seeking, for example, may not reduce activity in the same way as passive entertainment, and the gadget-use score used here does not distinguish between these purposes.

Poorer sleep quality was also related to lower physical activity, with a somewhat weaker relationship that lay between small and moderate in size. This is consistent with studies in adolescents that link sleep and physical activity: a large survey of Norwegian adolescents found that longer sleep duration was associated with a higher likelihood of being physically active (Grasaas et al., 2024), and a scoping review reported that lower physical activity was associated with poorer sleep quality and shorter sleep in adolescents (Cruz et al., 2024). Because the cross-sectional design cannot establish direction, the relationship may run both ways: poor sleep may reduce energy and motivation to be active, and less active students may sleep less well.

Gadget use and sleep quality were themselves related, which fits reviews showing that overuse, problematic use, and pre-bedtime use of devices impair adolescents' sleep quality and duration (Dibben et al., 2023; Silva et al., 2022). A shared pathway is therefore plausible: part of the variation in physical activity associated with sleep quality may be carried by gadget use, which could explain why sleep quality was no longer significant once gadget use was considered. This interpretation is tentative because mediation was not tested. The finding for sleep quality was also sensitive to how sleep duration was scored. The duration component followed the original PSQI cut-offs, and age-specific scoring has been proposed for adolescents (Sancho-Domingo et al., 2024); with an adolescent-oriented scoring, the relationship came close to significance, so a small independent contribution of sleep quality cannot be ruled out. The modest reliability of the researcher-adapted sleep questionnaire may also have weakened its

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association.

The main finding for gadget use held after taking sex and age into account. Although studies elsewhere report lower physical activity among girls (Grasaas et al., 2024), boys and girls in this sample did not differ clearly in physical activity, gadget use, or sleep quality. The association between gadget use and physical activity appeared stronger among girls than boys, but this difference was not statistically supported and the subsamples were small, so no sex-specific conclusion is drawn. Classes also differed in physical activity, and the association was weaker, though still present, when class was taken into account, which suggests that part of it reflects differences among classes rather than among students within the same class. With only four classes, this interpretation is tentative.

For PE teachers and schools, the findings suggest that students' gadget habits deserve attention when promoting an active lifestyle, for example through education on screen-time management and sleep habits and through learning activities that encourage movement. This is advice drawn from an association, not from an intervention that has been tested.

Several limitations should be noted. First, the cross-sectional correlational design cannot establish cause and effect. Second, all data were self-reported by students and are therefore subject to recall bias and social desirability. Third, the reliability of the researcher-developed gadget-use questionnaire and the adapted sleep quality questionnaire was below the conventional threshold because they contain few items that cover varied aspects, so the results should be interpreted cautiously and the instruments refined in future research. Fourth, inconsistent bedtime entries were corrected manually, and three respondents were excluded from the sleep quality analyses. Fifth, the sample came from four seventh-grade classes in one school, which limits generalization. Sixth, students were clustered in classes that differed in physical activity, and the main analyses treated them as independent; four classes are too few for a reliable multilevel analysis. Seventh, the Indonesian version of the PAQ-A was translated by the researchers and the supervising lecturer rather than adopted from a previously validated version, so its validity in this population rests on the reliability and item analyses reported. Eighth, the sleep-duration scoring follows the original PSQI pattern, and an adolescent-oriented cut-off changed the result for sleep quality. Ninth, the analyses by sex were exploratory and

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based on small subsamples. In addition, few students used their phones for very long hours each day, so the findings may not apply to students with heavier gadget use.

CONCLUSION

This study concludes that higher gadget use and poorer sleep quality were each related to lower physical activity among students of SMP Negeri 1 Barat, and that gadget use was the more consistent correlate when the two were considered together. These findings are associations and do not show cause and effect. They are in line with previous research linking gadget use and poor sleep to lower activity in adolescents, although some studies have found no such association, which suggests that how and why gadgets are used may also matter.

PE teachers and schools can use these findings to educate students about screen-time management and sleep habits and to design learning that encourages movement. Future research should improve the reliability of the instruments, involve more schools, consider the type of activity and the school or class context, and use longitudinal designs or objective measures such as accelerometers.

REFERENCE

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cruz, J., Llodio, I., Iturricastillo, A., Yanci, J., Sánchez-Díaz, S., & Romaratezabala, E. (2024). Association of physical activity and/or diet with sleep quality and duration in adolescents: A scoping review. *Nutrients*, *16*(19), 3345. https://doi.org/10.3390/nu16193345

Dahlgren, A., Sjöblom, L., Eke, H., Bonn, S. E., & Trolle Lagerros, Y. (2021). Screen time and physical activity in children and adolescents aged 10–15 years. *PLOS ONE*, *16*(7), e0254255. https://doi.org/10.1371/journal.pone.0254255

Dibben, G. O., Martin, A., Shore, C. B., Johnstone, A., McMellon, C., Palmer, V., … Simpson, S. A. (2023). Adolescents' interactive electronic device use, sleep and mental health: A systematic review of prospective studies. *Journal of Sleep Research*, *32*(5), e13899. https://doi.org/10.1111/jsr.13899

https://doi.org/10.20884/1.paju.2026.8.2.23222
e-ISSN : 2686-5807 | p-ISSN : 2686-5793

Grasaas, E., Hysing, M., & Sandbakk, Ø. (2024). The relationship between sleep duration and physical activity level among Norwegian adolescents: A cross-sectional study. *Frontiers in Public Health*, *12*, 1495826. https://doi.org/10.3389/fpubh.2024.1495826

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research,* *26*(3), 499–510. https://doi.org/10.1207/s15327906mbr2603_7

Jeong, A., Ryu, S., Kim, S., Park, H.-K., Hwang, H.-S., & Park, K.-Y. (2023). Association between problematic smartphone use and physical activity among adolescents: A path analysis based on the 2020 Korea Youth Risk Behavior Web-based Survey. *Korean Journal of Family Medicine*, *44*(5), 268–273. https://doi.org/10.4082/kjfm.22.0154

Kementerian Kesehatan Republik Indonesia. (2026). *Panduan edukasi aktivitas fisik bagi tenaga medis dan tenaga kesehatan*. Jakarta, Indonesia: Author. Retrieved from https://kesprimkom.kemkes.go.id/assets/uploads/contents/others/Panduan_Edukasi_Aktivitas_Fisik.pdf

Kowalski, K. C., Crocker, P. R. E., & Donen, R. M. (2004). *The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) manual*. Saskatoon, Canada: University of Saskatchewan.

Lesmana, C., Ridwan, M., & Prihanto, J. B. (2026). Association between gadget use and physical activity among high school students: Evidence from a cross-sectional study. *Holistic Journal of Sport Education*, *6*(1), 90–103. https://doi.org/10.52434/penjas.v5i2.44102

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw-Hill.

Nusi, I., Kadir, S., & Aulia, U. (2025). Hubungan durasi penggunaan alat elektronik (gadget), aktivitas fisik dan pola makan dengan status gizi pada remaja di SMP Negeri 1 Kota Gorontalo. *Jurnal Kolaboratif Sains,* *8*(1), 377–389. https://doi.org/10.56338/jks.v8i1.6686

Prakosa, T. K. W., & Hartati, S. C. Y. (2022). Peningkatan kebugaran jasmani siswa melalui aktivitas fisik ringan dalam pembelajaran PJOK. *Riyadhoh: Jurnal Pendidikan Olahraga, 5*(2), 39–49. https://doi.org/10.31602/rjpo.v5i2.7818

Rayhan, M. (2026). Hubungan penggunaan gadget dengan aktivitas fisik pada peserta didik kelas atas SDN Sejati Kecamatan Moyudan Kabupaten Sleman. *Jurnal Pendidikan Dasar dan Aktifitas Jasmani,* *5*(1), 14–23. https://doi.org/10.21831/pendaki.v5i1.94986

Sancho-Domingo, C., Carballo, J. L., Coloma-Carmona, A., & Buysse, D. J. (2024). Psychometric adaptation of the Spanish version of the Brief Pittsburgh Sleep Quality

https://doi.org/10.20884/1.paju.2026.8.2.23222
e-ISSN : 2686-5807 | p-ISSN : 2686-5793

Index in adolescents. *Journal of Pediatric Psychology*, *49*(8), 596–604. https://doi.org/10.1093/jpepsy/jsae046

Silva, S. S., Silveira, M. A. C., Almeida, H. C. R., Nascimento, M. C. P., Santos, M. A. M., & Heimer, M. V. (2022). Use of digital screens by adolescents and association on sleep quality: A systematic review. *Cadernos de Saúde Pública*, *38*(10), e00300721. https://doi.org/10.1590/0102-311xen300721

Utari, S. A. N., & Indawati, E. (2025). Pengaruh intensitas penggunaan smartphone terhadap kualitas tidur remaja. *MAHESA: Malahayati Health Student Journal, 5*(4), 1432–1441. https://doi.org/10.33024/mahesa.v5i4.16962

World Health Organization Regional Office for South-East Asia. (2024). *Physical activity profile 2024: Indonesia* [Fact sheet]. Retrieved from https://cdn.who.int/media/docs/default-source/searo/pa-factsheet2024/pa-factsheet-_indonesia2024.pdf

Zhao, H. H., Wu, N., Haapala, E. A., & Gao, Y. (2024). Association between meeting 24-h movement guidelines and health in children and adolescents aged 5–17 years: A systematic review and meta-analysis. *Frontiers in Public Health*, *12*, 1351972. https://doi.org/10.3389/fpubh.2024.1351972

https://doi.org/10.20884/1.paju.2026.8.2.23222
e-ISSN : 2686-5807 | p-ISSN : 2686-5793