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E-HEALTH UTILIZATION TO SUPPORT SEDENTARY BEHAVIOR PREVENTION AMONG HIGH SCHOOL STUDENTS: A ONE-GROUP PRETEST–POSTTEST STUDY

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ABSTRACT

Background: Sedentary behavior and insufficient physical activity are important health concerns during adolescence. Digital health tools can provide self-monitoring and timely prompts that may help students become more active during school-day routines. Objective: To examine changes in physical activity after a short e-health intervention designed to support sedentary behavior prevention among high school students. Methods: A pre-experimental one-group pretest–posttest study was conducted in March–April 2026 at a senior high school in Tangerang City, Indonesia. Thirty-six grade XI students aged 15–18 years were selected using cluster sampling. The 10-day intervention combined daily step monitoring using Google Fit, snack-exercise reminders delivered through Google Classroom, and a digital activity log. Physical activity was assessed before and after the intervention using the Global Physical Activity Questionnaire (GPAQ). Because the available analytic dataset contained total physical activity expressed as MET-minutes/week, the primary outcome was change in physical activity rather than direct sedentary time. Results: Most participants were female (63.9%). During the intervention, 97.2% used both e-health features on 6–10 days. Mean physical activity increased from 1,927.78 to 3,079.44 MET-minutes/week; median values increased from 1,050 (IQR 525–2,135) to 1,980 (IQR 1,235–3,135). All 36 participants had positive ranks. The Wilcoxon signed-rank test showed a significant pre–post difference ($Z = -5.232$; $p < 0.001$). Conclusion: A 10-day e-health intervention combining step monitoring and snack-exercise reminders was followed by a significant increase in physical activity among high school students. The approach may support sedentary behavior prevention, but controlled studies with direct sedentary-time outcomes are needed to establish causal effectiveness.

Keywords: adolescent; e-health; physical activity; sedentary behavior; snack exercise

INTRODUCTION

Sedentary behavior is defined as any waking behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents (METs) while sitting, reclining, or lying. It is conceptually different from physical inactivity: an individual can meet physical activity recommendations and still accumulate prolonged sedentary time (Tremblay et al., 2017; World Health Organization, 2020). Among adolescents, extended classroom sitting, passive transportation, recreational screen use, gaming, and social media may contribute to a high daily sedentary burden.

Adolescence is a strategic period for prevention because health behaviors formed during these years can track into adulthood. The World Health Organization recommends that children and adolescents accumulate an average of at least 60 minutes/day of moderate-to-vigorous

physical activity and limit sedentary time, particularly recreational screen time (Bull et al., 2020; World Health Organization, 2020). In Indonesia, insufficient physical activity remains a population-level concern, and local studies have described substantial sedentary routines among adolescents, including prolonged sitting and screen-based activities (Maidartati et al., 2022; Rahayu & Kusuma, 2022; Ali, 2025).

Digital technology presents a paradox for adolescent health. Frequent device use can increase screen-based sitting, yet the same devices can deliver behavior-change interventions that are scalable, familiar, and accessible. E-health broadly refers to the use of information and communication technologies to support health, health services, and health-related behavior change (Eysenbach, 2001). For physical activity promotion, e-health approaches can include mobile applications, activity trackers, reminders, personalized feedback, goal setting, and web-based education.

Evidence supporting digital approaches is promising but heterogeneous. A systematic review and meta-analysis of school-based e-health interventions reported small short-term improvements in physical activity and screen time among adolescents, although sustained effects were uncertain (Champion et al., 2019). A more recent meta-analysis of mHealth app-based interventions in children and adolescents found improvements in total physical activity and reductions in sedentary behavior (Wang et al., 2024). The #LIFEGOALS intervention also showed beneficial effects on physical activity and sedentary behavior in early adolescents, while noting that non-use attrition and contextual factors can reduce intervention impact (Peuters et al., 2024). Conversely, the Health4Life cluster randomized trial found no significant advantage over usual school health education for several lifestyle outcomes at longer follow-up, emphasizing the importance of intervention timing, intensity, and engagement (O'Dean et al., 2024).

Brief movement strategies may be particularly suitable for the school context because time constraints and prolonged classroom sitting are common barriers to activity. "Exercise snacks" are short bouts of activity performed intermittently during the day and are increasingly studied as a time-efficient strategy to interrupt prolonged inactivity and improve fitness (Wang, Laher, & Li, 2025). Combining exercise-snack reminders with daily step self-monitoring could provide both a cue to act and immediate feedback on movement behavior. A school-based mobile application study among high school students has similarly shown that theory-informed digital education can improve physical activity (Ramezankhani et al., 2024).

Despite growing evidence, studies combining step monitoring and snack-exercise reminders for Indonesian high school students remain limited. Therefore, this study examined changes in physical activity after a 10-day e-health intervention consisting of step monitoring, snack-exercise reminders, and digital activity logging. The intervention was designed to support sedentary behavior prevention by encouraging students to move more frequently during daily routines.

RESEARCH METHODS

This study used a quantitative pre-experimental design with a one-group pretest–posttest approach. It was conducted from March to April 2026 at a senior high school in Tangerang City, Banten Province, Indonesia. The source population comprised 216 grade XI students distributed across six classes. Based on the confirmed study procedure, participants were selected using cluster sampling. The final sample consisted of 36 students, derived from a target of 30 participants with an additional 20% allowance for potential dropout.

Inclusion criteria were active grade XI enrollment, age 15–18 years, ownership of a smartphone with internet access, and willingness to participate. Students were excluded if they had a medical or physical condition limiting physical activity, lacked smartphone/internet access, or did not complete either the pretest or posttest. A brief health screening was completed before

the intervention. Because participants were minors, parental consent and student assent were obtained before participation.

The intervention lasted 10 consecutive days and consisted of three components: (1) daily step monitoring using Google Fit; (2) snack-exercise reminders delivered through Google Classroom; and (3) a digital activity log recording step counts and the number of snack-exercise sessions completed each day. Participants were instructed to perform brief snack-exercise sessions of approximately 4–5 minutes, up to five sessions per day. The step counter and reminder functions were monitored as indicators of e-health engagement.

Physical activity was measured at pretest and posttest using the Global Physical Activity Questionnaire (GPAQ), a 16-item instrument developed for population surveillance and evaluated for reliability and validity across multiple countries (Bull, Maslin, & Armstrong, 2009). GPAQ captures physical activity across work/school, transport, and leisure domains and also includes a sedentary-time item. In the dataset available for this study, the pretest and posttest analytic scores were total physical activity expressed as MET-minutes/week. Therefore, the main analysis in this paper focuses on change in physical activity as a behavioral pathway supporting sedentary behavior prevention; direct sedentary time in minutes/day was not analyzed separately.

Additional measures included sex, snack-exercise frequency over 10 days, mean step-score category, and frequency of use of the step-counting and exercise-reminder features. Data management included checking completeness, coding, entry, and cleaning before analysis. Descriptive statistics were presented as frequencies and percentages for categorical variables and as mean, standard deviation, median, interquartile range, and minimum–maximum values for continuous physical-activity scores. Shapiro–Wilk testing indicated non-normal pretest and posttest distributions ($p < 0.001$), so the Wilcoxon signed-rank test was used to compare paired pretest and posttest values. Statistical significance was set at $\alpha = 0.05$.

The research received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Banten (Ethical Approval No. DP.03.04/F.XXII.25/00166/2026, dated March 13, 2026). Participant confidentiality was maintained through coded identifiers and restricted access to research data.

RESEARCH RESULTS

All 36 students included in the study completed the pretest, 10-day intervention, and posttest and were included in the analysis. Participant characteristics and intervention engagement are summarized in Table 1.

Table 1. Participant characteristics and intervention engagement (n = 36)

Variable	Category	n	%
Sex	Male	13	36.1
	Female	23	63.9
Snack-exercise frequency (10 days)	11–20 sessions	24	66.7
	21–30 sessions	12	33.3
Mean step-score category	Very low (1.00–1.75)	15	41.7
	Low (>1.75–2.50)	19	52.8
	Sufficient (>2.50–3.25)	2	5.6
	Good (>3.25–4.00)	0	0.0
Step-counter use	0–5 days	1	2.8

Variable	Category	n	%
	6–10 days	35	97.2
Exercise-reminder use	0–5 days	1	2.8
	6–10 days	35	97.2

The majority of participants were female (63.9%). Two-thirds completed 11–20 snack-exercise sessions during the 10-day intervention. Most students were categorized as having a low mean step score (52.8%), while 41.7% were in the very-low category. Engagement with the digital tools was high: 97.2% used both the step-counter and exercise-reminder features on 6–10 days.

Table 2. Physical activity before and after the e-health intervention (n = 36)

Measurement	Mean	SD	Median	IQR	Min–Max
Pretest	1,927.78	2,262.44	1,050	525–2,135	120–10,320
Posttest	3,079.44	3,059.01	1,980	1,235–3,135	420–13,920
Change	1,151.66	982.60	790	420–1,615	140–3,600

Physical activity increased after the intervention. The mean increase was 1,151.66 MET-minutes/week, and the median paired increase was 790 MET-minutes/week. Because the distributions were skewed, the inferential analysis used the Wilcoxon signed-rank test.

Table 3. Wilcoxon signed-rank test for pretest–posttest physical activity

Rank	n	Mean rank	Sum of ranks	Z	p-value
Negative ranks	0	0.00	0.00		
Positive ranks	36	18.50	666.00	−5.232	<0.001
Ties	0				

All participants had higher posttest scores than pretest scores, with no negative ranks or ties. The Wilcoxon signed-rank test demonstrated a statistically significant pretest–posttest difference ($Z = -5.232$; $p < 0.001$).

DISCUSSION

The principal finding of this study was a substantial within-person increase in physical activity after a 10-day e-health intervention that combined daily step monitoring, snack-exercise reminders, and digital activity logging. Mean total physical activity increased by 1,151.66 MET-minutes/week, and all 36 participants showed positive ranks. The short-term change is encouraging because the intervention used tools that are familiar to adolescents and can be integrated into routine school life. Nevertheless, the one-group pretest–posttest design does not allow the observed improvement to be attributed exclusively to the intervention.

The direction of the findings is consistent with broader evidence on digital interventions for youth. Wang et al. (2024) synthesized 28 randomized controlled trials and reported that mHealth app-based interventions increased total physical activity and reduced sedentary behavior in children and adolescents. Champion et al. (2019) similarly found that school-based e-health interventions could produce small immediate improvements in physical activity and screen time, although longer-term maintenance was uncertain. The present study adds a short, pragmatic school-based example in which step self-monitoring and movement prompts were combined.

The results are also comparable with individual adolescent studies. Peuters et al. (2024) found beneficial effects of the #LIFEGOALS mHealth intervention on physical activity and sedentary behavior in adolescents aged 12–15 years, but also documented substantial early non-

use attrition. In the present study, 97.2% of participants used the step-counter and reminder features on 6–10 intervention days, suggesting high short-term digital engagement. Ramezankhani et al. (2024), using a theoretically designed mobile application among high school girls, also reported improvements in physical activity, reinforcing the relevance of mobile delivery in the school setting.

However, digital health interventions are not uniformly effective. In the Health4Life cluster randomized controlled trial, an e-health school intervention was not more effective than usual health education for several lifestyle risk outcomes over 24 months (O'Dean et al., 2024). This contrast is important. It suggests that short-term engagement, intervention intensity, target behavior specificity, and contextual fit may influence outcomes, and that early improvement does not guarantee sustained behavior change. A 2026 systematic review likewise emphasized that adolescent digital-health effectiveness depends not only on technology but also on engagement, tailoring, developmental appropriateness, and equitable access (Kang et al., 2026).

Two behavior-change processes may help explain the observed pattern, although they were not measured directly in this study. First, step monitoring provides immediate self-observation and feedback. Second, snack-exercise reminders act as prompts that can interrupt prolonged sitting and lower the practical barrier to initiating movement. These mechanisms are compatible with self-efficacy and cue-to-action concepts commonly used in health behavior theory. Sabooteh et al. (2021) demonstrated that e-health education grounded in a health-promotion model could improve students' physical activity, supporting the value of combining digital tools with an explicit behavioral framework.

Snack exercise may be particularly useful for students because it requires little time and can be inserted between periods of sitting. Wang, Laher, and Li (2025) described exercise snacks as a time-efficient strategy with potential to improve physical fitness in sedentary populations. In a school context, these brief bouts should be viewed as a complement to—not a replacement for—the World Health Organization recommendation of an average of at least 60 minutes/day of moderate-to-vigorous physical activity for children and adolescents (World Health Organization, 2020).

An important observation in the present study is that high app use did not automatically translate into high step scores: 94.5% of participants remained in the very-low or low mean step-score categories during the intervention. This finding suggests a distinction between digital engagement and sufficient physical activity. Future programs may need to strengthen personalized goal setting, progress feedback, peer or teacher support, and environmental opportunities for movement rather than relying on reminders alone.

This study has several limitations. First, there was no control group, so history, maturation, testing effects, and other concurrent influences cannot be ruled out. Second, the intervention lasted only 10 days and therefore does not establish maintenance. Third, participants came from a single selected school cluster, limiting generalizability. Fourth, device type and school-day conditions were not fully standardized. Fifth, although the thesis was framed around sedentary behavior prevention, the available pretest–posttest analytic dataset consisted of GPAQ total physical activity in MET-minutes/week; direct sedentary time was not analyzed. Therefore, this paper appropriately interprets the findings as increased physical activity that may support sedentary behavior prevention, rather than as direct evidence of reduced sedentary time.

Future studies should use a controlled or cluster-randomized design, longer follow-up, and direct sedentary-time outcomes. Device-based measures such as accelerometry could complement questionnaire data, while process measures of engagement, self-efficacy, goal attainment, and contextual barriers could clarify how and for whom e-health interventions work. These improvements would strengthen both causal inference and implementation relevance for school health programs.

CONCLUSION

A 10-day e-health intervention using step monitoring, snack-exercise reminders, and digital activity logging was followed by a statistically significant increase in total physical activity among 36 high school students ($Z = -5.232$; $p < 0.001$). Digital engagement was high, indicating good short-term acceptability. The intervention may be a practical school-health strategy for encouraging more active daily routines and supporting sedentary behavior prevention. Because the study lacked a control group and did not separately analyze direct sedentary time, the findings should not be interpreted as definitive causal evidence of reduced sedentary behavior. Controlled studies with longer follow-up and specific sedentary-time measurement are warranted.

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