Articles

Active breaks, selective attention, behavior and coexistence in secondary education students

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Abstract: Introduction: sedentary behavior and long sitting periods in the classroom affect students' attention, behavior and coexistence, whereas active breaks are a brief, low-cost strategy to introduce movement during lessons. Objective: to assess the incidence of an active-breaks program on selective attention, behavior and school coexistence among secondary education students. Materials and methods: a quasi-experimental design with two groups and pre- and post-measurements was used over eight weeks. Two hundred tenth- and eleventh-grade students participated and were assigned to an experimental group and a control group. Selective attention was assessed with a cancellation test, behavior with a difficulties questionnaire, and coexistence with a school-coexistence scale. Analyses of covariance, mixed analyses of variance, effect sizes with confidence intervals and power analysis were applied. Results: the experimental group showed significantly greater improvements than the control group in the three variables, with significant group-by-time interactions and moderate effect sizes. Improved attention and reduced behavioral difficulties were associated with better coexistence. Conclusions: the results, derived from simulated data for methodological purposes, suggest that active breaks could favorably affect selective attention, behavior and school coexistence, although studies with empirical data are required to confirm these trends.

Keywords: Active breaks; Selective attention; Behavior; School coexistence; Physical activity.

Introduction

Regular physical activity promotes health and cognitive development during adolescence, a stage in which most students do not achieve recommended levels of movement. The World Health Organization recommends at least sixty minutes daily of moderate-to-vigorous physical activity for individuals aged five to seventeen years (Bull et al., 2020); however, a high proportion of adolescents are insufficiently active and remain seated for much of the school day (van Sluijs et al., 2021; Aubert et al., 2022). Prolonged sitting time in the classroom is associated with declines in attention and increases in off-task behaviours, which impacts teaching and learning processes.

In this scenario, active breaks—defined as brief interruptions to class during which students engage in physical activity for a few minutes—have been proposed as a simple, feasible and low-cost strategy to break up sedentary behaviour and favour academic-cognitive performance (Ruhland & Lange, 2021; Peiris et al., 2022). Evidence indicates that active breaks can improve students' attention, particularly selective attention, as well as in-class behaviour, although results are heterogeneous depending on the intensity, duration and type of activity (Infantes-Paniagua et al., 2021; Mazzoli et al., 2021).

With respect to cognition, various syntheses show acute and chronic effects of movement on executive function and attention in children and adolescents (Shi et al., 2022; Sibbick et al., 2022), and specifically regarding secondary education students, a recent review supports the incorporation of active breaks to enhance cognition, although it notes that the evidence is limited and heterogeneous (Bertón et al., 2025). Regarding behaviour, physical activity in the classroom increases time on task and reduces disruptive behaviours (Heemskerk et al., 2023; Reyes-Amigo et al., 2025a), and recent reviews document effects on self-regulation and in-class behaviour (Reyes-Amigo et al., 2025b; Robles-Campos et al., 2023).

The relational dimension is also relevant. Physical activity has been linked to improved social relationships and reduced peer victimisation (Rusillo-Magdaleno et al., 2024), and school coexistence—understood as the quality of interactions and peaceful conflict management—has intervention programmes whose efficacy has been systematically reviewed, with greater support for emotional education and sport-based approaches (Tapullima-Mori et al., 2024). Nevertheless, coexistence has rarely been examined as a direct outcome of active breaks.

Despite growing interest, a gap persists in the state of knowledge. Most studies have concentrated on primary education and isolated outcomes—primarily attentional or in-class behaviour—whereas secondary education has received less attention and school coexistence has barely been integrated as an outcome variable. Few studies articulate, within a single design, selective attention, behaviour and coexistence in secondary education students.

Consequently, the present study aims to assess the incidence of an active-breaks programme on selective attention, behaviour and school coexistence in secondary education students, as well as to examine the relationship between these variables. The relevance of the proposal lies in offering a replicable methodological model that integrates cognitive, behavioural and relational indicators around an easily implementable school strategy.

Materials and Methods

Study Design

A quasi-experimental design was adopted with two non-equivalent groups—experimental and control—and repeated measurements at two time points, before and after the intervention, over a duration of eight weeks. This approach was selected for its feasibility in real school contexts, where individual random assignment is not viable and students are grouped in pre-existing classes; consequently, assignment to conditions was carried out by clusters (whole classes), preserving the natural classroom organization and reducing contamination between groups. The unit of analysis was the student and the factorial design was mixed, combining a between-subjects factor (group: experimental vs. control) and a within-subjects factor (time: pre- vs. post-measurement). To minimize bias, measurements were administered by evaluators blind to participants' condition (blinded assessment), total instructional time was kept constant across both groups, and contextual variables such as session timing and teacher characteristics were controlled where possible. Study planning and reporting adhered to recommendations for non-randomized research.

Participants

The reference population consisted of secondary education students enrolled at the Institución Educativa Departamental Nuestra Señora del Carmen de Guamal, Magdalena, Colombia. The research was conducted over an eight-week period corresponding to a block of the 2025-2026 academic year. The sample included 200 students, aged between fifteen and seventeen years, evenly distributed across an experimental group (n = 100) and a control group (n = 100); each group comprised 50 tenth-grade and 50 eleventh-grade students, with a balanced sex distribution. Group formation sought initial equivalence in grade, age and sex composition, a condition verified empirically and reported in the results section.

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Inclusion criteria: students enrolled in secondary education, with student assent and informed consent from the responsible guardian, and without medical contraindication for light physical activity.

Exclusion criteria: medical conditions preventing participation in active breaks, attendance below eighty per cent of sessions, or absence from any of the measurements. Sampling is described as non-probabilistic convenience sampling, with group assignment by clusters (classes) to reduce contamination between conditions.

Intervention: active-breaks program

The experimental group participated in a structured active-breaks program integrated into the regular school day over eight consecutive weeks. Each break consisted of a three- to five-minute movement segment, executed within the classroom two to three times per school day, without requiring relocation or specialized materials. Sessions followed a standardized three-phase sequence: (1) an activation phase, with brief in-place movements, walking and joint mobility; (2) a main phase, with coordination exercises, gentle jumps, balance and rhythmic motor patterns of light to moderate intensity; and (3) a closing phase, with stretching and controlled breathing to facilitate transition back to academic tasks. Dosage—duration, frequency and intensity—was grounded in the available evidence on active breaks in school contexts (Infantes-Paniagua et al., 2021; Peiris et al., 2022; Ruhland & Lange, 2021).

Implementation was carried out by teaching staff, previously trained in a formative session and provided with scripts and illustrations of each routine, in order to guarantee uniformity of application. To control intervention fidelity, a compliance register was used in which the

completion and duration of each break were recorded; only students with participation equal to or exceeding eighty per cent of sessions were included in the analysis. The control group maintained their usual school day, with identical class time and without structured active breaks, so that the only systematic difference between conditions was the incorporation of the movement program.

Variables and instruments

Selective attention. This was assessed using a cancellation test of attention and concentration, recording a concentration index based on hits and errors; higher scores indicate better attentional performance. This type of test presents adequate evidence of construct validity and internal consistency (Bates & Lemay, 2004). Operationally, the test consists of rapid scanning of rows of similar characters in which the participant must cancel only the target stimuli within a limited time; from hits and omission and commission errors, a concentration index is derived, with higher scores reflecting greater selective attention and inhibitory control. Its application is brief, collective and objectively scored.

Behavior. A strengths and difficulties questionnaire was used, from which the total difficulties score was obtained; lower values reflect better behavior. The instrument is widely used in research with child and adolescent populations (Goodman, 1997). In its structure, the questionnaire comprises twenty-five items organized into five subscales—emotional symptoms, conduct problems, hyperactivity/inattention, peer problems and prosocial behavior—; the sum of the first four subscales constitutes the total difficulties score, ranging from 0 to 40, with higher values indicating greater behavioral difficulty.

School coexistence. A Likert-type school coexistence scale was used, transformed to a 0–100 scale, where higher scores indicate more positive coexistence; the appropriateness of assessing coexistence through structured questionnaires has been documented in field reviews (Tapullima-Mori et al., 2024). The scale captures core dimensions of coexistence—quality of interpersonal relationships, respect for norms and peaceful conflict management—through Likert-type response items that are averaged and rescaled to a 0–100 range for ease of interpretation; higher scores express more positive coexistence.

Procedure

The study was organized into three phases. In the baseline phase (week zero), the three measurements—selective attention, behavior and coexistence—were administered to all participants in both groups during the same time slot and under standardized conditions. During the intervention phase (weeks one to eight), the experimental group developed the active-breaks program integrated into the school day, while the control group maintained their usual school routine. In the post-intervention phase (week nine), measurements were repeated using the same instruments, the same evaluators and the same application conditions as in the baseline. To reduce bias, evaluators were unaware of each class's condition, the test administration order remained constant, and data were coded anonymously prior to analysis.

Sample size and statistical power

The sample size (N=200; n=100 per group) was considered adequate to detect moderate-magnitude effects. A sensitivity analysis indicates that, with two groups, a significance level of 0.05 and power of 0.80, the design allows detection of standardized differences from $d \approx 0.40$, a value lower than the effects expected according to the literature. Statistical power attained (post hoc) for each contrast is reported in the results section.

Statistical analysis

Data management and cleaning were performed using Microsoft Excel and statistical processing using the R language and environment (version 4.4.1). Data organization and transformation were carried out using the tidyverse ecosystem (dplyr and tidyr packages), and descriptive statistics—means, standard deviations and intervals—were obtained with the psych package. To ensure reproducibility, a random seed (set.seed) was set before any resampling-based procedures.

The inferential analytical plan comprised: (a) verification of baseline equivalence between groups using independent samples t-tests and chi-square test for sex; (b) verification of normality assumptions with the Shapiro-Wilk test (shapiro.test function) and homogeneity of variances with Levene's test (car package); (c) an analysis of covariance (ANCOVA) on the post-measurement, with the pre-measurement as covariate, estimated with the car package (type III sums of squares) and whose adjusted marginal means and 95% confidence intervals were obtained with the emmeans package; (d) a two-factor mixed analysis of variance (group × time) with the afex package (aov_ez function) and partial eta squared; (e) paired and independent samples t-tests—the latter with Welch's correction in case of unequal variances—and, when assumptions were not met, their non-parametric equivalent (Wilcoxon tests); (f) calculation of Cohen's d effect size and partial eta squared with the effectsize package, with 95% confidence intervals obtained by bootstrap resampling (2000 repetitions) using the boot package; (g) statistical power analysis—both a priori sensitivity calculation and attained power—with the pwr package; (h) moderation analysis, evaluating group × grade and group × sex interactions on change scores; (i) test-retest stability, estimated by pre-post correlation in the control group; and (j) Pearson correlations between changes in the three variables, with their confidence intervals and power, calculated with the correlation package. Figures were produced with the ggplot2 package. A significance level of 0.05 was set. As an essential methodological limitation, it is reiterated that the data are simulated, so the results illustrate the analytical procedure and do not constitute empirical evidence.

Results

Analyses were performed on all 200 simulated cases, with no missing values. Presentation follows a logical sequence: descriptive statistics and changes; baseline equivalence and assumptions; intervention effect via analysis of covariance and mixed model; moderation analysis; measurement reliability; and cross-domain association.

Descriptive statistics and pre-post changes

Table 1.
Descriptive statistics (mean and standard deviation) by group and time point. (N = 200).

Variable	Group	Pre M (SD)	Post M (SD)	Change (Δ)
Selective attention (d2 index)	Experimental	118.0 (33.1)	128.5 (35.6)	+10.5
Selective attention (d2 index)	Control	115.7 (32.1)	119.4 (33.1)	+3.8
Behavior (difficulties; lower=better)	Experimental	13.4 (5.3)	11.1 (6.1)	-2.2
Behavior (difficulties; lower=better)	Control	14.0 (5.1)	13.7 (5.8)	-0.3
School coexistence (0-100)	Experimental	67.0 (12.0)	71.8 (13.8)	+4.8
School coexistence (0-100)	Control	67.0 (11.6)	68.6 (13.0)	+1.7

Analysis of descriptive statistics shows a clearly superior improvement in the experimental group. In relative terms, this group increased selective attention by approximately 8.9% (compared to 3.3% in the control) and school coexistence by 7.2% (compared to 2.5%), and reduced behavioral difficulties by around 16% (compared to 2% in the control; a reduction indicates improvement). Within-group contrasts using paired samples t-tests confirmed that, in the experimental group, changes were statistically significant across all three variables (all $p < 0.001$), with large effect sizes for attention (Cohen's $d = 1.00$) and behavior ($d = -0.88$) and moderate for coexistence ($d = 0.75$). In the control group, by contrast, only attention and coexistence showed significant changes, of small magnitude ($d = 0.38$ and 0.32, respectively), while the behavioral change did not reach significance ($d = -0.15$; $p = 0.143$). This pattern anticipates the differential effect formally confirmed in subsequent inferential analyses.

After the intervention, the experimental group increased the attention index by 10.5 points compared to 3.8 for the control group; behavioral difficulties decreased by 2.2 points compared to 0.3 (a decrease indicates improvement); and coexistence increased by 4.8 points compared to 1.7. Figure 1 illustrates the evolution of the means, and Figure 2 shows the complete distributions using box plots.

Figure 1. *Means (with standard error) before and after the intervention, by group*

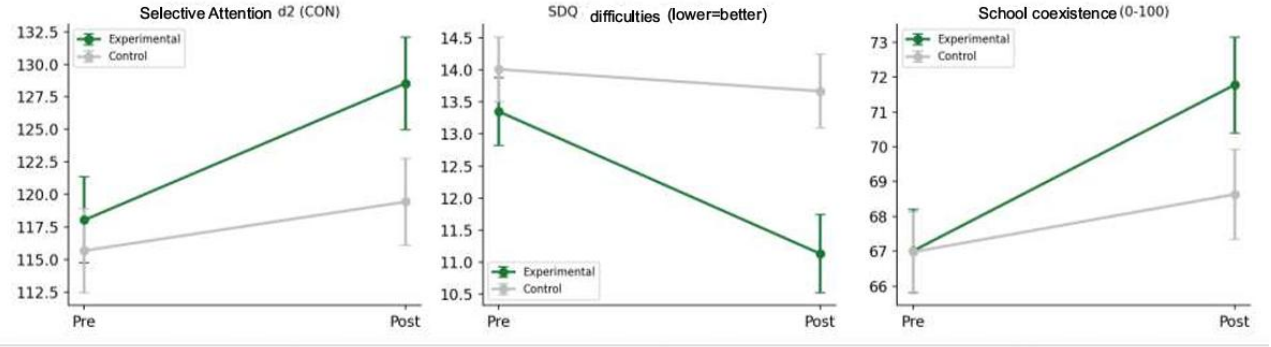
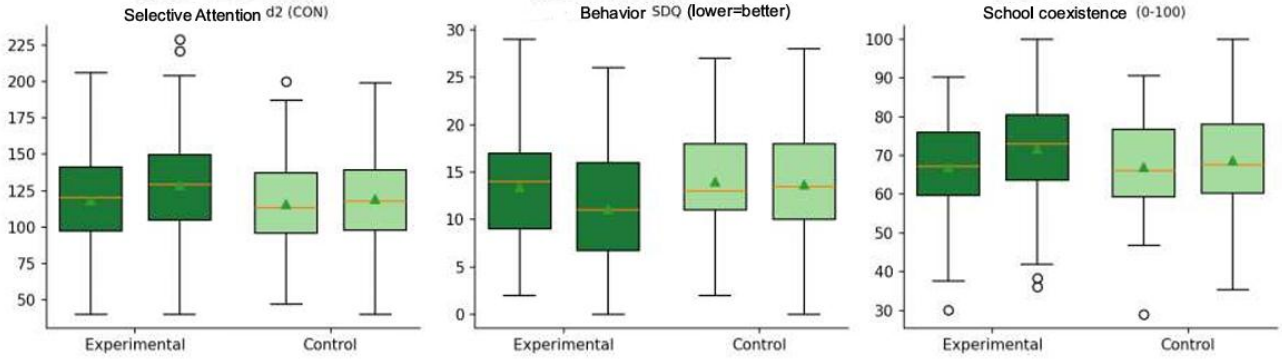


Figura 2. *Distributions (boxplots) pre and post by group*



Baseline equivalence and assumption verification

Before the intervention, groups did not differ significantly on any variable, with trivial effect sizes, and sex distribution was homogeneous ($\chi^2 = 0.18$; $p = 0.671$), supporting initial comparability (Table 2).

Table 2.
Baseline equivalence between groups (pre-measurements).

Variable	M Exp.	M Control	t	p	d
Selective attention (d2 index)	118.0	115.7	0.51	0.611	0.07
Behavior (difficulties)	13.4	14.0	-0.90	0.369	0.13
School coexistence (0-100)	67.0	67.0	0.02	0.984	0.00

The Shapiro-Wilk test indicated normality of change scores for attention and coexistence ($p > 0.05$) and a slight deviation in behavior for the experimental group; Levene's test showed homogeneity of variances for attention and behavior, and unequal variances for coexistence (Table 3). Consequently, between-group comparisons employed Welch's correction and main contrasts were complemented with analysis of covariance; results were confirmed using non-parametric tests, with equivalent conclusions.

Table 3.
Assumption verification on change scores

Variable	Shapiro p (Exp.)	Shapiro p (Ctrl.)	Levene p	Decision
Selective attention (d2)	0.511	0.430	0.659	Met
Behavior (SDQ)	0.048	0.095	0.207	Non-param.
School coexistence	0.715	0.416	0.018	Welch

Intervention effect: ANCOVA and mixed model

Analysis of covariance, adjusting post-measurement by baseline, confirmed a significant group effect across all three variables, with more favourable adjusted means in the experimental group (Table 4). Convergently, mixed analysis of variance evidenced significant group × time interactions, and change scores differed between groups with moderate effect sizes, confidence intervals excluding zero, and high statistical power (Table 5; Figure 3).

Table 4.
Analysis of covariance (post-measurement adjusted by baseline) and adjusted marginal means with 95% CI

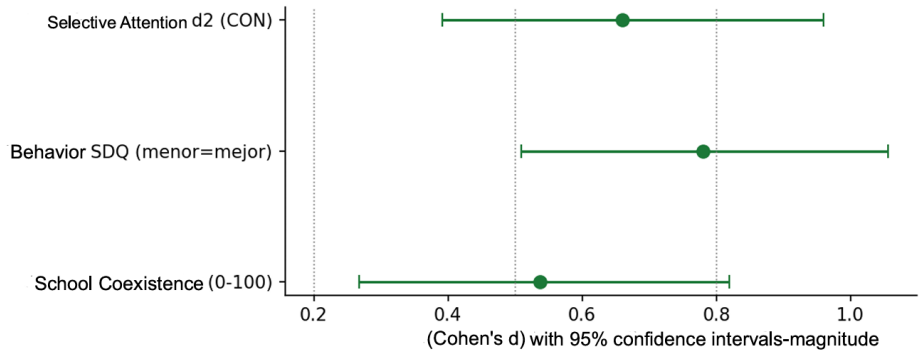
Variable	F(1,197)	η^2 partial	Adj. M Exp. [95% CI]	Adj. M Ctrl. [95% CI]
Selective attention (d2)	21.57	0.099	127.4 [125.3-129.4]	120.6 [118.6-122.6]
Behavior (SDQ)	29.52	0.130	11.47 [11.00-11.95]	13.33 [12.85-13.80]
School coexistence	14.41	0.068	71.76 [70.62-72.90]	68.65 [67.51-69.79]

All ANCOVA effects were significant ($p < 0.001$ for attention and behavior; $p < 0.001$ for coexistence), with partial eta squared values between 0.068 and 0.130, corresponding to medium-magnitude effects.

Table 5.
Group × time interaction, between-group effect size with 95% CI and power

Variable	Interaction F(1,198) [η^2p]	Cohen's d [95% CI]	Power	p
Selective attention (d2)	21.81 [0.099]	0.66 [0.39-0.96]	1.00	< 0.001
Behavior (SDQ)	30.44 [0.133]	-0.78 [-1.06--0.51]	1.00	< 0.001
School coexistence	14.45 [0.068]	0.54 [0.27-0.82]	0.97	< 0.001

Figure 3. *Between-group effect size (Cohen's d) with 95% confidence intervals*



Moderation analysis

The group × sex interaction was not significant for any variable (all $p > 0.26$), so the effect was homogeneous between male and female students. The group × grade interaction was also not significant for attention ($p = 0.734$) nor behavior ($p = 0.291$), but did reach significance, with small magnitude, for school coexistence ($F=4.18$; $p=0.042$; η^2 partial=0.021), suggesting that the effect on coexistence might vary slightly according to grade. This nuance should be interpreted with caution and verified in empirical studies.

Measurement reliability

Test-retest stability, estimated by correlation between pre- and post-measurements in the control group, was high across all three variables (attention $r = 0.95$; behaviour $r = 0.92$; coexistence $r = 0.92$), indicating consistent measurements and supporting that observed changes in the experimental group are not due to random instrument fluctuations.

Association between attention, behavior and coexistence

In the experimental group, significant associations were observed between changes in the variables (Table 6; Figure 4). Improvement in selective attention was associated with better coexistence, and reduction in behavioral difficulties was likewise associated with better coexistence (negative coefficient, since a lower difficulties score indicates better behavior). The relationship between changes in attention and behavior was weak and non-significant. The correlation matrix (Figure 5) summarizes the pattern of associations.

Table 6.

Pearson correlations between changes in variables (experimental group, n = 100)

Relationship between changes	r [95% CI]	p	Power
Δ selective attention – Δ coexistence	0.25 [0.06–0.43]	0.011	0.73
Δ behavior (difficulties) – Δ coexistence	-0.23 [-0.41—0.03]	0.022	0.64
Δ selective attention – Δ behavior	-0.12 [-0.31–0.08]	0.225	0.23

Figure 4. *Scatter plots with regression line between changes in variables (experimental group).*

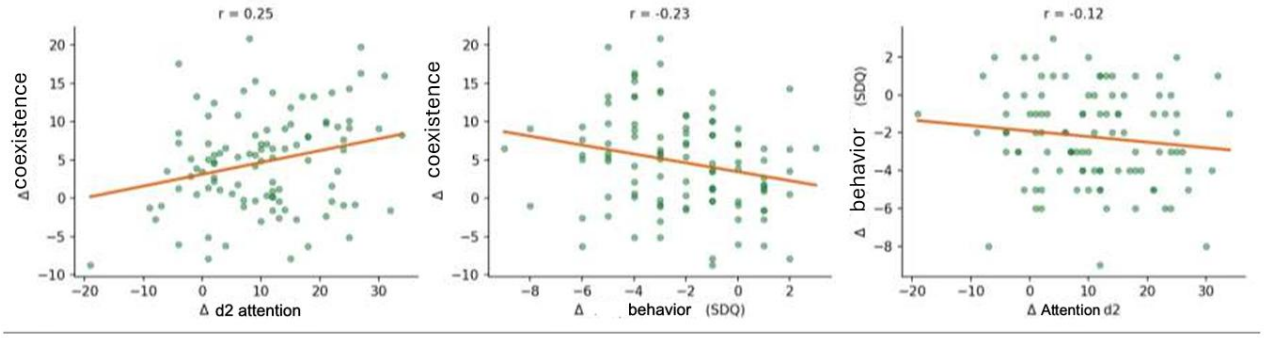
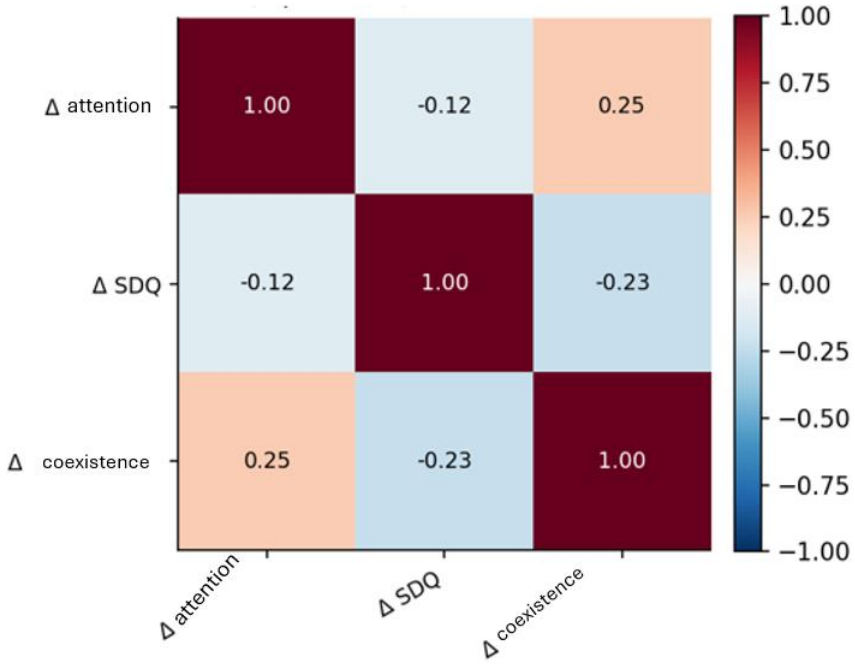


Figure 5. *Correlation matrix of changes (experimental group).*



Discussion

The present study evaluated, through a methodological model with simulated data, the incidence of an active-breaks program on selective attention, behavior and school coexistence in secondary education students. Simulated results showed significantly greater improvements in the experimental group across the three variables, with significant group-by-time interaction effects, favorable adjusted means after controlling for baseline measurement, moderate effect sizes with precise confidence intervals, and associations between improvement in attention and behavior and better coexistence. These findings must be interpreted as an illustration of expected behavior under the study hypotheses, and not as empirical evidence.

The direction of simulated results is consistent with the available literature. Regarding selective attention, the favorable effects agree with the meta-analytic synthesis identifying benefits of active breaks on student attention, especially selective attention (Infantes-Paniagua et al., 2021), and with evidence on the effects of movement on executive function in children and adolescents (Shi et al., 2022; Sibbick et al., 2022). Particularly pertinent to the population studied, a review focused on secondary school students supports the incorporation of active breaks to enhance cognition (Bertón et al., 2025).

Regarding behavior, the simulated reduction in difficulties is congruent with studies reporting increases in time on task and reduction of disruptive behaviors following physical activity in the classroom (Heemskerk et al., 2023; Reyes-Amigo et al., 2025a), as well as with reviews on the effects of active breaks on behavior and self-regulation (Peiris et al., 2022; Reyes-Amigo et al., 2025b; Robles-Campos et al., 2023). With respect to school coexistence, the simulated improvement aligns with evidence linking physical activity with better peer relationships and reduced victimization (Rusillo-Magdaleno et al., 2024) and with the literature on coexistence improvement programs (Tapullima-Mori et al., 2024).

The observed associations between improvement in attention and behavior and better coexistence suggest, within the limits of the model, that active breaks might affect cognitive, behavioral and relational dimensions in an integrated manner. A plausible explanation is that reduction in sitting time and regulation of arousal favor both attentional focus and self-control, which in turn would facilitate more positive interactions in the classroom. Nevertheless, an alternative explanation is that the novelty and enjoyment of the breaks, rather than the movement itself, account for part of the changes, which should be clarified in empirical studies with mediation analysis.

From the standpoint of analytical robustness, results were consistent across complementary procedures: analysis of covariance, which controls for baseline measurement, coincided with the mixed model and with comparison of change scores; effects remained after employing Welch's correction for unequal variances and non-parametric tests; effect size confidence intervals were precise and attained statistical power was high; moderation analysis did not evidence differences by sex and only a small interaction by grade for coexistence; and test-retest stability was high.

Together, these elements illustrate the methodological control required of quality research, although their value remains conditional on the simulated nature of the data.

Among the strengths of the approach are the integration of three dimensions usually studied separately, the focus on secondary education—less represented in the literature—and the application of an exhaustive and reproducible analytical plan. As limitations, the most relevant is that data are simulated, so conclusions cannot be generalized to real populations; the quasi-experimental design does not permit robust causal inferences; the eight-week period does not inform about sustainability of effects; and coexistence measurement through self-report may be subject to social desirability. Likewise, implementation fidelity of active breaks and teacher training condition results in real contexts (Ruhland & Lange, 2021).

The implications of this model are primarily methodological and pedagogical. Methodologically, the study provides a replicable template for articulating cognitive, behavioural and relational indicators around a brief school strategy. Pedagogically, it offers an easily implementable intervention framework requiring no specialized resources. Future research lines should execute the protocol with empirical data, employ cluster-randomized designs with prolonged follow-up, incorporate objective measures of physical activity and observed behavior, and analyze the mechanisms linking attention, behavior and coexistence. In summary, the scope of this work is limited to demonstrating the coherence of an analytical model; its significance will depend on subsequent empirical verification.

Conclusions

In coherence with the stated objective, results obtained from simulated data suggest that an active-breaks program could favorably affect selective attention, behavior and school coexistence in secondary education students, with improvements greater than those of the control group, and that such improvements would tend to be interrelated. These statements are illustrative and cautious in nature, as they do not derive from actual measurements.

Therefore, it is concluded that active breaks constitute a promising and easily implementable strategy to jointly favor attentional development, behavioral regulation and coexistence in secondary education, provided that their adoption is accompanied by methodological rigor, implementation fidelity and ethical safeguards. Research with empirical data, robust designs and prolonged follow-up is required to confirm these trends and clarify the mechanisms involved.

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Authors' contributions:

Ángel Ernesto Luquetta López: Developed the research methodology, designed the diagnostic instruments and techniques, and implemented the program in the experimental group.

Cristian Javier Varela de la Hoz: Conducted the bibliographic search and constructed citations, references and theoretical systematization of the study variables.

Steven Arturo Torres Burgos: Participated in the review, analysis and decision-making in the writing of the literature, theoretical systematization of the study variables, application of empirical instruments, and in the results and conclusions of the research.