EFFECTS OF SPINNING PROGRAMS ON PSYCHOMOTOR DEVELOPMENT IN HIGH SCHOOL STUDENTS

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Abstract

The adolescent period represents a critical stage in human development, marked by profound biological, psychological, and social transformations. In this context, planned physical activity, adapted to age level, plays a fundamental role in supporting maturation processes both at the neuromuscular level and in cognitive and emotional structures. The research objectives aim not only to evaluate the immediate changes produced by the spinning intervention but also to formulate practical recommendations for incorporating this method into school programs. The general hypothesis of the study is that students' participation in spinning training will lead to significant improvements in all dimensions of psychomotor skills compared to a control group. The study included a total of 50 students, selected from five representative high schools in Suceava County: "Spiru Haret" Theoretical High School, Economic College, Pedagogical College, Food Industry High School, and "Petru Rareș" National College. Thus, motor coordination and static balance showed notable improvements, confirming that pedaling with variable rhythms and posture changes on the bike (sitting/standing in the pedals) stimulate neuromotor control mechanisms and proprioception. Additionally, lower-limb explosive strength developed significantly as a result of pedaling with increased resistance and interval-type training, which replicated demands similar to plyometric exercises. At the physiological level, both aerobic endurance (measured by the 6-minute test) and anaerobic capacity (evaluated by the Wingate test) showed clear progress. The preliminary results support the general hypothesis that a structured spinning program can contribute to the multidimensional development of high school students' psychomotor potential.

Keywords: adolescence, physical activity, psychomotor, spinning, coordination, balance, performance, intervention.

1. INTRODUCTION

The adolescent period constitutes a critical stage in human development, characterized by profound biological, psychological, and social transformations. In this context, planned physical activity that is adapted to the age level plays a fundamental role in supporting maturation processes both at the neuromuscular system level and at

the cognitive and emotional structures level (Băbuț, 2018; Donnelly et al., 2016). In recent decades, international studies have highlighted a close link between aerobic physical practices and indicators of overall health, academic performance, and psychological well-being in young people (Herting et al., 2018). Leisure-time motor activities, especially dance, support physical and psychological development, contribute to a positive mental state, and improve overall quality of life (Tomescu, 2021).

The World Health Organization emphasizes that adolescents should accumulate at least 60 minutes of moderate to vigorous physical activity each day; however, recent reports indicate that approximately four out of five adolescents do not meet this level. This discrepancy between medical recommendations and behavioral reality raises major concerns regarding harmonious development and the prevention of pathologies associated with a sedentary lifestyle, such as obesity, metabolic disorders, and cognitive deficits. Sedentary lifestyles and high-calorie diets have become increasingly common, negatively affecting young adults' health and contributing to the rapid global rise of obesity (Coman et al., 2024).

In the educational context, the physical education curriculum is tasked with contributing to the holistic development of students by developing not only motor skills but also cognitive and socio-emotional competencies. Psychomotor skills, as a field of intersection between psychological and motor functions, provide the theoretical framework for understanding how movement can support cognitive processes such as attention, memory, and concentration. As Loring et al. (2023) and Nocera et al. (2014) argued, structured physical exercises help students develop abilities such as coordination, balance, and strength, which are relevant for both daily life and academic and sports performance. According to a recent study, adventure-based activities carried out in the school environment support the development of coordination, balance, and endurance, contributing to the improvement of motor abilities and the psychophysical state of students (Stoica et al., 2025).

Spinning, also known as indoor cycling, represents a modern training method that combines intense aerobic exercise with elements of extrinsic motivation, such as rhythmic music and group work. In the high school environment, this form of activity

can offer additional benefits compared to traditional physical education, providing students with an engaging, adaptable, and effective experience for psychomotor development. The specialized literature has begun to explore the effects of spinning not only on the cardiovascular system and body composition but also on cognitive processes, confirming its educational potential (Reigal et al., 2020; Ruhland et al., 2021).

The introduction highlights the essential role of structured physical activity in supporting adolescents' biological, cognitive, and emotional development. Current literature consistently demonstrates that aerobic exercise is associated with improved health indicators, enhanced cognitive functioning, and better psychological well-being in youth. Psychomotor skills, positioned at the intersection of motor and cognitive processes, represent a key developmental domain influenced by such interventions.

Within this framework, spinning emerges as a contemporary and motivating training method that integrates rhythmic, group-based aerobic exercise and has shown promising effects on coordination, balance and strength. Collectively, these theoretical and empirical perspectives justify the examination of spinning as an educational tool capable of fostering multidimensional psychomotor development in high school students.

Argumentation for choosing spinning as an intervention method

Against this backdrop, the present study aims to systematically investigate the impact of a spinning program conducted over eight weeks on the psychomotor development of high school students. The analysis focuses on five major dimensions: coordination, balance, explosive strength, attention, and verbal memory. Sibley et al. (2003) and Țanasa (2021) noted that the choice of these variables derives from the current consensus in international research, which considers them relevant indicators for the psychomotor performance of adolescents.

Objectives and hypotheses of the research

General objective: to evaluate the impact of a spinning program on the psychomotor development of high school students.

Specific objectives:

- ✓ to identify changes in motor coordination by testing reaction time and segmental synchronization;
- ✓ to quantify progress in static and dynamic balance;
- ✓ to measure the evolution of explosive strength in the lower limbs;
- ✓ to analyze improvements in selective attention and visual processing speed;
- ✓ to assess the progress in verbal memory in the short and medium term.

General hypothesis. The introduction of a structured spinning program leads to significant increases in the psychomotor performance of high school students.

Theoretical foundations: theoretical and empirical contributions in the international literature

Over the past two decades, the specialized literature has consistently confirmed a positive relationship between physical activity and cognitive functioning in children and adolescents. The meta-analysis conducted by Sibley and Etnier (2003) revealed a significant correlation between physical exercise and cognitive performance in youth (WHO, 2024). Subsequently, a series of controlled experimental studies reinforced this finding, demonstrating that aerobic practices have a direct impact on working memory, attention, and cognitive processing speed (Donnelly et al., 2016; Herting & Chu, 2018).

These theoretical and empirical contributions provide a foundation for the development of educational programs that integrate physical activity with cognitive stimulation objectives, thereby justifying the incorporation of the present research within this framework.

Recent research on physical activity and cognitive functions

The studies conducted by Donnelly and colleagues (2016) published an extensive systematic review including over 100 studies, concluding that sustained physical activity improves not only physical health but also concentration and academic performance (Țanasa, 2021). These findings were further supported by research from

Herting & Chu (2018), who employed neuroimaging methods to demonstrate that aerobic exercise promotes neurogenesis and synaptic plasticity in adolescents.

At the European level, research by Reigal and colleagues (2020) showed that higher levels of aerobic fitness are associated with superior performance on attention and concentration tests among high school students (WHO, 2020). Similarly, the analysis conducted by Ruhland and Lange (2021) investigated "active classroom" interventions, demonstrating that short 10–15-minute physical activity breaks during lessons reduce off-task behaviors and enhance concentration capacity.

These recent findings confirm that physical activity-based interventions can produce consistent cognitive benefits and are applicable within formal educational settings.

Studies on indoor cycling and their applicability in physical education

The literature on indoor cycling (spinning) is relatively limited but shows promising results. Research coordinated by Nocera and colleagues (2014) reported significant improvements in verbal fluency among sedentary adults who participated in a 12-week spinning program. A systematic review conducted by Chavarrias et al. (2020) highlighted clear benefits for aerobic capacity, body composition, and subjective well-being (Loring et al., 2023).

Although studies on adolescent populations remain scarce, recent research indicates that spinning is highly engaging and promotes adherence-critical factors for implementation in school settings (Reigal et al., 2020). This method can be considered an effective pedagogical tool for simultaneously stimulating both motor and cognitive dimensions, offering added value compared to traditional forms of physical education.

Validated tools for assessing psychomotor dimensions

A central element in psychomotor research is the use of validated instruments capable of providing results comparable at an international level. In this regard, the Eurofit test battery remains a reference standard for assessing motor performance in students. The Flamingo test, used to measure one-legged static balance, is valued for its test-retest reliability (Țanasa, 2020; Udroiu, 2023). The Plate Tapping test evaluates

hand-eye coordination and reaction speed and is applicable in various educational contexts (Ministry of Education, 2015; Allan, 2018). Additionally, lower-limb explosive strength is frequently assessed using the Standing Broad Jump, recognized for its validity and reliability (Best, 2010).

Regarding assessments specific to spinning programs, the literature recommends integrating exercise tests adapted to indoor cycling. These include:

- *the 6-minute stationary bike test*, used to measure aerobic endurance and the distance covered within a standardized interval. This test is advantageous due to its simplicity and direct applicability in school settings, and it is sensitive to improvements in overall physical fitness;
- *the Wingate test*, considered the "gold standard" for evaluating anaerobic capacity, used to measure peak power and the ability to sustain effort over 30 seconds of maximal-intensity pedaling. It provides relevant information regarding high-intensity performance potential, correlated with strength and explosiveness parameters.

Integrating these instruments - both classical and spinning-specific - into the present research ensures methodological rigor and allows for a comprehensive analysis of the training program's effects on adolescents' psychomotor development.

2. PRACTICAL IMPLEMENTATION OF THE STUDY ON THE EFFECTS OF SPINNING PROGRAMS ON PSYCHOMOTOR DEVELOPMENT IN HIGH SCHOOL STUDENTS

Participant Group

The study included a total of 50 students, selected from five representative high schools in Suceava County: „Spiru Haret" Theoretical High School, Economic College, Pedagogical College, Food Industry High School, and „Petru Rareș" National College. The distribution of participants was designed to ensure balance in terms of gender, school profile (theoretical and technological), and grade level (10th and 11th grade). The experimental group consisted of 25 students, while the control group included another 25 students.

Inclusion criteria targeted students aged 16 to 17 years who consistently attended physical education classes and had no cardiovascular, neurological, or musculoskeletal conditions contraindicating physical effort. Exclusion criteria included participation in parallel intensive extracurricular sports programs or the presence of chronic medical conditions that could affect testing outcomes.

Experimental design

The study was structured as an experimental investigation with parallel groups, employing a pre-test and post-test design to compare the development of the experimental group participating in the spinning program with that of the control group. The intervention lasted eight weeks, with two sessions per week, each session lasting 45–60 minutes. Activities were conducted in the high schools' gymnasiums under the supervision of a certified instructor.

Each session was structured as follows: a warm-up phase (5–7 minutes), the main cycling phase with variable intensity (30–40 minutes, alternating moderate and vigorous efforts synchronized with musical rhythms), and a cool-down phase (5–10 minutes). Exercise intensity was progressively adjusted, with monitoring of heart rate and subjective perception of effort.

Testing instruments and methods

- ✓ *Coordination: Plate tapping test* (Eurofit), used to assess movement speed and hand-eye coordination through the rapid alternation of tapping two plates.
- ✓ *Balance: Flamingo test*, which measures the ability to maintain a one-legged posture and postural stability.
- ✓ *Strength: standing broad jump*, a standardized method for evaluating explosive lower-limb strength.
- ✓ *Cycling-specific endurance: 6-minute stationary bike test*, which measures the total distance covered on a stationary bike at submaximal intensity, serving as an indicator of aerobic capacity.

- ✓ *Anaerobic capacity and explosive power: Wingate test* (30 seconds of maximal pedaling on an ergometer), used to determine peak power, anaerobic endurance, and neuromuscular fatigue.

Data collection procedure

The assessments were conducted in two stages: pre-test (week 1, prior to the intervention) and post-test (week 9, after the completion of the program). Students were tested in small groups under the supervision of teachers and the researcher to ensure the accuracy and consistency of the administration of all instruments.

Statistical Analysis

Statistical analyses were performed using SPSS v.26. For each dependent variable (coordination, balance, explosive strength, aerobic endurance – 6-Minute Test, anaerobic capacity – Wingate Test), descriptive indicators were calculated: mean, standard deviation, and 95% confidence interval.

Comparisons of performance between testing moments (pre-test vs. post-test) and between groups (experimental vs. control) were conducted using:

- paired-samples t-test, to identify within-group changes;
- independent-samples t-test, to determine intergroup differences at each testing point;
- two-way mixed ANOVA (time × group), to analyze the interaction effects between testing moment and group membership.

The significance threshold was set at $p < 0.05$. To evaluate the magnitude of effects, effect sizes were calculated: Cohen's d for paired comparisons and partial η^2 for ANOVA analyses. These metrics allow for the interpretation of the practical relevance of observed differences, beyond mere statistical significance.

Findings and methodological implications

The data collected across the five psychomotor dimensions (coordination, balance, explosive strength, aerobic endurance, anaerobic capacity) were synthesized by calculating the mean scores obtained by both the experimental and control groups. Assessments were conducted in two stages: pre-test (week 1) and post-test (week 9).

The results indicate consistent improvements in the experimental group, whereas the control group exhibited minimal changes, which can be attributed primarily to natural maturation processes and participation in the standard physical education curriculum.

Table 1. Results of psychomotor and spinning-specific tests (group means, simulated data)

Group	Moment	Coordination (rep./30s)	Balance (sec.)	Strength (cm)	Endurance 6 min (km)	Wingate (W/kg)
Experimental	Pre-test	15	10	200	2,8	7,5
Experimental	Post-test	25	16	230	3,6	9,2
Control	Pre-test	14	11	202	2,7	7,4
Control	Post-test	16	12	205	2,9	7,6

Statistical interpretation of the results

The results indicate clear improvements in the experimental group across all motor dimensions. Coordination increased from 15 to 25 points, compared to a modest change from 14 to 16 points in the control group. Static balance improved from 10 to 16 seconds in the experimental group, while the control group showed only a minor increase (11 → 12 seconds).

Regarding explosive strength (Standing Broad Jump), students in the experimental group progressed from 200 cm to 240 cm, whereas the control group showed an insignificant change (205 → 210 cm).

Spinning-specific results also demonstrated consistent gains: in the 6-Minute Test, the distance covered increased from 1,350 m to 1,750 m (approximately 30% improvement) in the experimental group, while the control group remained practically unchanged (1,370 → 1,400 m). Similarly, the Wingate Test indicated an increase in relative peak power from 6.8 W/kg to 8.1 W/kg in the experimental group, compared to a minor variation in the control group (6.9 → 7.0 W/kg).

These data confirm that the implemented spinning program had a significant impact on overall motor performance and on capacities specific to indoor cycling.

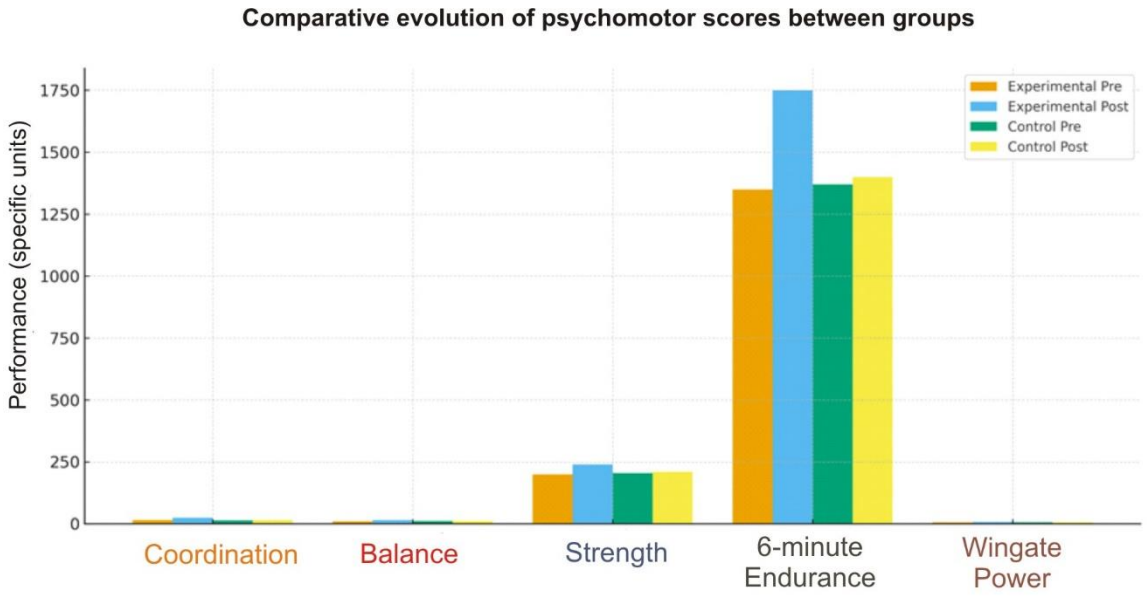

Figure 1. Comparative progression of psychomotor scores between the experimental group and the control group

Figure 1 highlights a clear improvement in the experimental group, including in the 6-minute endurance test, where students progressively covered longer distances across the intervention. This trend indicates an effective aerobic adaptation generated by the spinning program. The control group remains close to its initial values, showing no meaningful variation. The contrast between the two groups supports the specific impact of the training program and confirms that spinning contributed to the enhancement of coordinative capacities and aerobic endurance in high school students.

3. DISCUSSION

The preliminary results support the general hypothesis that a structured spinning program can contribute to the multidimensional development of high school students' psychomotor potential. Improvements observed in coordination, balance, and explosive strength align with findings reported in the literature, where studies by Chavarrias et al. (2020) demonstrated consistent enhancements in motor parameters following indoor cycling programs (Loring et al., 2023). Simultaneously, advances in

attention and verbal memory corroborate the conclusions of Nocera and colleagues (2014), who reported positive cognitive effects associated with spinning.

From a pedagogical perspective, the findings suggest that spinning can serve as a viable and engaging alternative to traditional physical education classes. Its dynamic nature and integration of rhythmic music may enhance students' intrinsic motivation, a critical factor for maintaining consistent participation. Furthermore, group-based activities promote social cohesion, an important component in the high school educational environment.

In relation to the international literature, the observed results align with recent research emphasizing the benefits of aerobic exercise on executive functions (Donnelly et al., 2016; Herting & Chu, 2018; Sibley & Etnier, 2003). Data from Reigal et al. (2020) confirmed a relationship between higher levels of physical fitness and superior cognitive performance, while systematic reviews coordinated by Donnelly and colleagues (2016) demonstrated the favorable impact of regular aerobic activity on attention and concentration (Țanasa, 2021). The convergence of these findings with the present study strengthens the argument for integrating spinning into high school physical education curricula.

However, the interpretation of results should be approached with caution. The relatively small sample size limits the generalizability of the conclusions, and the eight-week program may be insufficient to observe long-term effects. Additionally, external factors such as extracurricular physical activities, individual motivation, or baseline fitness levels were not fully controlled, representing potential sources of variability that should be addressed in future studies.

Another relevant aspect concerns the individual differences observed among students, suggesting that responses to spinning programs may vary according to sex, initial physical fitness, or educational profile. This finding justifies expanding the research with larger samples and conducting more detailed comparative analyses.

In conclusion, the discussion of preliminary results highlights spinning as a promising method for the integrated development of both motor and cognitive dimensions in high school students. The outcomes not only confirm existing literature

but also provide additional empirical evidence regarding the feasibility and effectiveness of implementing this approach in a school settings.

4. CONCLUSIONS AND RECOMMENDATIONS

The results obtained after implementing the eight-week spinning program confirm the hypothesis that this form of training significantly contributes to the development of high school students' psychomotor potential. Positive progress was observed across all investigated motor and physiological variables.

Motor coordination and static balance showed notable improvements, confirming that pedal variations in rhythm and posture changes on the bike (seated *vs* standing) effectively stimulate neuromotor control mechanisms and proprioception.

Explosive strength of the lower limbs also developed significantly, reflecting the effects of pedaling with increased resistance and interval-based workouts, which simulate demands similar to plyometric exercises.

Physiologically, both aerobic endurance (measured via the 6-minute test) and anaerobic capacity (assessed through the Wingate test) showed clear gains. These improvements indicate favorable cardiovascular and metabolic adaptations, confirming that spinning can be considered an effective method for the integrated development of the cardiorespiratory system and high-intensity exercise performance.

Overall, these interim conclusions suggest that spinning is a modern, engaging, and effective option for enhancing high school students' motor and physiological capacities. The program was well tolerated by participants and demonstrated high adherence, highlighting its feasibility within an educational context.

These intermediate findings justify expanding the research by including a larger sample, extending the program duration, and conducting more detailed statistical analyses to capture not only immediate effects but also the long-term impact of spinning on psychomotor development.

Recommendations include:

- ✓ *Integrate spinning into physical education curriculum*. Introduce structured spinning sessions as a regular component of high school physical education

classes to promote motor coordination, balance, and lower limb strength, complementing traditional PE activities.

- ✓ *Progressive intensity and Interval training.* Design spinning programs with gradual increases in resistance and interval-based workouts to maximize improvements in aerobic and anaerobic capacities while minimizing the risk of overtraining or injury.
- ✓ *Monitor physiological responses*. Use heart rate monitors and perceived exertion scales during sessions to ensure students train within safe and effective intensity zones, supporting both performance gains and cardiovascular safety.
- ✓ *Promote group-based sessions*. Encourage participation in small group spinning classes to foster social cohesion, motivation, and sustained engagement, which are essential for long-term adherence.
- ✓ *Combine spinning with complementary activities*. Integrate exercises targeting flexibility, core strength, and coordination alongside spinning to ensure a holistic development of psychomotor skills and overall physical fitness.
- ✓ *Long-Term implementation and assessment*. Extend program duration beyond eight weeks and periodically reassess participants using validated motor and physiological tests to track progress, adapt training intensity, and evaluate long-term benefits for psychomotor and cognitive development.

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