

Article

Beyond the Desk: Effects of the BALA+ Classroom-Based Intervention on Primary School Children

Adrián Belenguer-Troya ¹, Sergio Montalt-García ¹, María Mercedes Bisquert-Martínez ², Cristina Menescardi ¹ and Isaac Estevan ^{1,*}

¹ AFIPS Research Group, Faculty of Teacher Training, Department of Teaching of Physical Education, Arts and Music, University of Valencia, Avinguda dels Tarongers, 4, 46022 Valencia, Spain; ep.adrianbelenguer@lasalleuv.es (A.B.-T.); sergio.montalt@uv.es (S.M.-G.); cristina.menescardi@uv.es (C.M.)

² Faculty of Philosophy and Educational Sciences, Department of Research Methods and Diagnostic in Education, University of Valencia, 46010 Valencia, Spain; m.mercedes.bisquert@uv.es

* Correspondence: isaac.estevan@uv.es; Tel.: +34-963983210

Abstract

This study examined the effects of the BALA+ intervention, using a non-randomized, quasi-experimental controlled design with repeated measures on physical, motivational, and psychological outcomes among 100 fifth-grade students assessed at three time points: pre-test, post-test, and retention. The intervention (January–April 2023) integrated movement into the curriculum through active breaks, physically active learning, and manipulative activities, and was structured to provide daily opportunities for movement integration aligned with a 60 min of moderate-to-vigorous physical activity target; however, student's actual activity intensity and accumulated duration were not objectively monitored. Participants aged 9–11 years were recruited from two state-subsidized schools and voluntarily participated in the study. Group assignment was established at the school level, without individual randomization. The control group followed a traditional teacher-centered methodology. Repeated-measures ANOVA analyses revealed significant improvements in the experimental group for physical fitness ($\eta^2_p = 0.046$) and motor competence ($\eta^2_p = 0.081$), with effects maintained at retention. Furthermore, the intervention showed a protective effect, preventing an increase in classroom boredom ($\eta^2_p = 0.058$) compared to the control group. However, no significant group differences emerged for physical literacy, self-reported physical activity, enjoyment, or motivation. Overall, the findings suggest that the BALA+ program improved physical fitness and motor competence and may have contributed to preventing an increase in classroom boredom, while no significant intervention effects were observed for physical literacy, self-reported physical activity, enjoyment, or motivation.

Keywords: physically active learning; active breaks; motor competence; physical fitness; physical active; primary education



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1. Introduction

Sedentary behavior constitutes a global challenge that requires early intervention during childhood, as habits acquired at this stage may condition the present and future health of young people [1–3]. According to the World Health Organization (WHO) [4], children and adolescents aged 5 to 17 years should engage in at least 60 min per day of moderate-to-vigorous physical activity (MVPA). However, the Global Matrix 4.0 on physical activity (PA) reported that between 27% and 33% of young people do not meet

this recommendation [5], with physical inactivity levels reaching highly concerning values (76.6%) [6]). Recent evidence among primary and secondary school students further suggests that insufficient daily PA is not only an individual behavioral concern but is also related to school-time opportunities, health-related cognition, and the availability of resources for active participation, reinforcing the public health relevance of school-based PA promotion [7]. Studies, such as the PASOS [8] and ALADINO reports [9], have documented worrying levels of inactivity among Spanish schoolchildren, particularly among girls and adolescents, highlighting the urgent need to implement effective educational strategies that promote PA in early stages of development.

In this context, schools play a fundamental role in promoting PA by providing structured and sustainable opportunities that foster student's participation in active behaviors [3,10], thereby contributing to the prevention of chronic diseases, such as obesity, diabetes, and related cardiovascular conditions [11]. In this regard, the promotion of PA, not only through Physical Education (PE) but also through interdisciplinary activities whose effects reach the entire school population, is both necessary and feasible for the entire educational community [12]. This need is further supported by evidence of very low levels of physical participation during the school day, reinforcing the importance of organizational changes that systematically integrate PA [13], given its cognitive, academic, physical, and attitudinal relevance [14,15].

Traditionally, PE lessons and recess have been considered the primary opportunities for PA practice within the school setting [16,17]. However, recent research in education and school health emphasizes the need to integrate PA transversally across all curricular areas in order to promote physical well-being, academic performance, and student motivation [18,19], fostering PA habits during early childhood and generating persistent behavior throughout life [20].

Within the school context, movement-based methodologies, such as active breaks (ABs) and physically active lessons (PALs), have proven to be effective strategies to increase PA levels. On the one hand, ABs consist of short bouts of MVPA embedded within academic lessons, with the aim of interrupting prolonged periods of cognitive inactivity and sedentary time [21], releasing accumulated energy, and optimizing student's concentration and behavior [10,22,23]. On the other hand, PALs involve integrating PA into the academic curriculum [15], promoting dynamic and participatory learning that benefits both academic performance and intrinsic motivation [24]. These strategies have been shown to be effective not only in reducing sedentary behavior and increasing PA levels [15,21] but also in improving academic performance and enhancing executive functions, such as attention and working memory [17,25–27], as well as students' motor competence and levels of physical literacy (PL) [28,29]. Moreover, these approaches have been shown to improve physical fitness, motivation, and student well-being [21,30], in addition to fostering enjoyment and engagement in learning tasks, thereby increasing active participation during classroom activities [31]. All these factors are particularly relevant, as they are recognized as key determinants of adherence to PA and its associated benefits [2,32], integrating physical, cognitive, motivational, and affective components that facilitate sustained participation over time [24,33].

The adoption of these strategies aligns with the framework of the Comprehensive School Physical Activity Program (CSPAP), which proposes the structured integration of PA across the entire school environment to optimize both physical and cognitive development in students [22,34]. This framework suggests that the systematic implementation of ABs and PALs can strengthen the relationship between motor competence (MC), PA, and PPL, generating a positive feedback cycle from an early age [35–37]. Accordingly, the expected effects of BALA+ may be understood through complementary mechanisms. Repeated

movement opportunities distributed throughout the school day may support physical fitness by increasing students' exposure to active behaviors and structured movement stimuli [14,21]. In parallel, the recurrent practice of locomotor and object control patterns embedded in ABs and PALs may contribute to MC development, consistent with evidence showing that school-based PA interventions can enhance children's motor competence when movement practice is frequent, structured, and pedagogically meaningful [35]. At the perceptual level, successful participation in varied movement-based tasks may strengthen PPL by enhancing student's awareness of their movement abilities, confidence, social engagement, and understanding of PA-related behaviors [32,33,35]. From a motivational and emotional perspective, the novelty, autonomy-supportive, and game-based nature of active learning tasks might promote enjoyment and motivation, while the interruption of prolonged sedentary routines through cognitively activating movement experiences may help reduce classroom boredom [23,31].

However, the literature continues to show a scarcity of studies that comprehensively analyze the effects of these interventions, particularly within the Spanish context, where experiences of active learning and integrated PA remain limited. In this regard, recent studies have identified additional benefits derived from the integration of movement within the classroom. For instance, Ref. [38], through an intervention based on ABs (12 sessions/12 weeks), reported increased motor participation and enhanced social and cognitive interactions during lessons. Similarly, Ref. [39], through the PEDAL program, by using bike desks during theoretical subjects (four sessions/4 weeks), observed significant improvements in both physical fitness and mathematics performance. Likewise, Ref. [2], through their intervention (PALs: one session/week), demonstrated increases in school-time PA levels, improvements in specific physical fitness indicators, and enhanced interest in the subject of natural sciences, as well as in student's perceived well-being [2]. Furthermore, Ref. [29], through a short-term AB-based PA program (ABs: 4 weeks/15 min per day), examined its effects on schoolchildren, reporting improvements in PA levels as well as in key domains of PL, particularly physical competence, motivation and knowledge. Similarly, Ref. [40], in a study involving school-aged participants (AB program: 21 sessions/20 min per day), observed higher scores in overall PL and across most of its domains following the intervention. This evidence, together with the decline in PA levels during childhood, reinforces the need to promote programs that combine the potential of ABs and PALs altogether [17,35,41,42].

Grounded in the CSPAP framework, the present study aims to examine the effects of a PA program integrated into the school day, based on active learning strategies, in fifth-grade primary school students over an academic term (trimester) and to determine the extent to which it may generate both immediate and sustained benefits over time. Specifically, based on a previous intervention, the BALA (Breaks Active and Learning Active) project [35], a new intervention combining PALs and ABs was developed. This proposal, termed BALA+, extends the original BALA project by increasing the planned classroom-based movement opportunities across the school week and examining their short- and medium-term effects on physical, motor, motivational, and psychological outcomes in primary education. Thus, the study contributes empirical evidence on the feasibility and potential effects of integrating movement-based pedagogies into ordinary classroom routines.

2. Materials and Methods

2.1. Participants

The sample comprised 100 fifth-grade primary school students (48 girls and 52 boys) who voluntarily took part in the BALA+ study across three assessment points: T1 (pre-test; September), T2 (post-test; April), and T3 (retention; June). At baseline (T1), participants

were aged between 9 and 11 years ($M = 9.86 \pm 0.40$). Students were recruited from two state-subsidized schools (Experimental Group (EG) and Control Group (CG)) located in the city of Valencia, Spain, during the 2022–2023 academic year. All participants remained in the study across the three assessment points, with no attrition. Occasional missing data in specific measurements were due to justified school absences or medical reasons. The study followed a non-randomized, quasi-experimental controlled design. Group assignment was established at the school level, with one educational setting serving as the experimental condition and the other as the control condition, without individual randomization.

Written informed consent was obtained from parents or legal guardians in accordance with the ethical standards outlined in the Declaration of Helsinki. The study protocol, which builds upon a previously implemented classroom-based PA intervention [43], received approval from the Ethics Committee of the (University of Valencia and code 1564606).

2.2. Instruments

Firstly, cardiorespiratory fitness was assessed using the *Progressive Aerobic Cardiovascular Endurance Run* (PACER), included in the *FitnessGram* battery [44]. This field-based test, consisting of a progressive 20 m shuttle run paced by auditory signals, allows for the indirect estimation of maximal oxygen uptake, a key indicator of cardiorespiratory fitness [45]. Numerous studies have supported its validity and reliability in school populations, demonstrating significant associations with cardiometabolic health indicators [46] and adequate predictive capacity for aerobic performance [47,48]. Furthermore, its ease of administration, low cost, and suitability for assessing large groups make it an appropriate tool in both educational and research settings, providing an objective, reproducible, and ecologically valid measure of students' physical fitness [48].

Secondly, actual motor competence (AMC) was assessed using the *Canadian Agility and Movement Skill Assessment* (CAMSA; [49,50]), a validated tool for children aged 8 to 14 years that enables the integrated assessment of fundamental motor skills in a dynamic context. The instrument consists of a circuit comprising several motor tasks (jumping, lateral movement, catching, throwing, skipping, hopping, and striking), whose items are scored dichotomously (0 = incorrect; 1 = correct), with a maximum of 14 points for the skill component. Additionally, the time required to complete the circuit is transformed into an inverse scale ranging from 1 to 14 points, such that lower completion times correspond to higher scores. The combination of both components yields a total score ranging from 1 to 28 points. The literature has confirmed the ecological validity and reliability of this battery in educational settings [49,50].

Thirdly, PA levels were assessed using the *Physical Activity Questionnaire for Children* (PAQ-C; [51,52]), a widely used and validated instrument for child populations that allows the estimation of habitual participation in physical activities of varying intensities (light, moderate, and vigorous) over the previous seven days. The questionnaire consists of nine items with a five-point Likert response format and gathers information on PA engagement across different daily contexts (e.g., PE classes, leisure time), with higher scores indicating higher levels of PA.

Internal consistency was adequate, with 0.72, 0.81, and 0.79 for T1 (pre-test), T2 (post-test), and T3 (retention), respectively.

Perceived physical literacy (PPL) was assessed using the *Pictorial Questionnaire of Physical Literacy for Children* (PL-C Quest; [53]), an instrument that provides a comprehensive evaluation of this construct across its physical, psychological, cognitive, and social domains. The scale comprises 30 items with a four-point Likert response format, enabling a holistic assessment of students' perceptions of their competence and relationship with PA. Internal consistency was excellent with 0.90, 0.93, and 0.93 for each time measurement.

In turn, perceived motor competence (PMC) was evaluated using the *Pictorial Scale of Perceived Motor Skill Competence* (PMSC; [54]), a pictorial scale aligned with the *Test of Gross Motor Development* (TGMD-3; [54,55]) that assesses children's self-perception of their motor skills. The instrument comprises 19 items representing locomotor skills, object control skills, and active play, and uses a four-point Likert scale. Internal consistency was 0.89, 0.87, and 0.90 for each of the time measurements.

Moreover, classroom satisfaction was evaluated using the *Spanish version of the Satisfaction Instrument* (SSI) adapted to the classroom context [56,57], which consists of seven items designated to measure satisfaction in core academic subjects and uses two subscales that measure satisfaction/enjoyment (5 items) and boredom (2 items) with a five-point Likert response format. Internal consistency was 0.71 and 0.60 for both domains at T1, 0.77 and 0.60 for T2, and 0.82 and 0.84 for T3.

Finally, motivational regulation towards PA was assessed using the *Behavioral Regulation in Exercise Questionnaire* (BREQ; [58,59]) and grounded in Self-Determination Theory. This instrument allows the assessment of the motivational continuum, ranging from less self-determined forms (external and introjected regulation) to more self-determined forms (identified, integrated, and intrinsic motivation). Items are rated on a five-point Likert scale (0–4), yielding specific scores for each type of regulation. Evidence has supported its validity and reliability in youth populations [60], including Spanish adaptations, showing satisfactory levels of internal consistency [61,62]. Internal consistency was acceptable with 0.72, 0.80, and 0.82 for each of the time measurements.

2.3. Procedure

Regarding the intervention, this was implemented during the second trimester of the 2022–2023 academic year (January–April). The EG ($n = 50$) participated in a classroom-based PA program grounded in an extension of the BALA project [35]—the BALA+ study—which included ABs (10 min $\times$ 5 sessions/week); PALs, through short-duration activities (10 min $\times$ 3 sessions/week) and longer sessions (≥ 30 min $\times$ ≥ 1 session/week); and manipulative activities (50 min $\times$ ≥ 7 sessions/week), following intervention models based on the integration of movement into the curriculum [15,63]. Specifically, ABs consisted of brief, structured movement tasks, such as choreographies, clapping games, rhythmic dictations, and motor imitation activities, which were aimed at reactivating student's attention and interrupting sedentary time. PALs involved the integration of curricular content through movement, including movement-based dictations, mime activities, body-based constructions, relay races incorporating mathematical operations, outdoor learning experiences to contextualize content, vocabulary hopscotch, and adapted traditional games (e.g., Rabbit (handkerchief game)) using academic prompts. Manipulative activities primarily focused on cooperative movement-based tasks, such as team construction challenges through displacement, the use of logical blocks in dynamic contexts, and problem-solving activities requiring physical interaction with materials, thereby fostering both motor engagement and collaborative learning. BALA+ was structured to provide daily opportunities for movement integration aligned with a 60 min MVPA target across the five school days per week rather than being limited to a fixed weekly increase over the original proposal.

The intervention was implemented in two fifth-grade primary school classes from a state-subsidized school through direct collaboration with the participating teachers and school leadership team. To support the implementation of this daily MVPA-oriented target, the researchers designed a structured and calendarized plan detailing the activities to be carried out, their timing, and their distribution throughout the school day. These activities were previously discussed with the classroom teachers to facilitate accurate implementation. Additionally, the researchers assumed an active role in supervision and ongoing support

throughout the process, acting as a guide and accompaniment to ensure intervention fidelity and its appropriate execution within the educational context. Implementation fidelity was documented through the calendarized intervention plan, with weekly records completed by the two participating classroom teachers and continuous monitoring in collaboration with an assisting researcher. Across the intervention period, a total of 126 sessions were delivered: 40 AB sessions, 53 manipulative activity sessions, 9 long-duration PAL sessions, and 24 short-duration PAL sessions. Student attendance during the intervention averaged 94.6%, with absences corresponding to routine school absences and mostly justified through the school. Although the activities were designed to promote moderate-to-vigorous movement, intensity was not objectively verified using accelerometry, heart-rate monitoring, or direct observation.

In contrast, the CG continued with a typical methodology based on a teacher-centered approach and a conventional curriculum, in which the teacher acts as the primary transmitter of knowledge and students adopt a predominantly passive role.

2.4. Data Analysis

Statistical analyzes were performed using the Jamovi software (Version 2.3.28). Descriptive statistics, including mean (M) and standard deviation (SD), were calculated for all variables at baseline (pre-test), post-test, and retention phases. The assumption of normality was assessed using the Shapiro–Wilk test. Although deviations from normality were observed in several variables ($p < 0.05$), parametric tests were employed due to the central limit theorem, given the sample size ($N > 30$ per group), and the robustness of the F-test to violations of normality. Homogeneity of variances was assessed using Levene's test. To ensure that both groups were comparable at the start of the intervention, independent samples t-tests were performed on the pre-test scores of all dependent variables. No significant differences were found at baseline ($p > 0.05$), indicating that the groups were homogeneous prior to the intervention.

To analyze the effects of the intervention, a two-way repeated measures analysis of variance (ANOVA) was conducted with time (pre-test, post-test, and retention) as the within-subject factor and group (control, experimental) as the between-subject factor. The assumption of sphericity was verified using Mauchly's test. When sphericity was violated ($p < 0.05$), the degrees of freedom were corrected using Greenhouse–Geisser estimates.

Statistical significance was set at $p < 0.05$. Effect sizes were calculated to determine the practical significance of these differences, where a η^2_p value of >0.01 indicates a small effect, >0.06 indicates a medium effect, and >0.14 indicates a large effect. When significant interaction effects (time $\times$ group) were found, Bonferroni-corrected post hoc pairwise comparisons were conducted to identify specific differences between groups and time points.

3. Results

Descriptive statistics (mean and standard deviation) for all dependent variables across the three time points are presented in Table 1 and Figure 1.

Regarding physical fitness, the analysis revealed a large significant main effect of time ($F(2, 144) = 16.29, p < 0.001, \eta^2_p = 0.185$; see Figure 1). Also, a significant time $\times$ group interaction with a small effect size was observed ($F(2, 144) = 3.45, p = 0.034, \eta^2_p = 0.046$), indicating divergent trends between groups. Post hoc comparisons showed that while the control group did not improve significantly at post-test, the EG showed significant improvements at both post-test ($MD = 5.74, 95\% \text{ CI: } 2.89, 8.60, p = 0.044$) and retention ($MD = 9.74, 95\% \text{ CI: } 6.70, 12.80, p < 0.001$) compared to baseline.

Table 1. Descriptive statistics (mean $\pm$ SD) for variables by group across time points.

Variable	Group	Pre-Test (M $\pm$ SD)	Post-Test (M $\pm$ SD)	Retention (M $\pm$ SD)
Physical Fitness	Control	27.42 $\pm$ 18.43	27.78 $\pm$ 18.68	31.67 $\pm$ 18.97
	Experimental	27.52 $\pm$ 12.87	33.40 $\pm$ 14.39 *	37.11 $\pm$ 17.23 *
Motor Competence	Control	17.93 $\pm$ 3.00	18.90 $\pm$ 3.07	17.93 $\pm$ 3.00
	Experimental	18.19 $\pm$ 3.65	19.65 $\pm$ 3.82 *	20.35 $\pm$ 3.08 * [†]
Physical Literacy	Control	3.18 $\pm$ 0.43	3.16 $\pm$ 0.46	3.07 $\pm$ 0.45
	Experimental	3.01 $\pm$ 0.40	2.91 $\pm$ 0.46	2.99 $\pm$ 0.48
Self-Reported PA	Control	3.03 $\pm$ 0.63	3.04 $\pm$ 0.65	2.82 $\pm$ 0.63
	Experimental	2.95 $\pm$ 0.68	2.97 $\pm$ 0.71	2.85 $\pm$ 0.65
Boredom	Control	2.95 $\pm$ 1.12	3.60 $\pm$ 0.88 *	3.59 $\pm$ 1.18 *
	Experimental	2.80 $\pm$ 0.78	2.69 $\pm$ 0.94 [†]	3.09 $\pm$ 1.12 [†]
Enjoyment	Control	3.30 $\pm$ 0.85	3.06 $\pm$ 0.84	2.84 $\pm$ 0.93
	Experimental	3.48 $\pm$ 0.61	3.29 $\pm$ 0.73	3.30 $\pm$ 0.78
Motivation (RAI)	Control	5.87 $\pm$ 2.61	5.99 $\pm$ 2.50	6.47 $\pm$ 2.64
	Experimental	6.08 $\pm$ 2.85	6.01 $\pm$ 2.72	5.84 $\pm$ 3.19

M = mean; SD = standard deviation; PA = physical activity. Data extracted from descriptive analysis. * Significant difference within group compared to pre-test ($p < 0.05$). [†] Significant difference compared to CG at the same time point ($p < 0.05$).

For motor competence, Mauchly's test indicated a violation of sphericity ($p = 0.004$); thus, the Greenhouse–Geisser correction was applied. A significant main effect of time with a medium effect size was found ($F(2, 147) = 11.00, p < 0.001, \eta^2_p = 0.117$). Furthermore, a significant time $\times$ group interaction of medium magnitude was revealed ($F(2, 147) = 7.32, p = 0.001, \eta^2_p = 0.081$). Bonferroni-corrected post hoc tests indicated that the control group remained stable with no significant changes ($p = 0.324$), whereas the EG significantly improved their MC scores from pre-test to post-test ($MD = 1.34, 95\% CI: 0.52, 2.16, p = 0.022$) and retention ($MD = 1.89, 95\% CI: 1.09, 2.69, p < 0.05$). Consequently, significant differences between groups were found at retention, favoring the EG ($MD = 2.42, 95\% CI: 1.15, 3.69, p = 0.009$).

In the case of PPL, a significant main effect of time was observed ($F(2, 166) = 3.57, p = 0.030, \eta^2_p = 0.041$), representing a small effect. However, no significant time $\times$ group interaction was found ($F(2, 166) = 1.06, p = 0.348$), suggesting that the intervention did not differentially impact students' self-perception of PL compared to the control group. Similarly, for self-reported PA, although a significant main effect of time with a medium effect size was detected ($F(2, 174) = 7.37, p < 0.001, \eta^2_p = 0.078$), the analysis did not reveal a significant time $\times$ group interaction ($F(2, 174) = 0.60, p = 0.548$). Both groups showed similar fluctuations in self-reported PA levels throughout the study period.

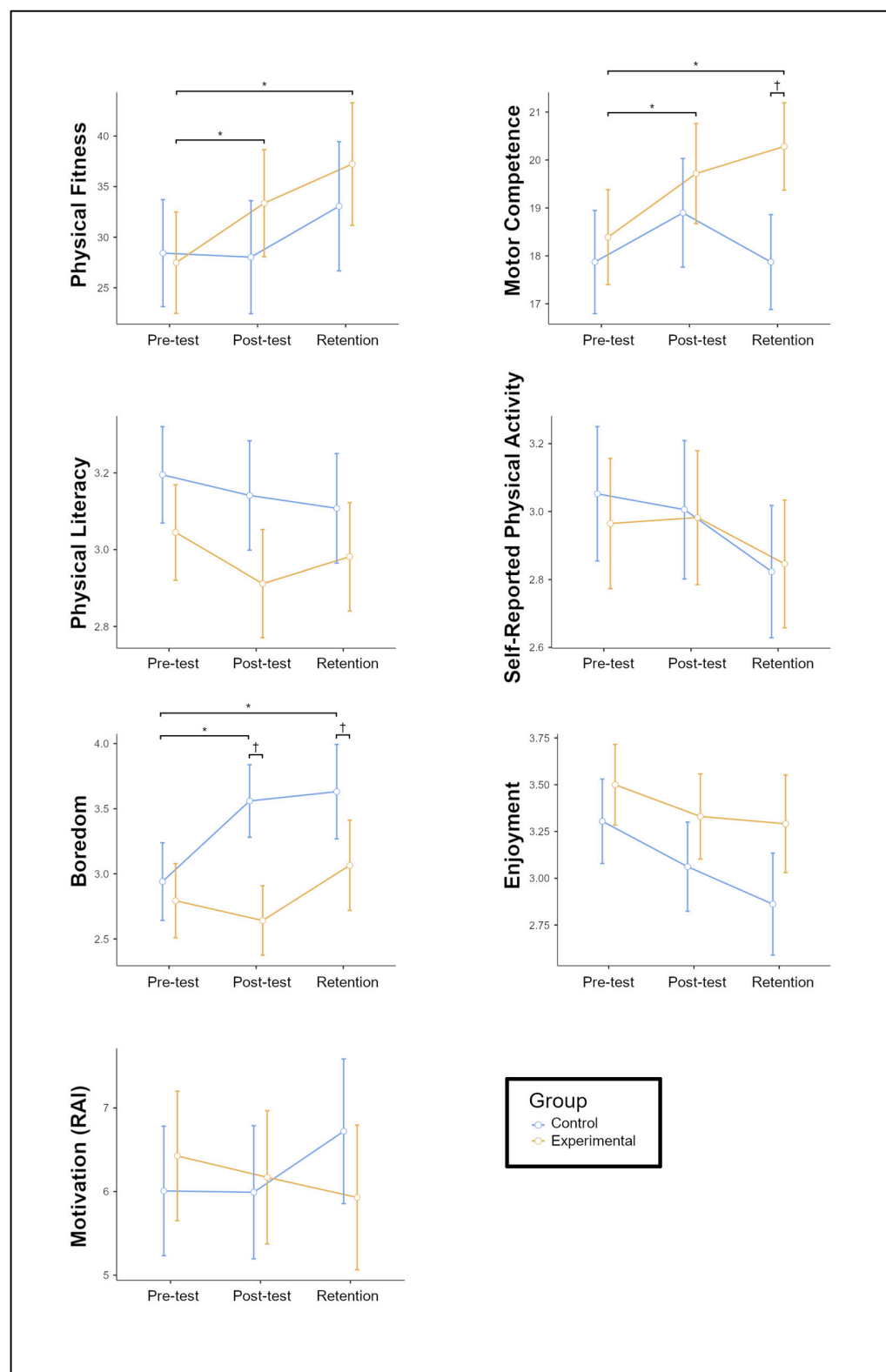


Figure 1. Intervention effects of variables analyzed. * indicates differences between time points in this group. † indicates differences between the experimental and control group at this time point.

In terms of boredom, the analysis yielded significant main effects of medium magnitude for both group ($p = 0.002$, $\eta^2_p = 0.105$) and time ($p < 0.001$, $\eta^2_p = 0.088$). Furthermore, a significant time $\times$ group interaction was observed ($F(2, 172) = 5.31$, $p = 0.006$, $\eta^2_p = 0.058$). Although the effect size was small, post hoc analysis clarified the divergent trajectories: the control group experienced a significant increase in boredom levels from pre-test to post-test

(MD = 0.62, 95% CI: 0.30, 0.93, $p = 0.003$) and to retention (MD = 0.65, 95% CI: 0.23, 1.07, $p = 0.007$), while the EG maintained stable levels ($p = 1.000$). Consequently, significant differences between groups were found at post-test (MD = 0.91, 95% CI: 0.54, 1.28, $p < 0.001$) and retention (MD = 0.51, 95% CI: 0.04, 0.98, $p < 0.001$).

Conversely, regarding enjoyment, a significant main effect of time with a medium effect size was found ($F(2, 172) = 9.30$, $p < 0.001$, $\eta^2_p = 0.098$), indicating a general decrease in scores over the academic term. A significant main effect of group was also observed ($F(1, 86) = 4.10$, $p = 0.046$, $\eta^2_p = 0.046$), with the EG reporting higher overall enjoyment levels. However, contrary to the findings for boredom, the time $\times$ group interaction did not reach statistical significance ($F(2, 172) = 1.23$, $p = 0.295$, $\eta^2_p = 0.014$).

Finally, regarding the relative autonomy index (RAI) of motivation, no significant main effect of time was found ($p = 0.678$). However, a trend toward significance was noted in the time $\times$ group interaction ($F(2, 168) = 2.66$, $p = 0.073$, $\eta^2_p = 0.031$), suggesting a potential small differential response to the intervention that did not reach the statistical threshold.

4. Discussion

Schools are increasingly recognized as a critical setting for health promotion, given that sedentary behavior has emerged as a significant public health issue [64]. Research indicates that traditional classroom environments often necessitate prolonged periods of sitting, with students spending a significant portion of their daily time in this setting [65]. To address this, classroom-based PA strategies, such as ABs and PALs, have been developed to optimize classroom time [30]. The primary aim of this study was to evaluate the effects of a school-based intervention combining PALs and ABs on students' physical fitness, MC, PL, and psychosocial variables. The findings indicate that the intervention was effective in improving physical fitness and MC. Notably, the intervention also yielded a protective effect regarding classroom boredom in comparison with the CG. However, no significant interaction effects were found for affective elements, such as self-reported PA, enjoyment, motivation, or PPL.

Regarding the physical variables, the intervention proved beneficial for both students' MC and physical fitness. On the one hand, the significant enhancement in MC observed in our study aligns with a growing body of evidence supporting classroom-based PA strategies [66–68]. Similar to the study in [69], which successfully integrated PA into Mathematics and English lessons, our results demonstrate that targeting academic and physical goals simultaneously does not compromise motor development; instead, it appears to stimulate it. This may be explained by the fact that MC does not develop automatically as a result of maturation alone but instead requires sufficient, structured practice opportunities supported by appropriate instruction to achieve adequate levels of proficiency [68,70]. In this regard, the significant interaction effect and the observed effect sizes in the present study suggest that the intervention provided a sufficient “dose” of movement, generating repeated and organized opportunities for the practice of fundamental movement skills, particularly locomotor patterns such as running, jumping, and dynamic displacement. Both PALs and ABs primarily targeted these movement patterns, which are also central components of the field-based assessments used to evaluate MC, thereby potentially facilitating the observed improvements. This interpretation is consistent with recent evidence indicating that interventions based on frequent, varied and contextually meaningful practice contribute to improvements in specific domains of MC [66–68]. Furthermore, these findings align with the model proposed in [71], which posits a reciprocal relationship between PA and MC, suggesting that increased exposure to PA during active sessions may have supported the development and consolidation of MC in school-aged children.

On the other hand, regarding physical fitness, our findings align with research indicating that integrating movement into the school day can lead to significant physiological adaptations [36,67,72]. Similar to the results reported in [73], where a multicomponent PA intervention led to improvements in cardiorespiratory fitness and muscular strength, our intervention group demonstrated improved physical fitness. This improvement may be attributed to the cumulative effect of the ABs and PAL sessions, which potentially contributed to increasing students' daily accrual of PA. Although activity intensity was not objectively measured in this study, a plausible explanation is that this repeated exposure to movement across the school day, which was designed to align with the 60 min daily MVPA target, may have enhanced cardiovascular efficiency and aerobic capacity. In this regard, the structured and frequent implementation of ABs and PALs could represent an effective stimulus to accumulate sufficient activity volume and intensity, thereby promoting cardiorespiratory adaptations and reinforcing active behavioral patterns in school-aged children [36,72].

Despite the improvements in objective physical measures (i.e., MC and physical fitness), no significant interaction effects were observed for PPL. Regarding PPL, the fact that students improved their actual MC without a concurrent significant increase in their self-perception suggests a potential temporal discrepancy between physical adaptations and psychological internalization. While speculative, as noted by [74], physiological domains can be enhanced within an 8–10-week intervention, but psychological or social elements likely require a more prolonged period of exposure to manifest significant changes [38]. Thus, it is plausible that the cognitive restructuring required to update one's PPL may lag behind physical gains, requiring sustained reinforcement beyond the duration of a short-term intervention.

Similarly, the lack of significant interaction in self-reported PA presents an interesting contrast to the tangible gains in physical fitness. While the intervention group significantly improved their fitness, their self-reported data did not reflect significant changes alongside. This finding may reflect how students cognitively categorized the intervention activities rather than a lack of behavioral change. It is plausible that because the ABs and PAL were integrated into the academic curriculum and classroom routine, students perceived them as part of their "schoolwork" or "learning time" rather than cognitively categorizing them as "PA" or "exercise," which they might typically associate with recess or sports. This phenomenon mirrors findings by [67], who observed that children participating in ABs did not report higher PA frequencies and even showed a reduction despite performing the activities. Ref. [67] suggested that students might engage in the proposed activities but fail to consciously register or categorize these classroom-based movements as "PA" when completing recall questionnaires, particularly if the instrument assesses the frequency of specific leisure-time or sport-like behaviors. Consequently, this discrepancy highlights a critical measurement and interpretation issue regarding the use of self-reported instruments in children. The lack of significant change in the questionnaires should be viewed as a limitation of subjective recall in capturing classroom-integrated movement, rather than implying that the students' total daily PA exposure necessarily increased across all contexts.

In terms of psychosocial outcomes, a distinctive finding of this study was the intervention's protective effect against classroom boredom. While the CG experienced a significant increase in boredom levels over time, the EG as a result of the intervention maintained stable low levels. This finding supports the notion that breaking prolonged sedentary bouts is essential to disrupt classroom monotony, which has been identified as a significant predictor of boredom [75]. Furthermore, Ref. [76] observed that students perceive "characteristics of instruction", specifically the lack of variety and repetitive teaching styles, as a frequent antecedent of academic boredom. By integrating movement, the intervention

effectively diversifies the instructional format, directly counteracting these antecedents. Moreover, this interruption of the sedentary routine aligns with evidence by [77], who suggest that continuous instruction without ABs can exacerbate classroom fatigue and monotony, whereas implementing them provides a necessary physical reset that helps mitigate these negative states.

Regarding the positive affective variables, the intervention did not yield significant interaction effects for enjoyment or motivation. This distinction can be interpreted through the lens of Control-Value Theory of achievement emotions [78]. According to this theory, positive activating emotions like enjoyment and autonomous motivation are primarily driven by student's cognitive appraisals of control (e.g., autonomy, perceived competence) and value (subjective importance) [78,79]. Enhancing these positive states requires not just the removal of negative stimuli (monotony) but the active fostering of autonomy support [79]. Although speculative, it is possible that the structured nature of the PALs and ABs provided a necessary reset that prevented boredom but lacked sufficient opportunities for student choice or value internalization to significantly elevate intrinsic motivation and enjoyment trajectories. Consequently, future interventions should prioritize autonomy-supportive strategies (e.g., allowing students to select the type of AB) to enhance perceived control and foster positive affective responses [80]. Additionally, while our findings focus on immediate classroom affects, broader psychosocial pathways suggest that regular physical exercise participation can yield wider mental health benefits in school-aged populations, such as improvements in body image and reductions in social anxiety [81], highlighting the multidimensional potential of school-based movement.

The interpretation of these findings must be considered in light of several limitations. First, the study followed a non-randomized, quasi-experimental design, with group allocation established at the school level; therefore, one school served as the experimental group and the other as the control group. The sample was also limited to 100 students from two state-subsidized schools, which restricts generalizability and prevents ruling out potential school-level influences, such as teacher practices, classroom culture, or institutional characteristics. In addition, the analyses did not adjust for the clustered nature of the data, which should be considered when interpreting the findings. Accordingly, selection bias and center-level confounding cannot be excluded. Second, regarding the measurement of PA, the reliance on self-reported questionnaires constitutes a methodological constraint. As highlighted in the discussion, the discrepancy between the significant improvements in objective physical fitness and the null results in self-reported activity suggests the presence of recall bias. Children often lack the cognitive maturity to accurately quantify the sporadic and intermittent nature of classroom-based PA, potentially leading to an underestimation of the intervention's impact on daily activity volume [82]. Moreover, although BALA+ was structured to provide daily movement opportunities aligned with a 60 min MVPA target, no accelerometers, heart-rate monitors, or direct observation procedures were used to objectively verify the intensity achieved; therefore, actual compliance with this daily MVPA target cannot be quantitatively confirmed. This represents a central measurement limitation, as the 60 min target should be interpreted as an implementation goal rather than as a verified PA dose. Future studies should prioritize device-based measures (e.g., accelerometry) to capture these acute bouts of movement more precisely. Third, the length of the intervention, while sufficient to elicit physiological and physical adaptations, appeared too brief to impact the multidimensional construct of PPL. Fourth, although the intervention was implemented by teachers to ensure ecological validity, autonomy-supportive strategies used during delivery were not assessed. Given our findings on motivation and enjoyment, future research should explicitly measure or manipulate the level of student choice provided during ABs and PALs to better understand

the mechanisms driving psychosocial outcomes. Finally, a methodological limitation must be acknowledged regarding the multiplicity of outcomes. Although Bonferroni corrections were appropriately applied to post hoc comparisons within each ANOVA model, the risk of Type I error is inherently increased when testing multiple dependent variables across several time points. The findings should be interpreted with caution. Future research should consider employing multivariate approaches to mitigate this risk.

Despite these limitations, this study presents notable strengths. First, the complementary active learning (combining ABs and PALs) addresses the need for comprehensive strategies that target reducing sedentary time through multiple pathways. Finally, the high ecological validity of the study implemented by classroom teachers rather than external researchers suggests that these strategies are feasible and scalable within the real-world constraints of the primary school curriculum.

5. Conclusions

In conclusion, this study suggests that movement-based pedagogy, through the integration of ABs and PALs into the primary school curriculum, may represent a promising strategy to enhance students' MC and physical fitness. In addition, the BALA+ intervention may have helped attenuate the progressive increase in classroom boredom observed in the CG, potentially reducing the monotony of sedentary instruction without disrupting the educational process.

While the intervention did not immediately alter PPL or intrinsic motivation and enjoyment, these null findings may reflect the temporal gap between physical improvements and psychological internalization, as well as the need for more autonomy-supportive implementation strategies. Nevertheless, given the non-randomized design and measurement limitations of the study, the observed improvements in physical fitness and MC should be interpreted as preliminary evidence of the potential value of integrating movement into classroom routines rather than as conclusive proof of effectiveness. Importantly, these findings should not be interpreted as evidence that students achieved recommended daily PA levels, since activity intensity and accumulated duration were not objectively verified. From a practical perspective, these findings suggest that schools do not need to choose between health and education as they can embed movement into the classroom routine. Thus, educators may contribute to a more dynamic learning environment that safeguards student engagement and promotes essential motor development. Future research should prioritize longitudinal designs with objective activity monitoring and longer follow-up periods, and explicitly investigate autonomy-supportive strategies, such as student choice, to further examine the potential of these interventions for enhancing intrinsic motivation, enjoyment, and lifelong PL.

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Data Availability Statement: The dataset generated and analyzed during the current study is available from the corresponding author upon reasonable request. The data are not publicly available due to ethical restrictions and participant confidentiality.

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Abbreviations

The following abbreviations are used in this manuscript:

AB	Active Break
AMC	Actual Motor Competence
BALA	Breaks Active and Learning Active
BREQ	Behavioral Regulation in Exercise Questionnaire
CAMSA	Canadian Agility and Movement Skill Assessment
CG	Control Group
CSPAP	Compressive School Physical Activity Program
EG	Experimental Group
M	Mean
MC	Motor Competence
MVPA	Moderate-to-Vigorous Physical Activity
PA	Physical Activity
PACER	Progressive Aerobic Cardiovascular Endurance Run
PAL	Physically Active Lesson
PAQ-C	Physical Activity Questionnaire for Children
PE	Physical Education
PL	Physical Literacy
PL-C Quest	Pictorial Questionnaire of Physical Literacy for Children
PMC	Perceived Motor Competence
PMSC	Pictorial Scale of Perceived Motor Skill Competence
PPL	Perceived Physical Literacy
RAI	Relative Autonomy Index
SD	Standard Deviation
SSI	Spanish Version of Satisfaction Instrument
TGMD-3	Test of Gross Motor Development
WHO	World Health Organization

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