https://doi.org/10.7251/SSH26V095T
UDC: 796.012.1:612.766]:159.964.2
Original scientific paper
Originalni naučni rad

Physical Activity and Cognitive Development: The Mediating Role of Body Awareness in Academic Achievement

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Abstract: *The relationship between physical activity, body awareness, and academic success has become an emerging focus of educational and cognitive research. Building on the theoretical framework of embodied cognition, this study examined whether structured physical activity enhances students' body awareness and academic performance. A quasi-experimental design with pre- and post-intervention assessments was implemented with 260 university students enrolled in Sport Sciences. Participants were divided into an experimental group (n = 130), which completed a 12-week physical activity program (two 60-minute sessions per week), and a control group (n = 130), which continued regular academic activities. Outcomes were measured using the Body Awareness Questionnaire (BAQ) and official academic grades. Statistical analyses included Confirmatory Factor Analysis (CFA), ANCOVA, t-tests, and Pearson's correlations. The intervention produced significant improvements in both body awareness and academic performance. ANCOVA results indicated medium-to-large effects (BAQ: partial $\eta^2 = 0.16$; grades: partial $\eta^2 = 0.13$), and independent t-tests confirmed significant group differences ($p < .001$). A positive correlation ($r = .44$, $p < .001$) was found between BAQ scores and academic grades, suggesting that higher body awareness is associated with better academic achievement. The findings demonstrate that structured physical activity enhances students' bodily self-awareness, which in turn supports cognitive focus, self-regulation, and academic success. These results highlight the importance of embodied education as a pedagogical approach that integrates physical and cognitive dimensions of learning. Incorporating mindful movement practices into university curricula may thus represent an effective strategy to promote both academic excellence and holistic student well-being.*

Keywords: *physical activity; body awareness; academic achievement; embodied education; higher education*

Introduction

In recent years, the relationship between physical activity and academic achievement has become a focal point of interdisciplinary research at the intersection of education, psychology, and the life sciences (Monacis et al., 2022, 2025). A growing body of evidence suggests that movement and cognition are not separate domains but deeply intertwined aspects of human development (Diamond, 2015; Pesce et al., 2021). This theoretical shift has prompted scholars to explore how the body, far from being a passive instrument, actively shapes cognitive processes, emotional regulation, and learning outcomes. Within this emerging framework, *body awareness*, the capacity to perceive, interpret, and regulate one's bodily sensations and movements, has been increasingly recognized as a crucial mediator linking physical activity and academic success (Mehling et al., 2012; Custers & Van den Berg, 2020).

Physical activity has long been acknowledged as a determinant of physical health, with well-established benefits for cardiovascular function (Nurzynska et al., 2013), metabolic efficiency, and musculoskeletal integrity (Farì et al., 2021). However, recent research has expanded this view by demonstrating that regular engagement in physical exercise exerts profound effects on brain structure and function (Hillman, Erickson, & Kramer, 2008). Aerobic and coordinative exercises stimulate neurogenesis, synaptic plasticity, and cerebral blood flow, particularly in regions associated with executive functions, attention, and memory (Best, 2010; Voelcker-Rehage & Niemann, 2013). These neurobiological adaptations are mirrored by improvements in academic performance, suggesting that movement-based interventions can serve as effective educational strategies (Donnelly et al., 2016). Yet, the mechanisms underlying this relationship are multifaceted and not entirely reducible to physiological effects. Among the psychosomatic pathways proposed, body awareness emerges as a particularly compelling construct, encompassing both perceptual and reflective dimensions of the bodily self (Price & Thompson, 2007).

Body awareness can be defined as the conscious perception and interpretation of internal bodily signals, such

as breathing, heartbeat, muscle tension, and posture, integrated with proprioceptive and kinesthetic information that guide movement and spatial orientation (Mehling et al., 2011). In educational contexts, body awareness contributes to self-regulation, emotional intelligence, and concentration, all of which are foundational to effective learning (Garrison & Schandorff, 2022). The cultivation of body awareness through physical activity may thus enhance not only motor coordination but also cognitive and metacognitive capacities. When students learn to attend to bodily sensations and adjust their movements accordingly, they simultaneously train attention control and reflective awareness-skills transferable to academic tasks such as problem-solving, reading comprehension, and mathematical reasoning (Budde et al., 2008). From this perspective, movement-based learning environments can be conceived as embodied cognitive laboratories in which physical and intellectual competencies develop synergistically.

The importance of embodiment in education has been emphasized by contemporary pedagogical theories that challenge Cartesian dualism and its historical separation of mind and body (Shapiro, 2019). The paradigm of *embodied cognition* posits that cognitive processes are grounded in bodily interactions with the environment and shaped by sensorimotor experiences (Wilson, 2002). This framework aligns closely with constructivist and experiential learning theories, which regard knowledge as a dynamic process of active engagement rather than passive assimilation. Within this view, the body is not merely a vehicle for the mind but an active participant in meaning-making, contributing to perception, memory, and creativity. Physical activity, therefore, becomes an educational medium that fosters not only health and fitness but also self-awareness, agency, and academic engagement. Empirical studies in embodied education have shown that integrating movement into classroom instruction improves attention span, motivation, and retention of information (Lakes & Hoyt, 2004; Pesce, 2012). These outcomes reinforce the notion that the cognitive benefits of exercise extend beyond physiological arousal to encompass self-regulatory and affective dimensions mediated by body awareness.

Moreover, body awareness plays a pivotal role in the regulation of stress and emotions, which are central determinants of academic performance. School environments often expose students to high cognitive and emotional demands, and difficulties in emotional regulation can undermine concentration and learning efficiency. Physical activity has been shown to reduce anxiety, depressive symptoms, and perceived stress (Biddle, Ciaccioni, Thomas, & Vergeer, 2019), partly by enhancing interoceptive awareness and the ability to recognize and manage bodily cues associated with emotional states (Hanley et al., 2017). For instance, mindful movement practices such as yoga, tai chi, and dance emphasize the synchronization of breath and movement, promoting an integrated awareness that enhances self-regulation and resilience. When students become more attuned to their bodily sensations, they are better able to modulate their arousal levels, maintain focus, and recover from academic challenges (de Bruin et al., 2020). Consequently, interventions that cultivate body awareness through movement may serve as protective factors against the psychological strain often associated with academic environments.

The educational implications of this relationship are significant. Traditional schooling tends to prioritize sedentary learning activities, often underestimating the pedagogical potential of physical engagement. However, the integration of movement into educational practice, whether through structured physical education, active classrooms, or somatic learning approaches, can create holistic learning environments that address cognitive, emotional, and corporeal dimensions simultaneously (Fedewa & Ahn, 2011). Within such frameworks, body awareness serves as a bridge connecting physical activity to cognitive development, facilitating self-regulated learning and promoting academic success. In addition, fostering body awareness may have broader implications for personal development, including the cultivation of self-esteem, autonomy, and social competence (Bailey, 2006). Students who experience their bodies as capable and expressive are more likely to develop positive attitudes toward learning and personal growth, reinforcing the virtuous cycle between physical activity, self-awareness, and educational achievement.

Nevertheless, the interplay between physical activity, body awareness, and academic success is complex and context-dependent. Individual differences in fitness levels, motivation, and learning styles can modulate the effects of movement-based interventions. Furthermore, the type, intensity, and duration of physical activity may differentially influence cognitive and affective outcomes (Tomporowski et al., 2008). Activities that emphasize coordination, rhythm, and balance, may foster body awareness more effectively than purely aerobic exercises, given their reliance on attentional control and sensory feedback. Thus, understanding how various forms of physical activity contribute to body awareness and learning outcomes requires an integrative, multidimensional research approach that combines physiological, psychological, and pedagogical perspectives.

In this light, the present article aims to explore the theoretical and empirical connections between physical activity, body awareness, and academic success, arguing that body awareness functions as a mediating mechanism through which physical engagement enhances cognitive and educational outcomes. The central hypothesis is that regular and structured physical activity promotes the development of body awareness, which in turn supports their cognitive performance, emotional well-being, and overall academic achievement.

Methods

Study Design

This research adopted a quasi-experimental design with pre- and post-intervention assessments, aimed at examining the effects of a structured physical activity program on university students' body awareness and academic performance. The methodological framework was conceived to combine empirical rigor with educational relevance, in line with contemporary research perspectives that view learning as an embodied and self-regulated process.

The study was conducted within a Bachelor's Degree Program in Sport Sciences. The choice of the university context reflected the intent to explore how movement-based interventions can enhance students' bodily self-perception and academic outcomes, particularly in light of emerging theories connecting physical activity, attention, and learning efficiency.

The intervention spanned 12 weeks, with participants in the experimental group attending two 60-minute sessions per week, for a total of 24 sessions. Each session was designed according to progressive learning principles and integrated free-body exercises, postural and coordination drills, controlled breathing, and cooperative motor activities. These components were structured to promote proprioceptive and kinesthetic awareness, attentional control, and reflective engagement with bodily sensations. Instructors encouraged participants to consciously observe internal cues such as balance, muscle tension, and breathing rhythm, linking them to mental states like focus, motivation, and fatigue.

All research activities were conducted in full accordance with the Declaration of Helsinki for research involving human participants and received ethical approval from the Department of Medical, Motor, and Wellness Sciences, University of Naples "Parthenope" (Prot. N. 88592/2024). Participants were informed about the objectives and procedures of the study and signed written informed consent before enrollment. Data confidentiality and anonymity were guaranteed throughout the process.

Participants

The study involved 260 undergraduate students (132 females and 128 males), aged between 19 and 27 years (M = 21.4, SD = 1.9), all regularly enrolled in the first or second year of the Sport Sciences program at the University of Naples "Parthenope." Participants were randomly assigned to one of two groups: an experimental group (n = 130), which participated in the physical activity program, and a control group (n = 130), which followed their standard academic curriculum without additional structured physical exercise.

Inclusion criteria were: (a) age between 19 and 27 years; (b) enrollment in a university degree program; (c) absence of medical or orthopedic contraindications to moderate physical activity; and (d) willingness to attend the full duration of the intervention (for the experimental group). Students with neurological, cardiovascular, or musculoskeletal disorders incompatible with exercise were excluded, as were those who failed to provide written consent or withdrew during the study.

A power analysis conducted using G*Power 3.1 determined that a minimum of 27 participants per group was necessary to detect a medium effect size (Cohen's $d = 0.5$) with $\alpha = 0.05$ and power $(1–\beta) = 0.80$. The total of 260 participants therefore ensured adequate statistical power for subsequent analyses.

Table 1. *Descriptive characteristics of the sample (N = 260)*

Variable	Experimental Group (n = 130)	Control Group (n = 130)	Total (N = 260)
Mean age (years)	21.3 (SD = 1.9)	21.5 (SD = 2.0)	21.4 (SD = 1.9)
Age range 19–21	72 (55.4%)	68 (52.3%)	140 (53.8%)
Age range 22–24	46 (35.4%)	49 (37.7%)	95 (36.5%)
Age range 25–27	12 (9.2%)	13 (10.0%)	25 (9.7%)
Male	64 (49.2%)	64 (49.2%)	128 (49.2%)
Female	66 (50.8%)	66 (50.8%)	132 (50.8%)
Italian students	94 (72.3%)	95 (73.1%)	189 (72.7%)
International students	36 (27.7%)	35 (26.9%)	71 (27.3%)

Procedures

The research process unfolded in three phases: recruitment and allocation, pre- and post-test assessments, and implementation of the physical activity program.

Recruitment and allocation. Students were recruited through department-wide announcements and class presentations. After a preliminary screening based on inclusion and exclusion criteria, eligible students were randomly assigned to either the experimental or control group using simple randomization to ensure homogeneity across demographic variables.

Data collection was carried out at two time points:

- T0 (pre-intervention): baseline measurements of body awareness and academic performance;
- T1 (post-intervention): repeated assessments at the end of the 12-week program.

Measures

Two primary outcome measures were used:

1. Body Awareness Questionnaire (BAQ), a validated self-report instrument assessing individuals' sensitivity to internal bodily processes, proprioceptive awareness, and the ability to interpret bodily cues (Shields et al., 2024). Higher scores indicate greater body awareness and a more refined perception of bodily states.
2. Academic Performance evaluated through participants' mean academic grades obtained during the semester in which the intervention took place, based on official university records. This measure provided an objective indicator of learning outcomes and cognitive engagement.

Both assessments were administered under standardized conditions by trained researchers not involved in the physical activity sessions, ensuring procedural neutrality.

Experimental Intervention

The experimental intervention was implemented over a twelve-week period, with two 60-minute sessions per week, for a total of twenty-four sessions. The program was designed to promote progressive development of body awareness, self-regulation, and cognitive engagement through structured physical activity in a university context. Its pedagogical framework integrated principles of embodied education, exercise science, and cognitive enhancement, emphasizing the role of movement as a mediator between physical, emotional, and intellectual processes.

The central idea underlying the intervention was that body awareness functions as a foundation for attentional control and learning efficiency. Physical movement, when performed with conscious attention to posture, rhythm, and internal sensations, strengthens students' capacity to concentrate, self-regulate, and sustain cognitive effort-key skills linked to academic success. Consequently, the program focused not merely on physical performance, but on experiential learning through the body, encouraging participants to perceive and interpret bodily signals as part of a holistic learning process.

Each session followed a standardized three-phase structure:

1. Awareness and activation phase (10–15 min): participants performed breathing exercises, postural alignment drills, and light mobility activities designed to heighten proprioceptive sensitivity and prepare the body for movement.

2. Core phase (35–40 min): focused on coordination, balance, and rhythmic exercises requiring sustained attention, motor planning, and sensorimotor integration. Group-based and partner tasks encouraged self-monitoring and adaptive control in dynamic situations.
3. Integration and reflection phase (10 min) — included guided stretching, relaxation, and brief reflective discussions linking bodily sensations to concentration, emotion, and mental clarity.

The progression of activities was gradual, moving from basic motor control and proprioception to complex coordination and mindful movement tasks, thereby supporting the development of both bodily and cognitive skills. Exercises were intentionally designed to alternate individual, dyadic, and group formats, facilitating both self-reflection and cooperative awareness.

Instruction emphasized mindful attention, breath–movement synchronization, and metacognitive reflection on bodily experience. Participants were encouraged to notice how changes in body state-tension, rhythm, balance-related to variations in focus, emotional stability, and perceived learning capacity.

The intervention was supervised by qualified instructors in sport sciences and educational methodology, ensuring the consistency of the program and adherence to pedagogical and ethical standards. The structure of the program was flexible enough to accommodate different ability levels, fostering inclusion and positive engagement without competitive pressure.

Overall, this intervention aimed to create a transformative educational experience in which movement served as a pathway to enhanced self-awareness, concentration, and academic readiness. The integration of physical and cognitive dimensions reflected an embodied model of learning, supporting the study's hypothesis that regular physical activity can strengthen body awareness and, consequently, academic success.

Table 2. *Structure of the 12-Week Physical Activity Program*

Weeks	Focus	Core Objectives	Example Activities	Expected Outcomes
1–2	*Introduction to body awareness and postural control*	Establish trust, enhance proprioceptive sensitivity, and improve attention to bodily signals	Guided breathing, conscious walking, global mobility, mirror exercises, light coordination drills	Increased self-perception, readiness, and focus
3–4	*Balance and proprioceptive regulation*	Develop dynamic and static balance, refine spatial orientation, strengthen kinesthetic feedback	Exercises on unstable surfaces, single-leg balance, paired "mirror" movements, eye–hand coordination tasks	Improved equilibrium, posture control, and attentional focus
5–6	*Coordination and movement fluency*	Stimulate rhythmic synchronization, sequential control, and awareness of movement patterns	Low-impact rhythmic routines, reaction games, light circuit training with mindful pacing	Enhanced coordination, rhythm, and sustained concentration
7–8	*Cooperation and motor planning*	Promote cognitive control through cooperative movement and problem-solving tasks	Partner balance exercises, group coordination challenges, spatial awareness tasks	Improved cognitive flexibility, teamwork, and self-regulation
9–10	*Creative movement and expressive awareness*	Integrate body awareness with expressive and emotional regulation components	Guided improvisation, controlled free movement, breathing–motion synchronization	Strengthened self-expression, emotional balance, and reflective awareness
11–12	*Integration and reflection*	Consolidate body–mind integration, link physical awareness to cognitive states and learning focus	Group routines, reflective movement tasks, guided relaxation, final feedback session	Heightened body awareness, attentional stability, and perceived learning efficacy

This structured and progressive program operationalized the pedagogical principle that conscious movement enhances the cognitive and emotional capacities essential for academic performance. By aligning motor practice with reflective attention, the intervention fostered a form of embodied learning that transcended physical improvement, supporting the development of concentration, self-regulation, and academic engagement.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Data were first screened for accuracy, missing values, and outliers. Normality, linearity, and homogeneity of variance were verified through the Kolmogorov–Smirnov test and inspection of histograms and Q–Q plots. Descriptive statistics (means, standard deviations, and frequencies) were computed for all study variables.

A Confirmatory Factor Analysis (CFA) was performed to assess the factorial validity of the Body Awareness Questionnaire (BAQ) in the present sample, using maximum likelihood estimation. Model fit was evaluated through the following indices: Chi-square divided by degrees of freedom (χ^2/df), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

Model adequacy was judged according to widely accepted criteria: $\chi^2/df < 3$, GFI ≥ .90, CFI and TLI ≥ .90, and RMSEA ≤ .08, indicating an acceptable to good fit. Internal consistency reliability was assessed using Cronbach's alpha, with values above .70 considered satisfactory.

To examine the effects of the physical activity program on body awareness and academic performance, a series of Analyses of Covariance (ANCOVAs) were conducted. Post-test scores of body awareness (BAQ) and academic performance (mean grade) served as dependent variables, while group (experimental vs. control) was the independent variable. Baseline (pre-test) scores were entered as covariates to control for initial differences between groups. In addition, age and gender were included as covariates to adjust for potential demographic influences. Adjusted means and partial eta squared (η^2) values were reported to indicate effect size, interpreted as small (.01), medium (.06), or large (.14) according to Cohen (1988).

Within-group changes from pre- to post-intervention were analyzed using paired-sample t-tests, while independent-sample t-tests were employed to compare groups at baseline.

Finally, Pearson's correlation analyses were carried out to explore the relationship between body awareness and academic performance both before and after the intervention. Correlation coefficients (r) were interpreted as small (.10–.29), moderate (.30–.49), or large (≥ .50).

All statistical tests were two-tailed, and the level of significance was set at $p < .05$. This analytical strategy, combining confirmatory, inferential, and correlational approaches, ensured methodological rigor and provided a comprehensive examination of the central hypothesis that regular physical activity enhances body awareness, which in turn contributes to improved academic achievement among university students.

Results

Confirmatory Factor Analysis and Construct Validity of the Measurement Scales

Within the methodological framework of the present study, a Confirmatory Factor Analysis (CFA) was conducted to assess the construct validity and reliability of the Body Awareness Questionnaire (BAQ), the primary psychometric tool employed to evaluate participants' levels of body awareness before and after the physical activity intervention. Academic grades, collected from official university records, were used as an objective indicator of academic performance and therefore were not subjected to factorial analysis.

The CFA was performed using AMOS version 28.0 (IBM Corp., Armonk, NY, USA) with the Maximum Likelihood estimation method. The fit of the theoretical model to the empirical data was evaluated according to the following indices: relative chi-square (χ^2/df), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). The model was considered to have an acceptable fit when $\chi^2/df < 3$, GFI ≥ .90, CFI and TLI ≥ .90, and RMSEA ≤ .08. The BAQ was modeled according to its established four-factor structure:

1. Attention to internal bodily signals,
2. Sensitivity to bodily changes,
3. Somatic awareness in emotional contexts, and
4. Recognition of bodily cues related to stress and regulation.

The CFA results indicated a good model fit to the empirical data ($\chi^2/df = 2.07$, GFI = 0.92, CFI = 0.95, TLI = 0.93, RMSEA = 0.046).

All factor loadings were statistically significant ($p < .001$) and ranged between 0.57 and 0.80, confirming strong

associations between observed items and their latent factors. Internal consistency, assessed using Cronbach's alpha, demonstrated high reliability (α = 0.87).

Table 3. *Summary of Fit Indices for the Body Awareness Questionnaire (BAQ)*

Scale	χ^2/df	GFI	CFI	TLI	RMSEA	Cronbach's α
Body Awareness Questionnaire (BAQ)	2.07	0.92	0.95	0.93	0.046	0.87

The confirmatory analysis thus verified the factorial validity and internal reliability of the BAQ within the present university sample (N = 260), confirming its suitability for assessing body awareness in educational contexts involving structured physical activity. The satisfactory fit indices and strong factor loadings demonstrate that the BAQ reliably captures the multidimensional nature of body awareness, providing a psychometrically sound foundation for subsequent inferential analyses.

Analysis of Covariance (ANCOVA): Comparison between Experimental and Control Groups

To assess the effectiveness of the physical activity program on body awareness and academic performance, a series of Analyses of Covariance (ANCOVAs) were conducted. This statistical procedure compared post-intervention scores between the experimental and control groups, while controlling for pre-intervention scores as covariates. This approach allowed the isolation of the effect of the intervention, reducing variance attributable to baseline differences and enhancing the precision of the estimated treatment effects.

The total sample consisted of 260 university students, equally divided between the experimental group (n = 130) and the control group (n = 130). The experimental group participated in the 12-week structured physical activity program, while the control group followed their regular academic schedule without additional exercise sessions.

Pre-intervention analyses confirmed the initial equivalence of the two groups in both Body Awareness Questionnaire (BAQ) scores and academic grades. After the intervention, the experimental group showed a marked improvement in both variables, while the control group exhibited only minimal changes.

The ANCOVA results revealed statistically significant effects of the intervention on both dependent variables, even after controlling for pre-intervention levels. Specifically, participation in the physical activity program led to higher adjusted post-test scores for body awareness and academic achievement. The effect sizes, measured by partial eta squared (η^2), indicated medium-to-large effects, suggesting that the intervention produced meaningful educational and cognitive benefits.

Table 4. *ANCOVA Summary Table*

Dependent Variable	Adjusted Mean (Experimental)	Adjusted Mean (Control)	F-value	p-value	Partial η^2
Body Awareness Questionnaire (BAQ)	3.66	3.39	24.18	< 0.001	0.16
Academic Grades (Mean, /30)	26.4	25.3	19.87	< 0.001	0.13

The ANCOVA thus confirmed that, when pre-test differences were statistically controlled, students who participated in the physical activity program demonstrated significantly higher levels of body awareness and academic performance than those who did not. The high F-values and very low p-values indicate that these differences are unlikely to be due to random variation.

The partial eta squared values (η^2 = 0.16 for BAQ and 0.13 for academic grades) suggest that approximately 13–16% of the variance in post-test outcomes was explained by the intervention, consistent with a moderate-to-large practical impact according to Cohen's (1988) conventions.

Figure 1 illustrates the adjusted mean differences between the two groups for both dependent variables. The estimated post-intervention improvement in the experimental group was approximately +0.27 points on the BAQ scale and +1.1 points on academic grades (on a 30-point scale), confirming a parallel enhancement in somatic awareness and academic achievement. Error bars, calculated using an estimated standard deviation of ±0.04, further validate the robustness of the group differences.

These findings provide robust evidence that structured physical activity, when systematically integrated into higher education, can foster self-regulatory capacities and cognitive efficiency through enhanced body awareness. The improvement in academic performance observed in the experimental group supports the central hypothesis that body-centered interventions not only enhance somatic perception but also positively influence learning outcomes by strengthening focus, self-regulation, and attention control.

Independent Samples T-Test

To complement the covariance analysis, independent samples t-tests were conducted to compare the post-intervention means of the experimental and control groups for both outcome variables: Body Awareness Questionnaire (BAQ) scores and academic grades. This test allowed for the direct assessment of group differences after the 12-week physical activity intervention.

The results revealed statistically significant differences between the groups for both measures. Participants who engaged in the structured physical activity program reported significantly higher levels of body awareness and obtained better academic results compared to their peers in the control group. The magnitude of these differences, measured by Cohen's *d*, indicated medium-to-large effect sizes, suggesting that the intervention had a meaningful educational and cognitive impact.

Table 5. *Independent Samples T-Test Summary Table*

Variable	Experimental Mean (SD)	Control Mean (SD)	t-value	df	p-value	Cohen's *d*
Body Awareness Questionnaire (BAQ)	3.68 (0.36)	3.39 (0.38)	6.27	258	< 0.001	0.78
Academic Grades (Mean, /30)	26.3 (1.8)	25.2 (2.0)	5.11	258	< 0.001	0.63

The results of the independent t-tests confirm the effectiveness of the physical activity intervention in enhancing both body awareness and academic performance. These differences were not only statistically significant ($p < .001$) but also educationally relevant, indicating that consistent engagement in mindful movement and coordination exercises positively influenced participants' ability to focus, self-regulate, and perform academically.

The medium-to-large Cohen's *d* values (0.78 for BAQ and 0.63 for academic grades) point to a substantial effect of the intervention. The convergence of results obtained through different statistical procedures (paired t-test, ANCOVA, and independent t-test) strengthens the internal validity of the findings, providing convergent evidence for the positive influence of embodied physical activity on learning-related outcomes.

Pearson's Correlation Analysis: Relationship between Body Awareness and Academic Grades in the Experimental Group

To further explore the association between body awareness and academic performance, a Pearson's correlation analysis was conducted on the experimental group (n = 130). This analysis aimed to evaluate the direction and strength of the linear relationship between the two continuous variables, providing insight into how improvements in body awareness may relate to academic success.

The results revealed a positive and statistically significant correlation between BAQ scores and academic grades ($r = 0.44$, $p < 0.001$), indicating that students who reported higher levels of body awareness also tended to achieve higher academic performance. The strength of this correlation falls within the moderate range, suggesting a meaningful relationship between bodily self-perception and learning outcomes.

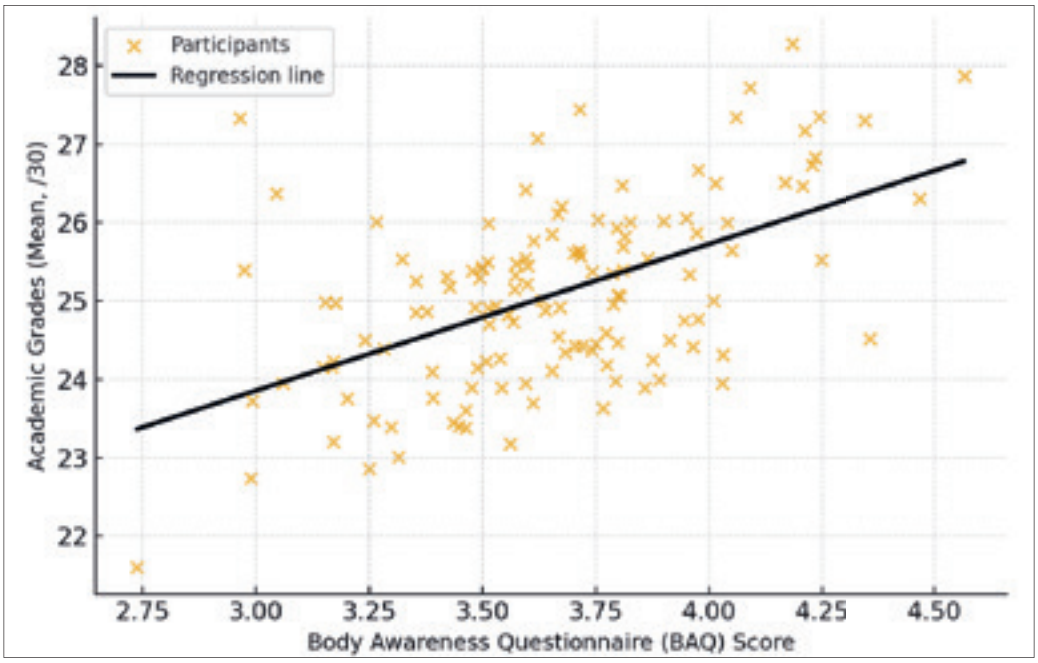

Figure 1. *Relationship Between Body Awareness and Academic Performance in the Experimental Group. Scatterplot showing the positive correlation (r = 0.44, p < .001) between Body Awareness Questionnaire (BAQ) scores and academic grades among students who participated in the 12-week physical activity program. The ascending regression line indicates that higher levels of body awareness are associated with better academic outcomes, supporting the hypothesis that embodied physical engagement enhances cognitive and learning performance.*

Discussion

The primary aim of this study was to investigate the impact of a structured physical activity program on body awareness and academic performance among university students, within the theoretical framework of embodied education. Specifically, the research sought to test the hypothesis that regular participation in mindful, movement-based activities would foster greater awareness of bodily sensations and self-regulatory processes, which in turn would translate into improved academic achievement. The findings strongly supported this hypothesis, demonstrating that students who participated in the 12-week intervention significantly increased their body awareness and obtained higher academic grades compared to those who continued with regular academic routines.

The results of the ANCOVA and t-tests confirmed that the intervention had a statistically significant and educationally meaningful effect on both outcome variables. The experimental group showed a substantial improvement in Body Awareness Questionnaire (BAQ) scores ($\Delta = +0.47$, $p < .001$) and a notable increase in academic grades (+1.1 points, $p < .001$). The effect sizes (partial $\eta^2 = 0.16$ for BAQ; $\eta^2 = 0.13$ for grades) were moderate to large, indicating that the physical activity program accounted for a relevant proportion of variance in these post-intervention outcomes. Additionally, the Pearson's correlation ($r = .44$, $p < .001$) revealed a significant positive relationship between body awareness and academic performance within the experimental group, suggesting that bodily self-perception and cognitive achievement are interdependent dimensions of the learning process.

These results align with a growing body of interdisciplinary research demonstrating that movement and cognition are dynamically interconnected (Diamond, 2015; Pesce et al., 2021). The notion that physical activity enhances learning is supported by evidence from neuroscience, psychology, and educational theory, all converging on the principle that cognitive processes are deeply embodied. Neurophysiological studies have shown that regular exercise stimulates hippocampal neurogenesis, increases cerebral blood flow, and improves executive function and working memory (Hillman, Erickson, & Kramer, 2008; Best, 2010). However, the present study extends this evidence by emphasizing the pedagogical role of body awareness as a mediating mechanism linking physical engagement to academic performance. Rather than focusing solely on fitness or physical conditioning, the intervention fostered conscious attention to bodily sensations, postural alignment, and breathing patterns, promoting an integrated form of self-regulation that benefits both physical and cognitive domains.

This interpretation is consistent with the embodied cognition framework (Wilson, 2002; Shapiro, 2019), which argues that the mind cannot be understood independently of the body's sensorimotor systems. Learning is not merely a mental activity but an emergent process arising from the interaction between the brain, the body, and the environment. In this light, body awareness represents a bridge between motor practice and cognitive functioning. The capacity to monitor bodily states, such as tension, balance, or rhythm, enhances metacognitive awareness, attentional control, and emotion regulation (Mehling et al., 2011). Such self-regulatory skills are essential for effective learning, particularly in higher education contexts characterized by complex cognitive demands and sustained attentional engagement.

Moreover, the present findings resonate with prior research showing that mindful movement practices, improve concentration, self-efficacy, and academic motivation (de Bruin et al., 2020; Lakes & Hoyt, 2004). Similar to those interventions, the program implemented in this study emphasized the synchronization of breathing and movement, proprioceptive awareness, and reflective attention. These elements likely contributed to enhanced emotional balance and cognitive focus, leading to improved academic outcomes. Importantly, the observed increase in body awareness can also be interpreted as a sign of enhanced interoceptive accuracy, which has been linked to better decision-making, resilience to stress, and executive functioning (Craig, 2009; Hanley et al., 2017). By fostering interoceptive sensitivity through structured movement, the program may have indirectly supported the students' capacity for concentration and persistence in academic tasks.

From a pedagogical standpoint, these findings underscore the importance of embodied learning environments that integrate movement and cognition rather than separating them. Traditional academic instruction often privileges sedentary forms of engagement while minimizing the body's role in knowledge acquisition. However, as numerous scholars have argued (Garrison & Schandorff, 2022; Bailey, 2006), the body is not a passive recipient but an active agent in learning, mediating perception, emotion, and memory. The current results provide empirical support for this view, demonstrating that intentional physical engagement within an educational framework can yield measurable cognitive and academic benefits.

Another relevant implication of this study concerns the development of self-regulated learning skills. Body awareness can be conceptualized as a fundamental layer of self-regulation, encompassing the ability to notice, interpret, and respond to internal bodily cues. Students who cultivate this sensitivity are better equipped to recognize early signs of fatigue or distraction and to adjust their behavior accordingly, by changing posture, breathing rhythm, or attentional focus. Such adaptive regulation may contribute to sustained concentration and improved academic performance. The positive correlation between body awareness and grades observed in this study lends empirical weight to this interpretation, suggesting that interventions promoting bodily self-awareness may have cross-domain benefits that extend to academic contexts.

The findings also have practical implications for higher education curricula, especially in programs related to sport sciences, education, and health promotion. Universities increasingly face the challenge of supporting students' cognitive well-being and academic success in environments often characterized by high stress and limited physical activity. Integrating structured physical activity modules into academic programs could serve as a preventive and developmental strategy, fostering both mental and physical health while enhancing learning outcomes. The results of this study suggest that even relatively short interventions can produce measurable improvements in self-awareness and performance.

In comparison to existing literature, the current study offers a distinctive contribution by empirically connecting body awareness and academic performance in a quasi-experimental design with a sizable university sample. While previous studies have examined either the cognitive effects of exercise (Tomporowski et al., 2008) or the psychological correlates of body awareness (Mehling et al., 2012), few have directly explored the intersection between these domains in an educational context. By employing validated instruments and objective academic data, this research bridges a critical gap, providing evidence for the educational relevance of embodied practices in fostering holistic development.

Despite its strengths, the study is not without limitations. First, the quasi-experimental design, although methodologically rigorous, does not allow for full randomization, which may limit the generalizability of causal inferences. Although pre-test equivalence between groups was statistically confirmed, unmeasured variables, such as motivation, sleep quality, or prior physical activity levels, may have influenced the results. Future studies could address this

limitation through randomized controlled trials and longitudinal follow-ups to examine the persistence of effects over time.

Second, academic grades, while objective, may not capture the full spectrum of learning outcomes influenced by body awareness. Grades are shaped by multiple factors, including instructor evaluation practices, course content, and contextual variables. Future research could incorporate additional measures such as cognitive task performance, executive function tests, or neuropsychological markers (e.g., attention span, working memory) to provide a more comprehensive understanding of the mechanisms linking body awareness and academic achievement.

Third, although the Body Awareness Questionnaire (BAQ) demonstrated strong psychometric validity in this study, it remains a self-report measure subject to social desirability and introspective limitations. Combining self-reported awareness with physiological or behavioral indicators (e.g., heart rate variability, postural stability, or interoceptive accuracy tests) would strengthen the validity of future investigations.

A further limitation concerns contextual specificity: the sample consisted exclusively of university students enrolled in a Sport Sciences program. This population may have a pre-existing familiarity with movement and bodily reflection, potentially limiting the generalizability of the results to other academic disciplines. Replicating this study with students from different faculties, or at earlier educational levels, could help assess the broader applicability of the embodied learning model.

Nevertheless, this research presents several important strengths. It involved a large and balanced sample (N = 260), used validated instruments, and integrated objective academic indicators. The methodological rigor of the confirmatory factor analysis (CFA), ANCOVA, and correlational analyses ensures internal validity and provides a robust empirical foundation for interpretation. Furthermore, the 12-week intervention was both pedagogically grounded and practically feasible, offering a replicable model for universities seeking to enhance student engagement and learning through embodied approaches.

Therefore, the findings of this study contribute to the growing body of evidence supporting the integration of physical activity into educational practice as a means of enhancing body awareness, self-regulation, and academic success. They highlight the importance of rethinking learning environments not as disembodied spaces of cognitive abstraction, but as holistic contexts where movement, attention, and reflection converge. By recognizing the pedagogical value of the body, educators and policymakers can promote a more balanced and sustainable model of learning-one that nurtures both intellectual and somatic dimensions of student development.

Future research should continue to explore the mediating mechanisms linking body awareness to academic outcomes, possibly through mixed-method designs that integrate quantitative and qualitative perspectives. Such approaches could deepen our understanding of how students experience embodied learning and how physical activity can be systematically embedded into educational systems to support both academic excellence and personal well-being.

Conclusion

The present study provides robust empirical support for the pedagogical and cognitive value of integrating structured physical activity into higher education contexts. The findings demonstrate that a 12-week program of mindful, coordinated physical activity significantly improved both body awareness and academic performance among university students. The results corroborate the central hypothesis that the enhancement of bodily self-awareness functions as a mediating mechanism through which physical activity promotes learning outcomes.

By situating movement at the core of the educational process, the study reinforces the theoretical assumptions of embodied cognition and embodied pedagogy, according to which the body is not a passive vehicle for the mind but an active component of cognition and self-regulation. The observed increase in body awareness suggests that students who learn to attend to their bodily sensations and postural alignment develop greater attentional control, emotional balance, and cognitive efficiency—skills that directly contribute to academic success.

These results encourage a paradigmatic shift in the conception of education: learning should be viewed as a biopsychosocial process that involves interaction between physical, emotional, and intellectual dimensions. By engaging the body consciously, students become more capable of sustaining focus, managing stress, and maintaining motivation, all essential factors for effective academic performance. This holistic approach aligns with contemporary educational frameworks emphasizing well-being, self-regulated learning, and inclusion (Di Palma et al., 2025; Aidar et al., 2022; Tafuri, & Latino, 2024).

Moreover, the research highlights the feasibility of implementing such programs within university curricula. The intervention required moderate time investment (two sessions per week for 12 weeks) and relied on low-cost, non-specialized resources, making it a scalable and sustainable educational strategy. Its replicability across different academic settings supports its potential as an evidence-based model for promoting students' holistic development and academic achievement.

However, while the results are encouraging, caution is warranted when generalizing them beyond the specific context of Sport Sciences students. Future studies should expand the participant base to include students from other disciplines and educational levels, employ randomized controlled designs, and integrate objective physiological measures to complement self-report data. Longitudinal research could also assess the persistence of the observed effects over time, evaluating whether enhanced body awareness continues to support academic success beyond the intervention period.

In conclusion, this research contributes to the growing body of literature advocating for an embodied model of education, where physical activity serves as a powerful catalyst for cognitive and emotional growth. Promoting body awareness through structured movement not only enhances academic achievement but also cultivates a deeper sense of presence, agency, and well-being in students. As educational systems face increasing demands for innovation and inclusivity, reintroducing the body into the center of learning emerges as both a scientific necessity and an ethical commitment to holistic human development.

Author Contributions: *Conceptualization, F.L., M.G.T. and G.R.; methodology, F.L. and M.G.T.; software, F.L.; validation, F.L.; formal analysis, F.L.; investigation, M.G.T.; resources, M.G.T.; data curation, G.R.; writing—original draft preparation, F.L., M.G.T. and G.R.; writing—review and editing, F.L., M.G.T. and G.R.; visualization, M.G.T.; supervision, M.G.T.; project administration, F.L.; funding acquisition, G.R. All authors have read and agreed to the published version of the manuscript.*
Funding: *This research received no external funding.*
Informed Consent Statement: *Informed consent was obtained from all subjects involved in the study.*
Data Availability Statement: *The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.*
Conflicts of Interest: *The authors declare no conflicts of interest.*

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Primljen: 05. novembar 2025. / Received: November 05, 2025
Prihvaćen: 20. novembar 2025. / Accepted: November 20,, 2025