

Effects of Daily Classroom Physical Activity Breaks on Mental Fatigue and Cognitive Performance in School-Age Students

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Article Info	Abstract
Article type: Research Article Article history: Received 24 March 2026 Received in revised form 27 May 2026 Accepted 10 June 2026 Available online 29 June 2026 Keywords: Exercise, Mental Fatigue, Cognition, Schools, Social Environment.	Introduction: Prolonged sedentary behavior during classroom instruction has been associated with increased mental fatigue (MF) and reduced cognitive performance among school-age students. Brief, structured classroom physical activity (PA) breaks have emerged as a potentially effective approach to enhance cognitive functioning by promoting physiological arousal and reducing cognitive fatigue; however, evidence regarding their sustained effects over several weeks remains limited. Objective: To evaluate the effects of daily classroom PA breaks on MF and cognitive performance in school-age students. Method: A quasi-experimental study was conducted with 120 students (ages 8–12 years) assigned to an intervention group (daily 5–10 minutes activity breaks; $n=60$) or a control group (standard classroom routines; $n=60$). The Pediatric Mental Fatigue Scale, Digit Span Task, and Flanker Task were administered to assess the study variables at baseline and following the four-week intervention. ANCOVA was used for data analysis. Results: The intervention group showed significantly lower levels of MF than those in the control group (19.0 ± 4.6 vs. 23.3 ± 5.0; $F(1,114)=37.8$, $p<0.001$, $\eta^2=0.25$). Adjusted cognitive performance scores were also significantly higher in the intervention group (88.8 ± 8.2 vs. 84.0 ± 8.8; $F(1,114)=28.6$, $p<0.001$, $\eta^2=0.20$). Conclusions: Brief daily classroom PA breaks may reduce MF and support improvements in cognitive performance among school-age students. Although longer-term studies are warranted, structured movement opportunities appear to represent a feasible strategy for promoting cognitive engagement within primary school classrooms. Cite this Article: Golzadeh, F. (2026). Effects of Daily Classroom Physical Activity Breaks on Mental Fatigue and Cognitive Performance in School-Age Students. <i>Physical Activity in Children</i>, 3(1), 43–48. https://doi.org/10.22034/pach.2026.582420.1087

1. Introduction

Classroom learning constitutes a substantial proportion of children's daily educational experience; however, prolonged sedentary behavior during classroom instruction has increasingly been recognized as a potential contributor to cognitive fatigue and diminished academic functioning (1). Mental fatigue (MF) refers to a psychobiological condition that may emerge after sustained engagement in cognitively demanding activities and is typically reflected in diminished alertness and reduced cognitive efficiency. In school-age children, this condition has been linked to difficulties in executive functioning, working memory, attentional processes, and academic achievement (2). As academic curricula become progressively more demanding, many students experience extended periods of uninterrupted sitting, which may reduce their ability to sustain attention and maintain optimal cognitive performance throughout the school day (3). Consequently, identifying practical, low-cost classroom strategies that help maintain students' cognitive readiness has become an important priority for both educational researchers and practitioners.

One promising strategy involves integrating brief classroom physical activity (PA) breaks, defined as short bouts of structured movement incorporated into regular classroom instruction without substantially interrupting academic teaching (4). Previous research suggests that these activities may improve cerebral blood flow, increase physiological arousal, and stimulate neurochemical processes associated with attention and executive functioning (5,6). Regular PA has consistently been associated with improvements in working memory, inhibitory control, cognitive flexibility, and academic achievement among children (7,8). Unlike traditional physical education lessons, classroom activity breaks require minimal equipment, can be implemented within existing instructional schedules, and may provide repeated opportunities to interrupt prolonged sedentary behavior throughout the school day (9).

The present study is primarily grounded in neurocognitive theories of physiological arousal and cognitive restoration. According to these frameworks, prolonged sedentary classroom activities may gradually reduce cognitive efficiency through sustained mental effort and declining physiological activation. In contrast, brief periods of moderate PA

may restore optimal levels of cortical arousal, increase cerebral blood flow, enhance glucose and oxygen delivery to the brain, and stimulate neurotransmitter systems, including dopamine and norepinephrine, that support executive functioning and attentional control (10–13). These underlying neurophysiological processes may help explain how even brief bouts of movement can alleviate MF while supporting cognitive performance in the classroom setting.

Although ecological and motivational perspectives may further explain students' responses to classroom movement opportunities, these frameworks are considered complementary rather than primary explanatory models in the present study. From an ecological perspective, modifying the classroom environment by incorporating opportunities for movement may create environmental affordances that facilitate attention, engagement, and learning (14–16). Likewise, Self-Determination Theory proposes that enjoyable movement experiences may satisfy students' basic psychological needs, thereby promoting intrinsic motivation and sustained engagement with classroom activities (17–22). Together, these perspectives support the broader educational value of classroom PA while complementing the neurocognitive mechanisms underlying the present investigation.

Although classroom-based PA interventions have attracted increasing research attention, several important knowledge gaps remain. Most previous studies have primarily examined either attention, academic achievement, or general cognitive function, while comparatively few have simultaneously investigated both subjective MF and objectively assessed cognitive performance within the same intervention (5,6). Furthermore, many investigations have focused on the immediate effects of a single activity session, providing limited evidence regarding the cumulative benefits of repeated daily activity breaks over multiple weeks. Moreover, relatively few studies have combined validated measures of MF, such as the Pediatric Mental Fatigue Scale (PMFS), with standardized neurocognitive assessments of executive functioning, thereby limiting understanding of how perceived fatigue and objective cognitive performance change concurrently following classroom-based movement interventions.

Accordingly, the present cluster-randomized controlled trial sought to examine whether implementing brief daily classroom PA breaks over a four-week period was associated with changes in both MF and cognitive performance among school-age students. By simultaneously evaluating subjective and objective cognitive outcomes within a school-based intervention, the present work further develops earlier research and provides a more comprehensive understanding of the potential educational benefits of structured classroom movement. It was hypothesized that students participating in daily PA breaks would report lower levels of MF and demonstrate superior cognitive performance compared with students receiving usual classroom instruction.

2. Methods

2.1. Study Design and Participants

This study employed a quasi-experimental, pre-post

design. A total of 120 school-age students (ages 8–12 years) from three public primary schools were recruited for the study. Inclusion criteria required that students be enrolled in grades 3–6, have no medical conditions restricting participation in PA, and possess normal or corrected-to-normal vision and hearing. Students were excluded if they had recent musculoskeletal injuries, diagnosed neurological or psychological disorders, or were unable to participate in classroom activities. Participants were randomly assigned by class to either the intervention group ($n = 60$) or the control group ($n = 60$). Within each participating school, eligible classrooms were first identified by school administrators. Classrooms with comparable grade levels and schedules were then randomly allocated to either the intervention or control condition using a computer-generated randomization sequence created by an investigator who was not involved in recruitment or outcome assessment. Allocation was performed at the classroom level to minimize contamination between students. Baseline demographic characteristics were compared between groups to confirm equivalence prior to the intervention. To further reduce contamination, intervention and control classrooms followed different daily schedules whenever possible, teachers were instructed not to share intervention materials with colleagues assigned to the control condition, and outcome assessments were completed before students from different groups interacted following the intervention period. Written parental consent and child assent were obtained prior to participation, and ethical approval was granted by the Institutional Review Board in accordance with the Declaration of Helsinki.

2.2. Intervention: Daily Classroom Physical Activity Breaks

Students assigned to the intervention participated in one structured classroom PA break each school day for four consecutive weeks. Each session lasted between 5 and 10 minutes and followed a standardized protocol consisting of three phases:

- Warm-up (1–2 minutes): light stretching and mobility exercises
- Moderate-intensity movement phase (3–6 minutes): jumping jacks, marching or jogging in place, dynamic balance exercises, coordinated stepping patterns, body-weight squats, and movement games requiring attention and bilateral coordination
- Cool-down (1–2 minutes): breathing exercises and light stretching

Exercise intensity was maintained at approximately moderate intensity (estimated 50–70% of age-predicted maximal heart rate) using children's ratings of perceived exertion and teacher observation. Activities were designed to be performed safely within standard classroom space without specialized equipment. Teachers attended a 2-hour training workshop before the intervention covering standardized activity delivery, safety procedures, progression, classroom management, and fidelity monitoring. Progression was introduced weekly by gradually increasing movement complexity and coordination demands while maintaining similar exercise duration. The control

classrooms continued their usual academic curriculum without structured PA breaks.

2.3. Measurements

2.3.1. Mental Fatigue

MF was measured using the Pediatric Mental Fatigue Scale (PMFS), a validated self-report questionnaire assessing cognitive exhaustion, difficulty concentrating, and mental tiredness. Students completed the scale before and after the intervention period, with higher scores indicating greater MF. In the present sample, the PMFS demonstrated excellent internal consistency (Cronbach's $\alpha = 0.88$).

2.3.2. Cognitive Performance

Cognitive performance was assessed using two standardized, age-appropriate tests:

1. **Digit Span Task (Forward and Backward):** measuring working memory and attention.
2. **Flanker Task:** measuring inhibitory control and selective attention.

Assessments were conducted in quiet classroom settings by trained research assistants. Pre-test scores were collected one week prior to the intervention, and post-test scores were collected immediately after the 4-week intervention. To obtain an overall index of cognitive performance, raw scores from the Digit Span and Flanker tasks were first converted into standardized z-scores and subsequently averaged to generate a composite cognitive performance score. Standardization was performed because the two tasks were measured on different numerical scales. Previous cognitive research has demonstrated that working memory and inhibitory control represent complementary executive functions and can be summarized into a global executive functioning index. Before creating the composite score, the correlation between the standardized task scores was examined ($r = 0.61$, $p < 0.001$), supporting their combination into a single composite indicator.

2.3.3. Covariates

Age, sex, and body mass index (BMI) were included as covariates because these variables may influence both PA participation and cognitive outcomes. Baseline PA level, socioeconomic status, previous academic achievement, and teacher instructional style were not available for statistical adjustment and are therefore

acknowledged as potential confounding variables in the interpretation of the findings.

2.4. Procedure

Baseline assessments of MF and cognitive performance were conducted in all participating classrooms prior to the intervention. During the four-week intervention period, classrooms assigned to the intervention group implemented daily PA breaks, while control classrooms continued with standard sedentary instruction. Compliance and fidelity were monitored through teacher logs and weekly observations by research staff to ensure consistent implementation. Following the four-week period, post-intervention assessments of MF and cognitive performance were conducted using the same standardized measures administered at baseline.

2.5. Data Analysis

All statistical analyses were performed in IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Participant characteristics and baseline variables were initially summarized using means and standard deviations. Baseline comparability between the two groups was then examined using independent-samples t-tests. The internal consistency of the instruments was assessed using Cronbach's alpha. Within-group changes from pre-intervention to post-intervention were examined using paired-samples t-tests. Between-group differences in post-intervention were subsequently evaluated using analysis of covariance (ANCOVA), with baseline scores, age, sex, and BMI entered as covariates. The assumptions underlying ANCOVA, including normality, equality of variances, linearity, and homogeneity of regression slopes, were assessed before the analyses and were adequately met. Cohen's d was calculated to estimate the magnitude of the observed between-group differences. Statistical tests were interpreted using a two-sided significance threshold of $p < .05$.

3. Results

3.1. Participant Demographics

The mean age of the sample was 10.1 ± 1.2 years, with a balanced distribution of boys ($n = 62$) and girls ($n = 58$). Baseline characteristics did not differ significantly between groups (all $p > 0.05$), indicating satisfactory baseline equivalence (Table 1).

Table 1. Baseline Participant Characteristics.

Variable	Intervention	Control	p
Age (years), Mean $\pm$ SD	10.2 $\pm$ 1.1	10.0 $\pm$ 1.3	0.43
Boys, n (%)	31 (51.7)	31 (51.7)	1.00
BMI (kg/m ²), Mean $\pm$ SD	18.9 $\pm$ 2.7	19.1 $\pm$ 2.9	0.67
Mental Fatigue, Mean $\pm$ SD	24.3 $\pm$ 5.2	23.8 $\pm$ 5.0	0.59
Cognitive Performance, Mean $\pm$ SD	82.5 $\pm$ 9.1	83.1 $\pm$ 8.8	0.67

3.2. Descriptive Statistics

Pre- and post-intervention scores for MF and cognitive performance are presented in Table 2 and Figure 1. Students in the intervention group demonstrated a reduction in MF and an improvement

in cognitive performance following the four-week intervention, whereas only minimal changes were observed in the control group.

Table 2. Pre- and Post-Intervention Mental Fatigue and Cognitive Performance.

Measure	Intervention-Pre	Intervention-Post	Control-Pre	Control-Post
Mental Fatigue	24.3 $\pm$ 5.2	19.1 $\pm$ 4.7	23.8 $\pm$ 5.0	23.2 $\pm$ 5.1
Cognitive Performance	82.5 $\pm$ 9.1	88.7 $\pm$ 8.3	83.1 $\pm$ 8.8	84.0 $\pm$ 8.9

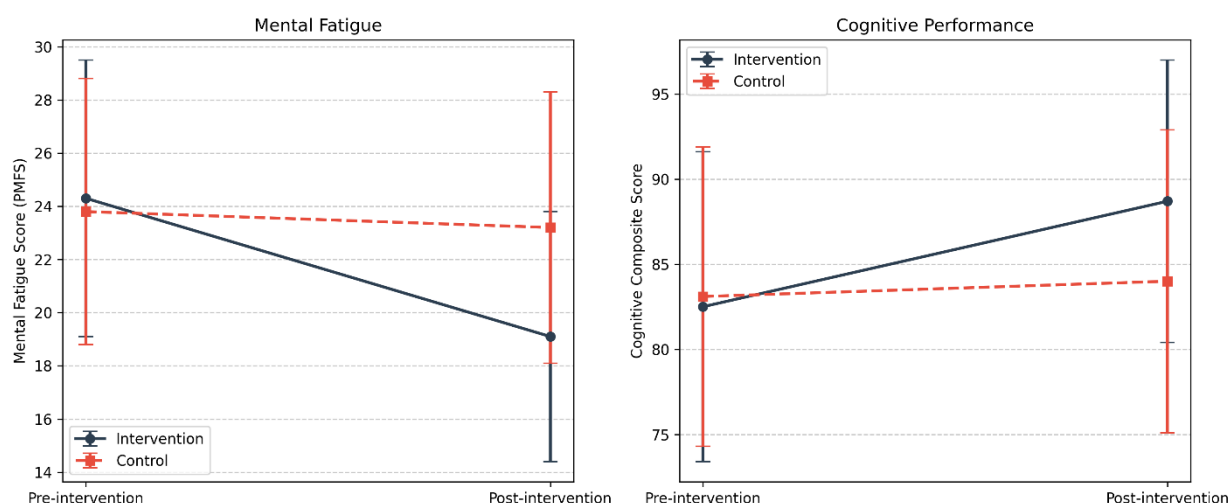


Figure 1. Group Differences in Study Variables following the Intervention.

3.3. Baseline Equivalence

Baseline equivalence was observed across the two groups, as neither MF nor cognitive composite performance differed significantly before the intervention (MF: $t(118) = 0.54$, $p = 0.59$; cognitive performance: $t(118) = -0.43$, $p = 0.67$).

3.4. Effects of Classroom Activity Breaks

3.4.1. Mental Fatigue

Students in the intervention group experienced a significant reduction in MF after four weeks (24.3 ± 5.2 to 19.1 ± 4.7 ; $t(59) = 8.45$, $p < 0.001$, Cohen's $d = 1.09$). No significant change was detected among students in the control condition (23.8 ± 5.0 to 23.2 ± 5.1 ; $t(59) = 1.02$, $p = 0.31$).

3.4.2. Cognitive Performance

The intervention group demonstrated a significant improvement in cognitive performance (82.5 ± 9.1 to

88.7 ± 8.3 ; $t(59) = 7.21$, $p < 0.001$, Cohen's $d = 0.93$). Conversely, the control group exhibited only a small, non-significant increase (83.1 ± 8.8 to 84.0 ± 8.9 ; $t(59) = 1.05$, $p = 0.30$).

3.5. Between-Group Comparisons

The ANCOVA revealed a significant group effect for MF ($F(1,114) = 37.80$, $p < 0.001$, partial $\eta^2 = 0.25$), indicating that students who participated in the classroom PA breaks reported significantly lower MF than students in the control group. Similarly, ANCOVA demonstrated a significant group effect for cognitive performance ($F(1,114) = 28.60$, $p < 0.001$, partial $\eta^2 = 0.20$), indicating significantly higher post-intervention cognitive performance in the intervention group after adjustment for baseline scores and demographic covariates. According to conventional benchmarks, both partial η^2 values indicate large intervention effects. Table 3 summarizes the adjusted post-intervention comparisons.

Table 3. Post-Intervention ANCOVA Results.

Outcome	F	p	Partial η^2	Group Mean $\pm$ SD (Adjusted)
Mental Fatigue	37.8	<0.001	0.25	Intervention: 19.0 ± 4.6 Control: 23.3 ± 5.0
Cognitive Performance	28.6	<0.001	0.20	Intervention: 88.8 ± 8.2 Control: 84.0 ± 8.8

4. Discussion

This research examined the impact of daily PA breaks in the classroom on MF and cognitive performance among school-age children. The principal findings indicate that students who participated in brief daily movement sessions demonstrated lower levels of MF and higher cognitive performance than students who followed usual classroom routines. Although the study design does not permit definitive causal inference, the findings suggest that integrating structured movement opportunities into classroom instruction may contribute to improved cognitive functioning during the school day.

The primary mechanism underlying these findings is likely related to physiological arousal and cognitive restoration. Brief bouts of moderate PA are known to increase cerebral blood flow, enhance oxygen delivery, and stimulate the release of neurotransmitters such as dopamine and norepinephrine, which play important

roles in attention, executive functioning, and cognitive alertness (13,14). Rather than viewing classroom activity breaks solely as opportunities for exercise, the present findings support the concept that strategically interrupting prolonged sedentary behavior may help restore cognitive resources that gradually decline during sustained classroom learning.

The reduction in MF observed in the intervention group is consistent with previous studies reporting that brief classroom movement breaks improve attention and reduce cognitive exhaustion in children (23–26). From a developmental perspective, school-age children possess limited capacity for prolonged sustained attention, making periodic cognitive recovery particularly important during classroom instruction. Likewise, the ecological framework suggests that modifying the classroom environment by introducing opportunities for movement changes the interaction between students and their learning environment, thereby creating conditions that may

facilitate sustained engagement (15–19). Although motivational processes described by Self-Determination Theory may also contribute through increased enjoyment and perceived competence, the present findings suggest that physiological restoration represents the primary explanatory pathway.

The observed improvement in cognitive performance further supports previous evidence demonstrating beneficial effects of moderate PA on executive functions, including working memory, inhibitory control, and attentional regulation (7,8,27). Because the cognitive composite score combined measures of working memory (Digit Span) and inhibitory control (Flanker Task), the results suggest improvements across multiple domains of executive functioning rather than enhancement of a single cognitive ability. This broader pattern is consistent with neurodevelopmental models proposing that brief PA activates neural networks within the prefrontal cortex responsible for executive control and information processing (13,28).

An important contribution of the present study lies in simultaneously examining perceived MF and objective cognitive performance following repeated classroom activity breaks. While previous studies have frequently focused on either attention, academic performance, or physical health outcomes, relatively few investigations have evaluated both subjective and objective indicators of cognitive functioning within the same intervention. Furthermore, by implementing activity breaks daily over four weeks rather than examining only immediate post-exercise responses, this study provides additional evidence regarding the short-term educational feasibility of integrating movement into routine classroom practice.

The observed effect sizes were relatively large. Although these findings indicate potentially meaningful educational benefits, they should be interpreted cautiously. School-based interventions are influenced by numerous contextual factors, including teacher enthusiasm, classroom climate, peer interactions, and school culture, all of which may contribute to intervention effectiveness. Consequently, the magnitude of the observed effects should not be interpreted as solely reflecting the influence of the PA program itself.

From a practical perspective, the findings suggest that daily classroom activity breaks represent a feasible and low-cost strategy that can be incorporated into routine teaching without substantial disruption of instructional time. Short sessions lasting only 5–10 minutes required no specialized equipment and were easily implemented by classroom teachers following standardized training. Rather than replacing academic instruction, these movement breaks may complement existing teaching practices by helping students maintain attention and reduce cognitive fatigue during prolonged classroom learning.

The present study possesses several strengths. Standardized intervention procedures were implemented across classrooms, validated instruments were used to assess both subjective and objective outcomes, intervention fidelity was monitored throughout the study, and important demographic variables were statistically controlled using ANCOVA. These methodological features increase confidence in the internal consistency of the findings.

Nevertheless, several limitations should be acknowledged. First, although classrooms rather than individual students were allocated to study groups to

minimize contamination, statistical analyses were conducted at the individual level, and potential classroom-level clustering cannot be entirely excluded. Second, the intervention lasted only four weeks; therefore, the long-term sustainability of the observed improvements remains unknown. Third, MF was assessed using self-report measures, which may be influenced by response bias. Fourth, outcome assessors could not be fully blinded to study timing, and teacher characteristics may have influenced implementation quality. Finally, baseline PA levels, socioeconomic status, previous academic achievement, and classroom instructional practices were not included as covariates and therefore remain potential sources of residual confounding.

Future research should employ larger cluster-randomized trials involving multiple schools, longer intervention periods, and extended follow-up assessments to determine whether the observed improvements are maintained over time. Incorporating objective indicators of PA (e.g., accelerometry), cognitive function, and physiological arousal would further strengthen understanding of the mechanisms through which classroom movement influences learning. Additionally, future studies should investigate whether intervention effects differ according to age, sex, academic achievement, or baseline PA levels.

4.1. Conclusion

This quasi-experimental study suggests that incorporating brief daily classroom PA breaks may be associated with reduced MF and improved cognitive performance among school-age students. After controlling for baseline scores, age, sex, and BMI using ANCOVA, students who participated in the four-week intervention demonstrated lower levels of MF and higher cognitive performance than those who followed standard classroom routines. These findings provide preliminary evidence that integrating short, structured movement opportunities into the classroom may represent a feasible and low-cost strategy for supporting students' cognitive functioning during the school day. However, because of the quasi-experimental design, classroom-level allocation, relatively short intervention period, and absence of long-term follow-up, the findings should be interpreted with appropriate caution and should not be considered definitive evidence of causal effects.

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Ethical Considerations: The research was conducted in accordance with the ethical principles established in the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all participating students before their inclusion in the study. The students were given an age-appropriate explanation of the study and participated voluntarily.

Data Availability: The study data are available from the corresponding author upon reasonable request, subject to relevant ethical, privacy, and confidentiality considerations.

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Conflicts of Interest: The author declares that there are no financial, personal, or professional conflicts of interest associated with this study.

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