JOURNAL OF PHYSICAL EDUCATION, SPORT AND HEALTH

UNIVERSITY ARENA

vol. 8, issue 5, 2025

UNIVERSITY OF BUCHAREST

DEPARTMENT OF PHYSICAL EDUCATION AND SPORT

JOURNALS

UNIVERSITY OF BUCHAREST

DEPARTMENT OF PHYSICAL EDUCATION AND SPORT

UNIVERSITY ARENA

JOURNAL OF PHYSICAL EDUCATION, SPORT AND HEALTH

Vol. 8, issue 5, 2025

2025

The cover design & layout: EUB-BUP

University of Bucharest, Bucharest University Press

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Coperta: Designer graphic EUB-BUP, Tehnoredactare: Mariana IONICĂ

https://university-arena.unibuc.ro/

ISSN 2602-0440
ISSN-L 2602-0440

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ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-1

HEALTH-ORIENTED FITNESS IN THE CONTEXT OF THE "ACTIVE SCHOOL"

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Abstract. *Background.* In Slovakia, less than one-third of the school population meets the requirement of physical activity of 1 hour per day at medium and higher intensity levels according to WHO global recommendations. This fact gradually manifests in the quality of pupils' health-oriented fitness as an indicator of their physical health. Gradually, there is an increase in various chronic non-communicable diseases, which are directly proportional to the lifestyle of pupils. School, as a setting, is suitable for fostering a positive attitude toward physical activity, cultivating movement habits, and promoting physical activity within the framework of an active school.
Objectives. The aim of the research was to determine the current level of the physical, functional, and movement system in non-exercising 4th-grade primary pupils and subsequently apply a health-oriented program through the Active School initiative to improve overall posture concerning the dynamic function of the spine.
Methods. Regarding the methods of obtaining somatometric data, the HW-900B device was used. Functional development was monitored using the Ruffier test (sport tester), and the movement system was evaluated through standardized tests for assessing the dynamic function of the spine (Th, Sch, St, Ott, L-test; body posture – Thomas, Klein mod. Mayer). The pupils (N = 117) completed a 12-week movement program composed of 15-minute exercises performed 5 days per week during a long break.
Results. Our findings in the area of functional fitness of younger school-age pupils via the Ruffier test showed that both girls and boys fell into the range of weak fitness. In the area of somatometry, average body height and weight, as well as BMI, were similar, but significantly higher ($p<0.01$) compared to 25 years ago. Regarding posture, pupils were classified into the 3rd qualitative level, which characterizes poor posture. This was also reflected in the quality of the dynamic function of the spine. Through the health-oriented program under the Active School initiative, we observed significant ($p<0.01$) improvements in our group of pupils, both girls and boys, in terms of individual aspects of posture, overall posture, and the dynamic function of the spine. Significant ($p<0.01$) improvement was also noted in the area of functional fitness, with pupils moving from the "weak" category to the "average" category. Additionally, pupils were reclassified to the 2nd qualitative level, indicating good posture.
Conclusion. Our findings indicate that the Active School initiative is one of the viable options for improving health-oriented fitness in non-exercising pupils, whether in terms of physical development focusing on body weight, functional development, or the movement system (dynamic function and posture). *The listed study is part of the research project VEGA 1/0301/25 titled "Active School Promoting the Quality of Health-Oriented Fitness Focused on Postural Health of Pupils".*

Key words: Active School, fitness, body posture, health, pupils.

Introduction

Regular, long-term physical activity is a fundamental pillar of success in maintaining a healthy population. The concept of the so-called *Active School*, which has been gaining popularity in neighbouring countries, is gradually finding acceptance in Slovakia as well. In this context, a key factor is health-oriented fitness, which differs from performance-oriented fitness in that it is not based on performance norms but on the individual needs and abilities of each person for a healthy and active life.

Health-oriented fitness consists of several components such as muscular fitness, flexibility, aerobic (cardiorespiratory) fitness, and posture–forming the foundation of active health through the lens of active rest.

The *Active School* initiative responds to the alarming lack of physical activity (hypokinesia) and sedentary lifestyle (WHO, 2018, 2020) among children both abroad and in Slovakia, as well as to the deteriorating state of their physical and mental health (Reillz, 2008).

The primary goal of the Active School is to increase the amount of physical activity within the daily routine of school-aged children, thereby improving their overall fitness, developing physical literacy, cultivating health-oriented fitness, and ultimately also enhancing mental health as part of pupils' overall educational well-being (Bendíková, Šagát, 2024).

The primary task of the Active School is to create conditions and encourage active transport to and from school, as well as to implement various physical activities through morning warm-ups, active breaks, or exercise moments–before, during, and after lessons–linked to the subject of Physical and Sports Education. All these activities influence the overall physical and mental health of pupils throughout the school week.

In Slovakia, Physical and Sports Education is currently allocated a minimum of two lessons per week, as recommended by the State Educational Program, which in practice means about 66 hours per school year. Increasing this number is possible through discretionary hours within the School Educational Program, but this is rarely applied in practice. Therefore, as of June 2025, the Ministry of Education of Slovakia introduced the national project *"Well-being through Movement"* under the concept of *Active School*.

The project consists of five interrelated pillars, forming a compact whole, targeting lower secondary school pupils (aged 10–15), with the ambition to reach approximately 60,000 pupils across all regions of Slovakia (500 schools).

The essence of the Active School within these pillars includes Testing general motor skills (legs/36, arms/15, trunk/12 – 63 max score) in order to provide feedback to schools, pupils, and parents. Identifying opportunities to increase physical activity in the school environment.

Methodological support and school scoring, aimed at identifying each school's strengths and weaknesses and providing methodological assistance. Teacher training, focusing on modern teaching methods, approaches, and styles integrating physical activity into the educational process. Experts in school clubs, fostering a positive relationship with and interest in movement activities. Applying the Active School concept into regular school practice.

According to WHO (2020), children and adolescents aged 6–17 should engage in at least 1 hour of moderate-to-vigorous activity per day. There are recommendations suggesting that physical activity can be divided into shorter segments of at least 10 minutes, with a total of at least 90 minutes daily at moderate intensity (Sigmundová, 2012).

Improvement in general physical performance can also be achieved through intermittent activities of 20–35 minutes, three times per week, at submaximal intensity (above 80% of maximum heart rate).

Another criterion for optimizing the recommended daily activity is step count: children aged 5–19 should take at least 12,000 steps per day (Silva et al., 2015).

Enríquez-Del-Castillo et al. (2022) showed that moderate-intensity exercise improves muscle strength, cardiorespiratory fitness, and motor skills in school populations. In general, the qualitative level of physical fitness is influenced by intensity of load and its duration (Bendíková et al., 2023).

The *Active School* concept should be viewed as both a diversification of subject content and a change in one's approach to personal physical and mental health, as well as lifestyle. Lifelong physical activity should be an inseparable part of prevention against non-communicable diseases (Lavie et al., 2019; Bendíková, 2020), which are on the rise not only among adults but also among school-aged populations (Freedman et al., 2017; Koedijk et al., 2017).

The level of physical activity also reflects the stage of a child's psychological and motor development. It is proven that movement during school age affects the child physiologically and motorically, but also psychologically and socially (Ekeland et al., 2005). Research findings (Jago et al., 2005; Graf et al., 2014) indicate a strong relationship between regular physical activity and health markers (Clemente et al., 2022), such as body composition, cardiovascular and metabolic health (Seabra et al., 2020; Vermeiren et al., 2021), motor performance, posture (Hricková, Junger, 2016), and quality of life even in preschool and early school age.

Postural health is a fundamental pillar of overall health. Its most common symptom is pain, manifested through poor posture. Incorrect posture is now observable even in young children, and its occurrence increases with age. This condition is attributed to adaptation of the musculoskeletal system to reduced movement stimuli, accompanied by repetitive, one-sided movements and static overloading of muscles during prolonged sitting or standing in improper positions. If imbalances persist, the disproportion between antagonistic and agonistic muscles increases. Postural muscles take over stabilizing functions, which leads to muscle shortening the most serious consequence of muscular imbalance. On the opposite side of the shortened muscle, functional inhibition develops, with muscles becoming stretched, weakened, and losing strength (Bendíková et al., 2023).

Posture is influenced by many factors: spinal shape, muscle function, joint mobility, ligament flexibility, musculoskeletal load, and psychological condition. Correct posture assumes muscular balance, where every movement is performed economically. According to Čermák et al. (2008), posture is an individually specific way of solving the classical task of coping with gravity and maintaining body balance.

Muscle groups involved in posture are divided into postural (tonic) and phasic. Postural muscles (usually slow red fibers) ensure stability, body fixation, and posture in space. They are deeper, more fatigue-resistant, and recover more quickly. However, they tend to shorten and stiffen and often take over the work of weakened muscles. Phasic muscles (usually fast white fibres), by contrast, are responsible for movement, are more superficial, fatigue easily, and require strengthening, as they tend to weaken and stretch (Véle, 2006).

Awareness of posture is therefore essential. Correct, active posture has a preventive function, protecting against spine disorders in adulthood. Schools, where pupils spend on average 6 to 6.5 hours daily, offer an important space to cultivate quality postural health (Vidal et al., 2011).

The aim of the research was to determine changes in non-exercising fourth-grade elementary school pupils by applying an exercise program within the Active School in experimental group, focusing on:

– the overall functional state of the cardiovascular system as a manifestation of the organism's readiness for stress,

– primary somatometry with an intention for body weight,

– overall posture and dynamic spine function as a manifestation of the functionality of the muscular system.

Methods

Participants

The group we monitored consisted of 384 younger school-age pupils who attended the 4th grade of primary schools. For the purposes of the research, we selected and evaluated only the pupils from the Active School program, in whom incorrect posture and higher body weight were recorded, in a total number of N = 117, of which 60 were girls and 57 were boys. The pupils were willing to participate in the research with the consent of their legal guardians and in compliance with GDPR. The primary characteristics of the group are presented in Table 1.

Table 1. Total body posture of younger school-age pupils (N = 384)

Factors/gender	Correct body posture	Good body posture	Bad body posture	Incorrect body posture
Girls (N = 208)	N = 35 (16.83 %)	89 (42.79 %)	60 (28.85 %)	24 (11.53 %)
Boys (N = 176)	N = 25 (14.20 %)	79 (44.90 %)	57 (32.38 %)	15 (8.52 %)

Legend: N – numbers, % – percentage

Data collection

The experiment we conducted was a pedagogical, field-based, two-group, and multi-factor study. The pupils (N = 117) completed a 12-week movement program consisting of 15-minute exercises performed 5 days per week during a long break. Additionally, twice a week (Monday and Wednesday), before lessons, the pupils attended brief 10-minute lectures on health, with a focus on the cardiovascular, metabolic, and postural systems.

Example from an exercise program focusing on the cervical spine: Sit upright on a fitball, arms along the body, lower limbs at a right angle. Rotation of the head right, left 6x, bend head to the right, left 6x, half circle of the head in forward bend 6x, pressing the chin to the chest 6x, nodding the head right, left 6x, Repeat all 4x. Plus breathing exercises.

We obtained information on the qualitative effectiveness of the program from the pupils through a questionnaire that was created for the needs of the research and validated through a test/retest. Regarding the methods for obtaining somatometric data, the HW–900B device was used (Table 2). Functional development was monitored using the Ruffier test (sport tester) (Table 3), and the movement system was evaluated through standardized tests for assessing the dynamic function of the spine (Th, Sch, St, Ott, L-test) and body posture (Thomas, Klein mod. Mayer).

Test1: Basic Somatometry

The body weight and the body height were measured using HW-900B device. Subsequently, the pupils were divided into the groups listed below (table 2).

Table 2. BMI Rating and Percentile Range

Weight category (BMI)	Percentile range (%)
1. underweight (16.5 – 18.5)	< 5.0 percentile
2. normal body weight (18.5 – 25)	5.1 - 85.0 percentile
3. overweight (25.1 – 30.0)	85.1 - 95.0 percentile
4. obesity (> 30.1)	> 95.1 percentile

Test 2: Ruffier Test

The Ruffier test determines the functional state of the cardiovascular system and the body's readiness for physical exertion. This test consists of three parts. In the first part, a 2-minute observation of resting heart rate (HR) is performed while sitting. This is followed immediately by the second part, which involves performing 30 squats in 30 seconds. The final part of the test is a 2-minute cool-down, again while sitting. There is no break between the two 2-minute observation periods; they follow immediately after each other.

Measurements:
S1 – The lowest HR value during the first sitting period when fully at rest.
S2 – The highest HR value after the squats.
S3 – The lowest HR value during the second sitting period when fully at rest.
Index Calculation: IR=((S1+S2+S3)−200)/10

Table 3. Ruffier Test Index Values

	Ruffier test index
1. ≤ 3.0	excellent functional condition
2. 3.1 – 7.0	good functional condition
3. 7.1 – 12.0	average functional condition
4. 12.1 – 15.0	poor functional condition
5. ≥ 15.1	very poor functional condition

Test 3: Dynamic Spine Function

The last data acquisition method was the evaluation of dynamic spine function. It is a standardized method, typical for clinical and Physical Education (PaSE) practice, which consists of the following tests (the underlined tests were used) (Labudová, Vajcziková 2009): 1. Thomayer's test, 2. Schober's test, 3. Stibor's test, 4. Otto's test, 5. Test of lateroflexion.
Thomayer's Test (Total spinal flexibility)

Description: A deep forward bend with reach is performed while standing. The standard is for the hands to touch the mat with the fingertips. Reduced flexibility is noted by subtracting the number of centimetres the fingertips are from the mat.

Schober's Test (Lumbar Spine)

Description: A mark is made 10 cm above the 5th lumbar vertebra. Norm: When bending forward, the distance increases by 4–6 cm. Decreased flexibility: If the increase is less than the norm.

Stibor's Test (Lumbar and Thoracic Spine)

Description: The distance from the 7th cervical vertebra to the 5th lumbar vertebra is measured. Norm: When bending forward, the distance increases by 7.5–10 cm. Decreased flexibility: If the increase is less than the norm.

Otto's Test (Thoracic Spine)

Description: A mark is made 30 cm below the 1st thoracic vertebra. Norm: When bending forward, the distance increases by 2–3 cm. When leaning backward, the distance decreases by 2.5–3 cm, as the total variation should be 6 cm. Decreased flexibility: If the variation is less than the norm.

Test of Lateroflexion (Flexibility of the Lumbar Spine to the Sides R, L)

The depth of bending to the right and left is measured by the distance the middle finger of the hand moves down the thigh in a standing position after performing the maximum possible torso bend.

✓ Physiological norm: 20–22 cm.
✓ Reduced flexibility: If the extension is less than the established norm.
✓ Increased flexibility: If the extension is greater than the established norm.

Test 4: Overall Posture

The method for evaluating body posture is based on Bendíková et al. (2023). It is a visual evaluation method according to Klein and Thomas, modified by Mayer. The evaluation of individual areas was expressed as the sum of points, with each area scored 1, 2, 3, or 4 according to the current level of body posture. This was followed by a classification into qualitative body posture levels. The evaluation focused on: I. Head and neck posture II. Chest (shape) III. Abdomen and pelvic inclination IV. Spine curvature V. Frontal body posture (Evaluation of shoulders – Shoulder blades/scapulas).

Evaluation of body postures:

✓ I. Correct body posture: 5 points
✓ II. Good (almost correct) body posture: 6–10 points
✓ III. Bad body posture: 11–15 points
✓ IV. Incorrect body posture: 16–20 points

Data Analysis

In terms of data processing, we used descriptive statistical methods defined for the research based on the normality of the sample distribution: arithmetic mean (x), standard deviation (s), percentage frequency analysis (%), range (Vrmin - max), paired T-test (for comparison within the sample between V1 and V2), and unpaired T-test (between genders). We also used the chi-square goodness-of-fit test ($\chi 2$, $p < 0.01$) to express the pupils' understanding of the importance of health education (survey method: test/retest). The statistical analyses were performed using MS Excel 2016, IBM SPSS 22, and JASP 0.16.4.0 software with significance levels of $p < 0.01$ ($p < 0.05$).

Results

Our findings in the area of functional fitness of younger school-age pupils via the Ruffier test V1 (input) showed that both girls and boys were into the range of weak fitness (table 4). By completing the active school program, we noted significant improvements in the final evaluation (V2) of pupils (both girls $T_{\text{-test}} = 2.523$, $p < 0.01$ and boys $T_{\text{-test}} = 4.47$, $p < 0.01$).

Table 4. Ruffier test of pupils (N = 117)

Factors	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
Ruffier test/Girls (N = 60)	V1	14.89	4.56	12.50	26.48	13.98	
	V2	12.21	3.09	12.30	20.79	8.49	< 0.01
Ruffier test/Boys (N = 57)	V1	14.21	4.38	13.22	27.50	14.28	
	V2	12.89	3.74	11.90	21.81	9.91	< 0.01

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

In terms of body weight and BMI we recorded significant improvements in both girls (BW/T_{-test} = 2.354 $p < 0.01$) ($BMI\%T_{-test}$ = 2.121 $p < 0.01$) and boys (BW/T_{-test} = 2.442 $p < 0.01$) ($BMI\%T_{-test}$ = 2.232 $p < 0.01$) after the active school program (table 5, 6). In the area of somatometry, average body height and weight, as well as BMI, were similar, but significantly higher ($p < 0.01$) compared to 25 years ago.

Table 5. Primary somatometry of girls (N = 60)

Somatometry factors	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
Body weight/(kg)	V1	42.71	8.95	39.21	50.91	11.7	< 0.01
	V2	37.18	6.88	36.42	49.20	12.78	
Body height/(cm)	V1	143.17	7.36	130.52	144.23	14.03	< 0.01
	V2	145.67	6.50	133.20	147.81	14.61	
BMI /(percentil)	V1	27.40	4.58	28.09	30.53	2.44	< 0.01
	V2	25.16	2.37	22.86	26.48	3.62	

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

Table 6. Primary somatometry of boys (N = 57)

Somatometry factors	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
Body weight/(kg)	V1	38.97	8.55	39.6	49.0	9.4	< 0.01
	V2	34.45	9.29	35.4	45.5	10.1	
Body height/(cm)	V1	144.78	6.18	133.2	145.7	12.5	< 0.01
	V2	147.24	8.7	136.7	149.8	13.1	
BMI /(percentil)	V1	27.49	3.24	26.4	29.9	3.5	< 0.01
	V2	25.21	2.69	25.9	27.9	2.0	

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

Regarding posture, pupils were classified into the 3rd qualitative level, which characterizes poor posture. This was also reflected in the quality of the dynamic function of the spine.

Through the health-oriented program under the Active School initiative, we observed significant ($p < 0.01$) improvements in our group of pupils, both girls (N = 60) (T_{test} = -6.16**) and boys (N = 57) (T_{test} = -7.42**), in terms of individual aspects of posture, overall posture (table 7), and the dynamic function of the spine (Girls/T_{test} $p < 0.01$, Th = 6.25, Scho = 4.37; St = 4.41, Ott = 3.78, LR/LF = 3.61) (Boys/T_{test} $p < 0.01$, Th = 6.05, Scho = 4.21; St = 4.11, Ott = 3.77, LR/LF = 3.70) (table 8, 9).

Table 7. Overall posture of pupils (N = 117)

Overall posture of pupils	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
Girls (N = 60)	V1	11.4	1.8	9.0	15.0	6.0	< 0.01
	V2	9.4	1.5	6.0	12.0	6.0	
Boys (N = 57)	V1	12.4	1.9	9.0	17.0	8.0	< 0.01
	V2	10.4	1.6	8.0	15.0	7.0	

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

Significant ($p<0.01$) improvement was also noted in the area of functional fitness, with pupils moving from the "weak" category to the "average" category. From a gender perspective, we did not find significant changes between girls and boys during the initial and final measurements (Unpaired T-test p=0.0027). Additionally, pupils were reclassified to the 2nd qualitative level, indicating good posture.

Our secondary findings suggest that the 10-minute lectures on health before class, which focused on the cardiovascular, metabolic, and postural systems, were a suitable supplement and clarification for pupils with increased body weight in understanding the importance of health ($df=3$, $\chi2=8.58$, $p<0.01$). We see a positive impact through a reduction in body weight, BMI, and an improvement in the Ruffier test.

Table 8. The dynamic function of the spine of girls (N = 60)

Factors/Girls	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
$Thomayer_{-test}$	V1	15.5	2.84	-2.0	21.3	23.3	< 0.01
	V2	3.8	1.38	-2.0	4.6	6.6	
$Schober_{-test}$	V1	2.8	2.46	1.5	3.5	5.0	< 0.01
	V2	5.8	1.15	3.1	6.1	9.2	
$Stiibor_{-test}$	V1	7.1	3.35	5.2	8.0	13.2	< 0.01
	V2	9.4	1.76	9.3	10.1	19.4	
Ott_{-test}	V1	3.6	3.29	3.1	4.3	7.4	< 0.01
	V2	6.0	1.42	3.4	6.1	9.5	
$Lateroflexion^{R}_{-test}$	V1	18.5	3.13	17.0	23.2	40.2	< 0.01
	V2	22.1	2.0	18.0	23.2	41.2	
$Lateroflexion^{L}_{-test}$	V1	18.5	3.13	17.0	23.0	40.0	< 0.01
	V2	22.1	2.0	18.9	23.0	40.9	

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

Table 9. The dynamic function of the spine of boys (N = 57)

Factors/Boys	V1/V2	x	s	min	max	$Vr_{min - max}$	T_{-test}
$Thomayer_{-test}$	V1	16.9	2.92	–1	22.8	23.8	< 0.01
	V2	4.1	1.56	–2	3.5	5.5	
$Schober_{-test}$	V1	2.9	2.46	1.9	3.7	5.6	< 0.01
	V2	5.7	1.15	3.3	6.0	9.3	
$Stiibor_{-test}$	V1	7.4	3.18	5.4	8.0	13.4	< 0.01
	V2	9.4	1.76	9.2	10.0	19.2	

Ott_{-test}	V1	3.7	3.29	3.2	4.2	7.4	< 0.01
	V2	6.0	1.42	3.5	6.0	9.5	
$Lateroflexion^{R}_{-test}$	V1	18.1	3.13	16.5	22.5	39. 0	< 0.01
	V2	22.0	2.0	20.9	22.5	43.4	
$Lateroflexion^{L}_{-test}$	V1	18.3	3.13	16.5	22.5	39.0	
	V2	22.0	2.0	< 0.01	22.4	42.4	

Legend: arithmetic mean (x), standard deviation (s), variation range ($Vr_{min - max}$), paired T_{-test}

Discussion

Insufficient physical fitness and postural deviations are a common problem among children, caused by the long-term effects of poor posture stemming from various factors of a modern lifestyle, which undoubtedly include watching television, motorized transport, and a lack of physical activity (Bull et al., 2020). Children first experience functional changes within the cardiovascular, metabolic, and motor systems (Binkley, Specker, 2016; Chung et al., 2018), which are the basis for many (structural) health disorders in adulthood (Simmonds et al., 2016).

Similarly, the findings of Bendíková et al. (2024) point to changes in health-oriented fitness through somatic indicators and body posture in female pupils of younger school age. Migueles et al. (2023) confirm the positive effect of an exercise program in overweight children concerning cardiovascular and mental health.

Many health benefits are associated with musculoskeletal fitness, such as reduced coronary risk factors, increased bone mineral density (reduced risk of osteoporosis), increased flexibility, improved glucose tolerance, and greater success in activities of daily living (ADL) (Kell et al., 2001; Bouchard et al., 2007).

In the context of our findings, it is necessary to realize that the "Active School" concept should be part of the curriculum reform of every school in Slovakia. The vision is for pupils to be physically active at school for at least one hour every day. This is an achievable goal if we include pupils' transportation to school by their own effort, such as cycling or walking, and assume the active use of breaks between lessons. This could be done by transforming schoolyards and hallways into motivating exercise spaces, and by including school sports days or nature trips as part of the school's identity.

The solution is hidden in the very name, "Active School." The strength of the project lies in applying all available options that a school can use to "get pupils moving". This reality represents one of the forms of solving the current problem, which is a lack of movement among the school population with a direct impact on their health.

According to Wang (2006), it is extremely important how a pupil approaches their health even in the first grade of elementary school, as this behaviour will significantly affect their future health.

Currently, as Sachi and Vikas (2023) state in their study, postural disorders are no longer limited to the field of medicine but affect society as a whole. They play a significant role in defining an individual's social personality and are responsible for their upbringing. Since these disorders are widespread in children, the importance of preventive programs needs to be emphasized. Therefore, children should be taught correct posture, encouraged to increase physical activity, and supported in leading a healthy lifestyle. We similarly agree with this view based on our findings and confirm the possibility of improving postural health in the school environment for pupils with higher body weight and incorrect posture.

Conclusion

Our findings within the Active School research present a way of enhancing pupils' health through improvements in the cardiovascular, metabolic, and postural systems. This is evidenced by the significantly achieved results in the Ruffier test, as well as in body weight, BMI, overall posture, and with a positive impact on their spinal flexibility.

In relation to these findings, we can conclude that an appropriately and purposefully designed healthy oriented exercise program aimed at preventing and correcting postural health disorders can substantially reduce future problems with the musculoskeletal system as well as overall pupil health. The improvement in the Ruffier test, as an indicator of cardiovascular functionality, demonstrates that for pupils with higher body weight, every regularly implemented physical activity – even within the school environment – plays a crucial role. Therefore, in preschool and younger school-aged populations, it is essential to emphasize the promotion of physical activity as a source of support for health-oriented fitness.

The results indicate that correct posture and even mild postural deviations need to be identified and addressed already at this early age, since treatment and management of the consequences of such problems are not only financially, but also time-wise far more demanding in the future, with significant economic implications for health insurance systems.

Limitations of the study:

- ✓ The experimental group consisted of pupils who had poor posture and higher body weight. At the same time, they were non-exercising pupils who did not perform physical activity in the school and extracurricular environment. In this research, we did not monitor dietary factors and their impact on the monitored factors. Our research is currently larger in terms of the number of experimental groups and has a control group in terms of future generalization of the results.
- ✓ During squats, the frequency of 30 squats in 45 seconds was maintained. However, this often resulted in a potentially non-objective SHR2 measurement.
- ✓ We avoided testing immediately after prior physical exertion.
- ✓ The repeated test was carried out under the same conditions as the initial one (e.g., in the morning during the first lesson). If this standardization is not maintained, the index differences may be larger.

Acknowledgment

The listed study is part of the research project VEGA 1/0301/25 titled "Active School Promoting the Quality of Health-Oriented Fitness Focused on Postural Health of Pupils". "KEGA project 014KU–4/2025 "Pre-graduate education of physical education and sports teachers from the perspective of developing their movement literacy with an intention for postural health."

The study was conducted in accordance with the ethical standards set forth in the Declaration of Helsinki.

References

Bendíková, E. (2020). Diversification of the physical and sport education syllabi and its effects on the musculoskeletal system in young female students. *Trends in Sport Science*, 27(3), 149–155. doi.org/10.23829/TSS.2020.27.3-5

Bendíková, E., Balint, G. (2023). Selected factors influencing the qualitative level of postural health of students in Slovakia. *European Journal of Contemporary Education*, *12*(3), 756–756. doi.org/10.13187/ejced.2023.3.756

Bendíková, E., Tomková, Š., Palaščáková Špringrová, I. (2023). *Základy posturálneho zdravia [The Basics of Postural Health].* Praha, Čelákovice: Rehaspring.

Bendíková, E., Rozim, R., Talaghir, L. G. (2024). Changes in somatic indicators, body posture and health-oriented fitness among younger school-age female pupils. Revista Românească pentru Educaţie Multidimensională, 16(1), 241-256. doi.org/10.18662/rrem/16.1/82

Bendíková, E., Šagát, P. (2024). Active school and its role in promoting health of younger school-age children. *Retos,* 61, 356-366. doi.org/10.47197/retos.v61.107614

Binkley, T. L., Specker, B. L. (2016). The negative effect of sitting time on bone is mediated by lean mass in pubertal children. *J. Musculoskelet. Neuronal Interact.*, 16(1), 18–23.

Bouchard, C., Blair, S. N., Haskell, W. L. (2007). *Physical activity and health*. Champaign, IL: Human Kinetics Publishers.

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G. et al. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med.*, 54(24), 1451–1462.

Clemente, F. M., Moran, J., Ramirez-Campillo, R., Oliveira, R., Brito, J., Silva, A. F. et al. (2022). Recreational Soccer Training Effects on Pediatric Populations Physical Fitness and Health: A Systematic Review Children. 9(11). doi.org/10.3390/children9111776

Čermák, J., Chválová, O., Botlíková, V. (2008). *Záda už mě nebolí [My back doesn't hurt anymore]*. Praha: JanVašut s.r.o.

Ekeland, E. F., Heian, A., Hagen, K. B. (2005). Can exercise improve self-esteem in children and young people? A systematic review of randomised controlled trials including commentary. *British Journal of Sports Medicine*, 39(11), 792–798. doi.org/10.1136/bjsm.2004.017707

Enríquez-Del-Castillo, L. A., Ornelas-López, A., De León, L. G., Cervantes-Hernández, N., Quintana-Mendias, E., Flores, L. A. (2022). Strength and VO_{2max} changes by exercise training according to maturation state in children. *Children*, 9, 938. doi.org/10.3390/children9070938

Freedman, D. S., Butte, N. F., Taveras, E. M. et al. (2017). BMI z-Scores are a poor indicator of adiposity among 2- to 19-year-olds with very high BMIs, NHANES 1999–2000 to 2013–2014. *Obesity (Silver Spring).* 25(4), 739–746. doi.org/10.1002/oby.21782.

Graf, C., Beneke, R., Bloch, W. et al. (2014). Recommendations for promoting physical activity for children and adolescents in Germany. A consensus statement. *Obes Facts*, 7(3), 178–190

Hricková, K., Junger, J. (2016). Physical Activity and Compensation of Body Posture Disorders in Children Aged Seven. *Polish Journal of Sport and Tourism*, 23(3), 153–160.

Chung, S. T., Onuzuruike, A. U., Magge, S. N. (2018). Cardiometabolic risk in obese children. *Ann N Y Acad Sci.,* 1411(1), 166–183. doi.org/10.1111/nyas.13602

Jago, R., Baranowski, T., Thompson, D., Baranowski, J. C. (2005). Sedentary behavior, not TV viewing, predicts physical activity among 3-to7-year-old children. *Pediatric Exercise Science*, 17(4), 364–376.

Kell, R. T., Bell, G., Quinney, A. (2001). Musculoskeletal fitness, health outcomes and quality of life. *Sports Medicine.* 31(12), 863–873.

Koedijk, J. B., Van Rijswijk, J., Oranje, W. A., Van den Bergh, J. P., Bours, S. P., Savelberg, H. H. et al. (2017). Sedentary behaviour and bone health in children, adolescents and young adults: a systematic review. *Osteoporos Int.*, 28(9), 2507–2519. doi.org/10.1007/s00198-017-4076-2

Labudová, J., Vajcziková, S. (2009). *Športová činnosť pri poruchách orgánov opory a pohybu. [Sports activity for disorders of the musculoskeletal system].* Bratislava: SZRTVŠ, 2009.

Lavie, C. J., Ozemek, C., Carbone, S., Katzmarzyk, P. T., Blair, S. N. (2019). Sedentary behavior, exercise, and cardiovascular health. *Circ Res.*, 124(5), 799–815. doi.org/10.1161/CIRCRESAHA.118.312669.

Migueles, J. H., Cadenas-Sanchez, C., Lubans, D. R., Henriksson, P., Torres-Lopez, L. V., Rodriguez-Ayllon, M., Plaza-Florido, A., Gil-Cosano, J. J., Henriksson, H., Escolano-Margarit, M. V., Gómez-Vida, J., Maldonado, J., Löf, M., Ruiz, J. R., Labayen, I., Ortega, F. B. (2023). Effects of an exercise program on cardiometabolic and mental health in children with overweight or obesity: a secondary analysis of a randomized clinical trial. *JAMA Netw Open.*, 6(7): e2324839. doi.org/10.1001/jamanetworkopen.2023.24839.

Reillz, J. J. (2008). Physical activity, sedentary behaviour and energy balance in the preschool child: Opportunities for early obesity prevention. *Proceedings of the Nutrition Society,* 67(3), 317–325.

Sachi, S. Vikas, R. (2023). The importance of body posture in adolescence and its relationship with overall well-being. *Indian Journal of Medical Specialities,* 14(4), 197–205. doi.org/10.4103/injms.injms_29_23

Seabra, A., Brito, J., Figueiredo, P., Beirão, L., Seabra, A., Carvalho, M. J., Abreu, S., Vale, S., Pedretti, A., Nascimento, H., et al. (2020). School-Based soccer practice is an effective strategy to improve cardiovascular and

metabolic risk factors in overweight children. *Prog. Cardiovasc. Dis.*, 63(6), 807–812. doi.org/10.1016/j.pcad.2020.07.007.

Sigmundová D, Sigmund E, Šnoblová R. (2012). Návrh doporučení k provádění pohybové aktivity pro podporu pohybově aktivního a zdravého životního stylu českých dětí [Proposal of physical activity recommendations to support of active lifestyle of Czech children]. *Tělesná kultura*, 35(1), 9–2. doi.org/10.5507/tk.2012.001

Silva, M. P., Fontana, F. E., Callahan, E. et al. (2015). Step-count guidelines for children and adolescents: A systematic review. *J Phys Act Health*, 12(8), 1184–1191.

Simmonds, M., Llewellyn, A., Owen, C. G., Woolacott, N. (2016). Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obesity reviews: an official journal of the International Association for the Study of Obesity.*, 17(2), 95–107. doi.org/10.1111/obr.12334.

Vermeiren, E., Bruyndonckx, L., De Winter, B., Verhulst, S., Van Eyck, A., Van Hoorenbeeck, K. (2021). The effect of weight regains on cardiometabolic health in children with obesity: A systematic review of clinical studies. *Nutr Metab Cardiovasc Dis*. 31(9), 2575–2586. doi.org/10.1016/j.numecd.2021.05.020.

Véle, F. (2006). *Kineziológie: Přehled kineziologie, patokineziologie pro diagnostiku a terapii poruch pohybové soustavy [Kinesiology: Overview of kinesiology, pathokinesiology for the diagnosis and therapy of disorders of the locomotor system].* Triton: Praha.

Vidal, J., Borras, P. A., Ortega, F. B., Cantallo, P. S., Ponseti, X., Palou, P. (2011). Effects of postural education on daily habits in children. *International Journal of Sports Medicine*, 32(4), 303–308.

Wang, Y. (2006). Childhood obesity: trends and potenciál causes. *Future Child.*, 16(1), 19–45.

World Health Organization. WHO. (2018). *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World.* [cit. 2021-07-07] available: https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

World Health Organization. WHO. (2020). *WHO guidelines on physical activity and sedentary behaviour.* World Health Organization. https://iris.who.int/handle/10665/336656. License: CC BY-NC-SA 3.0 IGO, https://iris.who.int/handle/10665/336656

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 20-26
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-2

THE IMPACT OF MOTOR COORDINATION ON COGNITIVE DEVELOPMENT IN PRIMARY SCHOOL CHILDREN

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Abstract. Enhancing both physical and cognitive well-being supports children's learning, focus, and emotional balance. Coordinative capacities, skills involving balance, rhythm, spatial orientation, and reaction–represent essential components of motricity that influence attention, memory, and executive functions. Understanding the connection between movement and cognitive processes allows physical education teachers to design learning environments that foster balanced development and academic success.Our study conducted a systematic review examining the relationship between coordination skills and cognitive abilities in children aged 6–12, evaluating the effectiveness of existing research on this topic.
Methodology**:** A systematic literature review was conducted, following PRISMA guidelines, to analyze studies published between 2015 and 2025. Searches were performed in PubMed, ProQuest, Elsevier, Frontiers, and Google Scholar. Twenty peer-reviewed studies on children aged 6–12 were included, examining the effects of coordinative activities on cognitive outcomes.
Findings: Evidence shows that programs integrating coordinative exercises with perceptual, attentional, and creative tasks lead to measurable improvements in attention, working memory, and inhibitory control. Interventions combining movement with active learning also enhance children's motivation and participation in learning activities.
Conclusion: Incorporating coordinative activities into primary school physical education represents an effective and accessible strategy to promote attention, executive functioning, and overall cognitive development in children.

Keywords: cognitive skills, primary school students, psychomotor development, coordinative capacities.

Introduction

Cognitive development in childhood is closely linked to motor activity, particularly tasks that require coordination, rhythm, and precision. Coordinative capacities are defined as the set of psychomotor abilities that enable individuals to perform movements in a controlled, accurate, and efficient manner, by integrating sensory input with motor output (Meinel & Schnabel, 1987; Gallahue & Ozmun, 2012). They include balance, spatial orientation, rhythm, differentiation, and reaction ability. Recent studies have emphasized that these capacities play a crucial role not only in improving motor performance but also in supporting cognitive processes such as attention, working memory, and executive functions (Gallotta et al., 2012). For example, Donnelly et al. (2016) showed that complex motor tasks integrated in school curricula were associated with significant gains in children's selective

attention. Unlike simple physical activity, coordinative tasks require continuous problem solving and decision making, which stimulate prefrontal brain areas.At the same time, current educational contexts are strongly influenced by children's increasing exposure to screen time, which has been associated with reduced attentional capacity and weaker participation in real-world learning (Cliff et al., 2017; Tamana et al., 2019). Excessive use of electronic devices may affect the prefrontal cortex, hinder the development of attentional control, and displace physical and social interactions essential for cognitive growth (Adelantado-Renau et al., 2019; John et al., 2021; Ponti, 2023). Moreover, screen use has been linked to poorer sleep quality and impaired sustained attention (Chiu et al., 2022). Experts suggest that attention problems often appear early and are closely linked to the child's need for balance and emotional self-regulation. At the same time, motor interventions can positively influence attention and learning outcomes, as confirmed by recent studies (Romeu et al., 2023; Zheng et al., 2023). Taken together, these findings point to a dual challenge: on the one hand, sedentary behavior and digital exposure tend to reduce concentration and motivation; on the other hand, coordinative physical activities offer a promising way to counteract these effects and to stimulate higher-order cognitive functions (Kurnaz & Altinkök, 2023; Marsigliante et al., 2023). The purpose of this systematic review is therefore to synthesize evidence regarding the relationship between coordinative capacities and cognitive development in primary school children (ages 6–12), with a focus on attention and executive functions.

Methodology

This systematic literature review was conducted in accordance with the PRISMA guidelines, which provide a standardized framework for ensuring transparency and reproducibility in systematic reviews. Between January 2015 and March 2025, the following databases were searched: PubMed, ProQuest, Elsevier, Frontiers, and Google Scholar. The search strategy included combinations of the following terms: *"motor coordination", "coordinative capacities", "cognitive development", "attention", "executive functions", "primary school children"*. Studies were included if they were peer-reviewed, published between 2015 and 2025, focused on non-clinical populations of children aged 6 to 12, and examined interventions or assessments addressing coordinative capacities (e.g., balance, rhythm, orientation, reaction, differentiation) in relation to cognitive outcomes such as attention, working memory, inhibition, or cognitive flexibility. Exclusion criteria were studies conducted on clinical populations (neurological disorders, ADHD, autism, traumatic brain injury), editorials, commentaries, narrative reviews, papers outside the target age range, and studies lacking empirical data.

The initial search identified 312 records**.** After the removal of duplicates, 248 records were screened by title and abstract. A total of 53 full-text articles were assessed for eligibility, and in the final stage, 21 studies met all inclusion criteria and were retained for analysis.

Study quality and potential risk of bias were evaluated using the PRISMA checklist items, with attention to methodological clarity, sample size, intervention design, outcome measures,and reporting transparency. Key information, including author, year, sample characteristics, intervention type, outcomes, and main findings – was extracted and synthesized in a **comparative table (Table 1)**. The overall selection process is summarized in a **PRISMA flow diagram (Figure 1)**. Although a total of 30 sources were referenced in this paper, only 20 empirical studies met all inclusion criteria and were analyzed in the systematic review.

Results

The main characteristics and findings of the included studies are presented in Table 1. The overall selection process of the reviewed articles is illustrated in Figure 1.

Table 1. Summary of studies included in the systematic review (2015–2025)

Author(s), Year	Sample (age/group)	Intervention / Focus	Cognitive outcomes	Key findings
1. Greeff et al., 2018	Children 6–12	Physical activity with rhythm and spatial tasks	Working memory, attention	Improved WM and attention control
2. Contreras-Osorio et al., 2021	Primary school children	Sport-based intervention	Cognitive flexibility, inhibition	Gains in flexibility and inhibitory control
3. Shi et al., 2022	Children 7–11	Real-world exercise settings	Executive functions	Positive outcomes in EF tasks
4. Vilella-Cortez et al., 2019	Primary school children	Motor skill assessment	Academic performance	Poor motor skills linked to low school performance
5. Demetriou et al., 2018	Primary school children	Daily PE, active breaks	Motor and academic outcomes	Improved movement skills and academic engagement
6. Dollaway et al., 2024	Primary school	Structured PA	Attention, memory, spatial-temporal organization	Significant improvements
7. Shi & Feng, 2022	Children 6–12	Motor skills in social/physical environments	Coordination, fitness	Gains linked to better brain function
8. Arabi et al., 2023	Children 8–12	Coordinative exercises	EEG/brain wave activity	Higher engagement-related brain activity
9. Klizienė et al., 2023	Children 9–10	Dynamic PE program with repeated motor skill practice	Spatial orientation, sequencing, information processing; anxiety levels	Improved cognitive skills and reduced anxiety
10. Miklánková, 2019	Primary school children	Assessment of gross motor skills	Cognitive functioning, academic progress	Gross motor skills positively linked to cognition and school achievement
11. González-del-Castillo & Barbero-Alcocer, 2025	Children 6–12 (N≈2400, RCTs)	School-based PA programs (cognitively demanding tasks, PE, active breaks, sports)	Inhibitory control, working memory, cognitive flexibility, attention	Consistent improvements in inhibitory control and WM; mixed effects on flexibility; stronger when PA included executive demands
12. Savina, 2025	Preschool/early primary (5–7)	Movement-based activities in early education	Self-regulation, attention, emotional control	Movement interventions promoted better self-regulation and attentional control

13. Daly-Smith et al., 2018	School-aged children	Acute physical activity interventions (school-based)	Cognitive function, attention, memory	Short bouts of PA improved attention and classroom readiness
14. Gao et al., 2024	Children with DCD, 6–12	Assessment and intervention approaches for DCD	Executive functions, attention, planning	Evidence-based tools and interventions improve EF and motor planning
15. Schmid, 2024	Children and adults (implications for children)	Cognitive-motor entrainment (synchronization of processes)	Attention, memory, executive functions	Entrainment reduces cognitive load, improves dual-task performance
16. Zhang et al., 2024	Children (<18, focus 6–12)	Functional training for fundamental motor skills	Attention, motor competence, engagement	Functional training improved locomotor and balance skills
17. Lorås, 2020	Children & adolescents, 3–13	Curriculum-based PE vs. active controls	Motor competence, cognitive links	Curriculum PE had significant positive effect on motor competence (Hedges' g=0.69)
18. Morawietz & Muehlbauer, 2021	Children 4–15	Sports, motor-coordinative, orienteering	Spatial orientation, visuo-spatial WM	Exercise interventions improved spatial orientation and WM
19. Mura et al., 2015	Children & adolescents, 6–18	School-based physical activity programs	Attention, EF, academic achievement	PA interventions had positive effects on cognition and academic performance
20. Alvarado-Melo et al., 2024	School children/adolescents	General PA in school	Attention (especially selective attention)	PA positively associated with attention; optimal parameters unclear

Note: *PA = Physical Activity; PE = Physical Education; WM = Working Memory; EF = Executive Functions; DCD = Developmental Coordination Disorder. The table synthesizes the main characteristics of each study: author(s) and year, sample (age/group), type of intervention or focus, cognitive outcomes assessed, and key findings.*

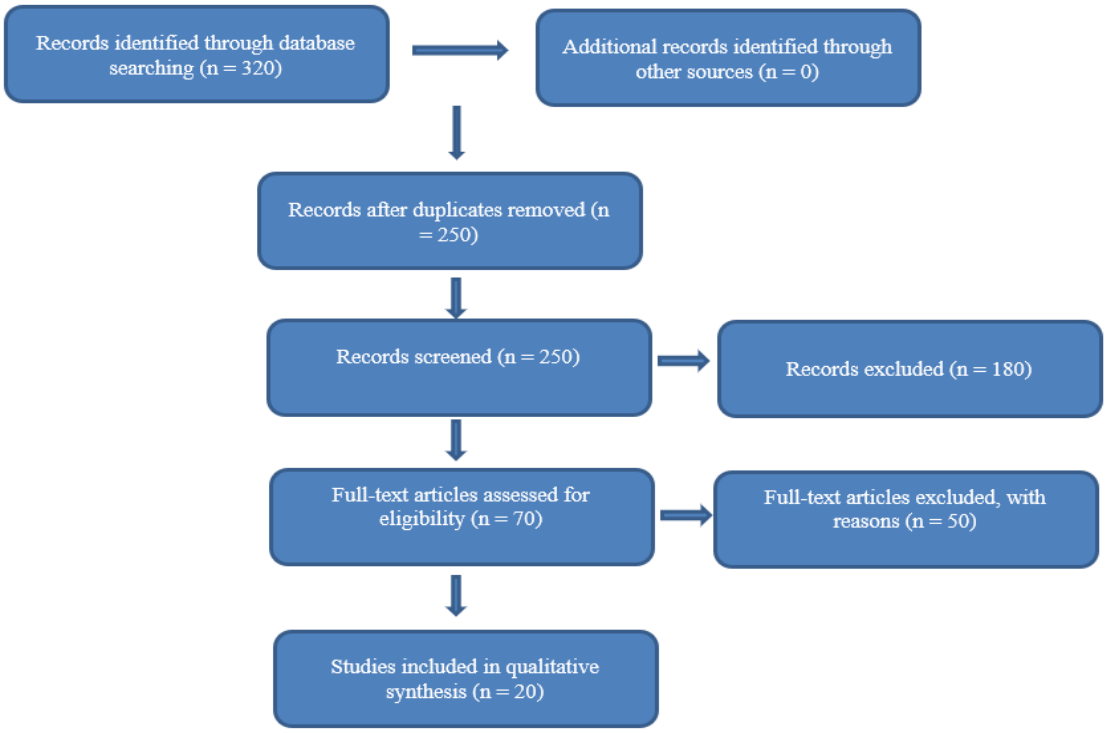

Figure 1. PRISMA flow diagram of study selection.

Note: *The diagram illustrates the identification, screening, eligibility, and inclusion process of studies for the systematic review. After removing duplicates, 250 records were screened, 70 full-text articles were assessed for eligibility, and 20 studies met all inclusion criteria.*

Discussion

This review shows that coordinative capacities and structured physical activity interventions contribute significantly to the development of attention and executive functions in primary school children. Consistent with previous findings (Gallotta et al., 2012; Donnelly et al., 2016; Klizienė et al., 2023), tasks involving balance, rhythm, and spatial orientation stimulate higher-order cognitive processes. More recent studies (Arabi et al., 2023; González-del-Castillo & Barbero-Alcocer, 2025) further demonstrate that cognitively demanding physical activities integrated in school curricula enhance working memory and inhibitory control, counteracting the negative influence of excessive screen time (Tamana et al., 2019; Savina, 2025). Additional evidence from school-based interventions shows that combining physical education with active teaching strategies lowers anxiety and improves academic achievement (Marsigliante et al., 2023; Kurnaz & Altinkök, 2023).

Several limitations must be noted. The studies varied in their design, sample size, and assessment tools, which made it harder to compare and generalize the results.Cultural and regional biases were also evident, as most research was concentrated in Europe and Asia. Another limitation lies in the lack of consistency across sleep - and attention-related measures, as highlighted by Chiu et al. (2022). Future studies should use long-term research designs and consistent intervention methods to better understand which types, intensities, and durations of coordinative activities bring the most lasting benefits. Combining physical activity with cognitive tasks and exploring these approaches in different educational contexts could open new ways to strengthen children's attention and cognitive resilience in today's digital world.

Conclusion

This systematic review confirms that coordinative physical activities play a valuable role in developing attention and executive functions in primary school children, offering a counterbalance to the negative effects of excessive screen exposure. The results are positive, but differences in methods and small participant numbers make it hard to draw firm conclusions. Future research should focus on longitudinal designs and standardized protocols to clarify long-term benefits and effective intervention parameters. From a practical perspective, integrating structured movement into daily school routines appears to be a feasible and impactful strategy to support both cognitive and physical development in children.

Authors' Contribution: The authors have equally contributed to this study.
Funding: This research received no external funding.
Data Availability Statement: Data are available upon request to the contact author.
Conflicts of Interest: The authors declare no conflict of interest.

References

Greeff, J. W., Bosker, R. J., Oosterlaan, J., Visscher, C., & Hartman, E. (2018). Physical activity with rhythm and spatial tasks improves working memory and attention in children. *Journal of Science and Medicine in Sport, 21*(6), 594–598. https://doi.org/10.1016/j.jsams.2017.10.020

Contreras-Osorio, F., Campos-Jara, C., Martínez-Salazar, C., & Chirosa-Ríos, L. (2021). Sport-based interventions and executive function in primary school children. *International Journal of Environmental Research and Public Health, 18*(13), 6886. https://doi.org/10.3390/ijerph18136886

Shi, Y., Liu, H., & Yu, X. (2022). Exercise in real-world settings enhances executive functions in school-aged children. *Frontiers in Psychology, 13*, 824315. https://doi.org/10.3389/fpsyg.2022.824315

Vilella-Cortez, J., Ferrer-Cascales, R., Albaladejo-Blázquez, N., & Reig-Ferrer, A. (2019). Motor skills and academic performance in children. *Frontiers in Psychology, 10*, 1589. https://doi.org/10.3389/fpsyg.2019.01589

Demetriou, Y., Hebestreit, A., Reimers, A. K., et al. (2018). Effects of school-based physical activity interventions on motor and academic outcomes. *Health Education Research, 33*(5), 449–464. https://doi.org/10.1093/her/cyy023

Dollaway, D., Smith, T., & Brown, P. (2024). Structured physical activity and cognitive development in primary education. *Journal of Physical Education and Sport, 24*(2), 555–563. https://doi.org/10.7752/jpes.2024.02069

Shi, Y., & Feng, Q. (2022). Motor skills in social and physical environments: Links to coordination and fitness. *Frontiers in Psychology, 13*, 927450. https://doi.org/10.3389/fpsyg.2022.927450

Arabi, R., Al-Khalil, M., & Osman, M. (2023). Coordinative exercises and brain engagement in children: An EEG study. *Neuroscience Letters, 804*, 137368. https://doi.org/10.1016/j.neulet.2023.137368

Klizienė, I., Emeljanovas, A., Mieziene, B., & Trinkuniene, L. (2023). Dynamic physical education program improves cognitive skills and reduces anxiety in children. *Children, 10*(2), 259. https://doi.org/10.3390/children10020259

Miklánková, L. (2019). Gross motor skills and academic achievement in primary school children. *Acta Gymnica, 49*(1), 3–10. https://doi.org/10.5507/ag.2019.001

González-del-Castillo, J., & Barbero-Alcocer, N. (2025). Cognitively demanding school-based physical activity and executive functions in children: A systematic review. *Frontiers in Psychology, 16*, 1456215. https://doi.org/10.3389/fpsyg.2025.1456215

Savina, E. (2025). Using movement to promote self-regulation in early childhood education. *Contemporary School Psychology, 29*(3), 461–471. https://doi.org/10.1007/s40688-024-00520-9

Daly-Smith, A., McKenna, J., Defeyter, G., & Manley, A. (2018). A review of school-based studies on the effect of acute physical activity on cognitive function in children and young people. In R. Meeusen et al. (Eds.), *Physical activity and educational achievement* (pp. 277–302). Routledge. https://doi.org/10.4324/9781315305790-16

Gao, J., Song, W., Zhong, Y., Huang, D., Wang, J., Zhang, A., & Ke, X. (2024). Children with developmental coordination disorders: A review of approaches to assessment and intervention. *Frontiers in Neurology, 15*, 1359955. https://doi.org/10.3389/fneur.2024.1359955

Schmid, D. G. (2024). Prospects of cognitive-motor entrainment: An interdisciplinary review. *Frontiers in Cognition, 3*, 1354116. https://doi.org/10.3389/fcogn.2024.1354116

Zhang, D., Soh, K. G., Chan, Y. M., Feng, X., Bashir, M., & Xiao, W. (2024). Effect of functional training on fundamental motor skills among children: A systematic review. *Heliyon, 10*(10), e39531. https://doi.org/10.1016/j.heliyon.2024.e39531

Lorås, H. (2020). The effects of physical education on motor competence in children and adolescents: A systematic review and meta-analysis. *Sports, 8*(6), 88. https://doi.org/10.3390/sports8060088

Morawietz, C., & Muehlbauer, T. (2021). Effects of physical exercise interventions on spatial orientation in children and adolescents: A systematic scoping review. *Frontiers in Sports and Active Living, 3*, 664640. https://doi.org/10.3389/fspor.2021.664640

Mura, G., Vellante, M., Nardi, A. E., Machado, S., & Carta, M. G. (2015). Effects of school-based physical activity interventions on cognition and academic achievement: A systematic review. *CNS Neurological Disorders & Drug Targets, 14*(9), 1194–1208. https://doi.org/10.2174/1871527315666151111121536

Alvarado-Melo, J. E., Leon-Ariza, H. H., & Ladino-Marín, E. V. (2024). Physical activity in students and its association with attention: A systematic review. *Retos, 53*(53), 754–762. https://doi.org/10.47197/retos.v53i53.115204

Adelantado-Renau, M., Moliner-Urdiales, D., Cavero-Redondo, I., Beltran-Valls, M. R., Martínez-Vizcaíno, V., & Álvarez-Bueno, C. (2019). Association between screen media use and academic performance among children and adolescents: A systematic review and meta-analysis. *JAMA Pediatrics, 173*(11), 1058–1067. https://doi.org/10.1001/jamapediatrics.2019.3176

Chiu, K., Lewis, F. C., Ashton, R., Cornish, K. M., & Johnson, K. A. (2022). Higher tablet use is associated with better sustained attention performance but poorer sleep quality in school-aged children. *Frontiers in Psychology, 12*, 742468. https://doi.org/10.3389/fpsyg.2021.742468

Cliff, D. P., McNeill, J., Vella, S. A., Howard, S. J., Santos, R., Batterham, M., & Rosnay, M. d. (2017). Adherence to 24-hour movement guidelines and associations with social-cognitive development in preschool children. *BMC Public Health, 17*(S5), 857. https://doi.org/10.1186/s12889-017-4858-7

John, J. J., Joseph, R., David, A., & et al. (2021). Association of screen time with parent-reported cognitive delay in preschool children of Kerala, India. *BMC Pediatrics, 21*, 73. https://doi.org/10.1186/s12887-021-02545-y

Kurnaz, M., & Altinkök, M. (2023). Exploring the impact of coordination-based movement education practices on fundamental motor movements and attention skills in 5–6-year-old children. *Journal of Physical Education and Sport, 23*(10), 2567–2583. https://doi.org/10.7752/jpes.2023.10295

Marsigliante, S., Gómez-López, M., & Muscella, A. (2023). Effects on children's physical and mental well-being of a physical-activity-based school intervention program: A randomized study. *International Journal of Environmental Research and Public Health, 20*(3), 1927. https://doi.org/10.3390/ijerph20031927

Ponti, M. (2023). Screen time and preschool children: Promoting health and development in a digital world. *Paediatrics & Child Health, 28*(3), 184–192. https://doi.org/10.1093/pch/pxac125

Romeu, J., Camerino, O., & Castañer, M. (2023). Optimising motor coordination in physical education: An observational study. *Apunts Educación Física y Deportes, 153*, 67–78. https://doi.org/10.5672/apunts.2014-0983.es.(2023/3).153.07

Tamana, S. K., Ezeugwu, V., Chikuma, J., Lefebvre, D. L., Azad, M. B., Moraes, T. J., & Mandhane, P. J. (2019). Screen-time is associated with inattention problems in preschoolers: Results from a birth cohort study. *PLOS ONE, 14*(4), e0213995. https://doi.org/10.1371/journal.pone.0213995

Zheng, Q., Chi, A., Shi, B., Wang, Y., Ma, Q., Zhou, F., & Ning, K. (2023). Differential features of early childhood motor skill development and working memory processing: Evidence from fNIRS. *Frontiers in Behavioral Neuroscience, 17*, 1279648. https://doi.org/10.3389/fnbeh.2023.1279648

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 27-32
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-3

THE IMPORTANCE OF PSYCHOMOTOR ASSESSMENT IN STRUCTURING THE TRAINING PROGRAM OF THE UNIVERSITY OF BUCHAREST'S REPRESENTATIVE FOOTBALL TEAM

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Abstract. *Background*. Within non-profile higher education, football stands out as one of the most highly regarded sports disciplines, consistently ranking among the top preferences of students at the University of Bucharest. Furthermore, students who have previously engaged in football at a competitive level, or those who demonstrate an advanced level of motor skills and sport-specific abilities, may be considered for selection to join the University of Bucharest Representative Football Team, hence the need to approach the selection process and the specific training in a more modern and objective manner.
Objectives. This study aims to underscore the significance of assessing the initial stage of psychomotor development in prospective members of the University of Bucharest Representative Football Team. Furthermore, it seeks to emphasize the necessity and timeliness of integrating psychomotor evaluation as a complementary element within the selection process and the specific training.
Methods. The participants in this study, totaling 20 male individuals, age between 19–21 years old, are first-year students enrolled in various faculties within the University of Bucharest. At the commencement of the 2024–2025 academic year, they expressed their intention to take part in the selection process for admission into the University's Representative Football Team. In addition to the motor assessments specific to the discipline, the participants underwent psychomotor evaluation through the administration of four subtests drawn from the Second Edition of the Bruininks-Oseretsky Test of Motor Proficiency.
Results. The four subtests selected from the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, for the purposes of this study included Bilateral Coordination, Balance, Running Speed and Agility, and Strength. The results obtained from the subtests assessing Running Speed and Agility, Bilateral Coordination, and Balance, while relatively homogeneous, predominantly fell within the average range when compared to the specific sample. In contrast, the scores obtained in the Strength subtest were, in the majority of cases, above the average for the specific sample of participants in the assessment.
Conclusion. The results obtained from the current research, despite being subject to certain limitations primarily related to the number of participants and the absence of the logistical resources required for the full implementation of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, affirm the significance and necessity of understanding the psychomotor profile of the students who are members of the University of Bucharest's Representative Football Team.

Keywords: students, football, psychomotor evaluation

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Introduction

As a sporting discipline, football has undergone remarkable development, progressing simultaneously in qualitative terms (motor performance) and quantitative terms (an increasing number of participants). Its practice is governed by the official rules of the game and adheres to the principles of sports ethics, thereby contributing to the fulfillment of the human drive for competition (Gozu, B., 2023).

Due to the evolution of the game of football, the organization and implementation of the processes of selection, training, and development can no longer be carried out without a theoretical and practical scientific foundation, continuously adapted to the latest innovations and trends in this sport discipline (Ciolcă, S. 2006).

Hence, there is a continuous concern to identify modern methods and means of selection and training that lead to increased efficiency of activities and the achievement of specific objectives (Hun-Hee, L., Suk-Jun, L., Hyun-Wook, K., 2024; Seitmuratov T., S., 2021; Deepak, S., Navaraj Chelliah, J., R., Yuni, A., Nirmal, M., S., Debajit, K., Masilamani, E., Soumya, J., Ethiraj, B., Bekir, E., O., 2024).

Within non-profile higher education, football stands out as one of the most highly regarded sports disciplines, consistently ranking among the top preferences of students at the University of Bucharest. Furthermore, students who have previously engaged in football at a competitive level, or those who demonstrate an advanced level of motor skills and sport-specific abilities, may be considered for selection to join the University of Bucharest Representative Football Team, hence the need to approach the selection process and the specific training in a more modern and objective manner.

Purpose

This study aims to underscore the significance of assessing the initial stage of psychomotor development in prospective members of the University of Bucharest Representative Football Team. Furthermore, it seeks to emphasize the necessity and timeliness of integrating psychomotor evaluation as a complementary element within the selection process and the specific training.

Research Methods

The participants in this study, totaling 20 male individuals, age between 19–21 years old, are first-year students enrolled in various faculties within the University of Bucharest. At the commencement of the 2024–2025 academic year, they expressed their intention to take part in the selection process for admission into the University's Representative Football Team. In addition to the motor assessments specific to the discipline, the participants underwent psychomotor evaluation through the administration of four subtests drawn from the Second Edition of the Bruininks-Oseretsky Test of Motor Proficiency. The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT–2**)** is an individually administered, standardized battery designed with clearly defined and targeted objectives aimed at assessing a wide range of motor skills in individuals aged 4 to 21 years. This test battery was specifically developed for use by professionals such as physical therapists, psychologists, physical education teachers, and coaches, providing them with a reliable and effective tool for evaluating both fine and gross motor skills (Bruininks, R.H., & Bruininks, B.D., 2005). The BOT–2 assesses abilities across four distinct motor areas:

- *Fine Manual Control* (comprising the subtests of *Fine Motor Precision* and *Fine Motor Integration*);
- *Manual Coordination* (including the *Manual Dexterity* and *Upper-Limb Coordination* subtests);
- *Body Coordination* (encompassing *Bilateral Coordination* and *Balance* subtests);
- *Strength and Agility* (including *Running Speed and Agility* and *Strength* subtests).

Due to the absence of the logistical resources required for the full implementation of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, for this research I opted for the use of only four subtests deemed relevant to .the proposed objectives, namely *Bilateral Coordination*, *Balance*, *Running Speed and Agility*, *and Strength*, each comprising the following specific items:

Bilateral Coordination:
1. Touching Nose with Index Fingers–Eyes Closed
2. Jumping Jacks
3. Jumping in Place–Same Sides Synchronized
4. Jumping in Place–Opposite Sides Synchronized
5. Pivoting Thumbs and Index Fingers
6. Tapping Feet and Fingers–Same Sides Synchronized
7. Tapping Feet and Fingers–Opposite Sides

Balance:
1. Standing with Feet Apart on a Line–Eyes Open
2. Walking Forward on a Line
3. Standing on One Leg on a Line–Eyes Open
4. Standing with Feet Apart on a Line–Eyes Closed
5. Walking Forward Heel-to-Toe on a Line
6. Standing on One Leg on a Line–Eyes Closed
7. Standing on One Leg on a Balance Beam–Eyes Open
8. Standing Heel-to-Toe on a Balance Beam
9. Standing on One Leg on a Balance Beam–Eyes Closed

Running Speed and Agility:
1. Shuttle Run
2. Stepping Sideways over a Balance Beam
3. One-Legged Stationary Hop
4. One-Legged Side Hop
5. Two-Legged Side Hop

Strength:
1. Standing Long Jump
2. Full Push-ups
3. Sit-ups
4. Wall Sit
5. V-up

Results

Statistical processing of the research results was carried out using the BOT–2 ASSIST™ Scoring and Reporting System (software specific to the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition) as well as Microsoft Excel 2013**.** The BOT–2 ASSIST™ software converts the raw total scores obtained by the participants into derived scores, enabling a standardized interpretation across subtests and age groups.

As part of the scientific methodology, the interpretation of results was based on two types of derived scores: *scale scores* (which indicate the extent to which a participant's raw score deviates from the mean score of individuals within the same age group, while accounting for the standard deviation observed in the normative sample) and *descriptive category (*which offer a qualitative representation of the approximate distance between a subject's score range and the age-normed group mean).

Table 1. Descriptive Categories Corresponding to Scale Score

Descriptive Category	*Scale Score Range*
Well-Above Average	25 or greater
Above Average	20–24
Average	11–19
Below Average	6–10
Well-Below Average	5 or less

Table 2. Scale Scores on Bilateral Coordination, Balance, Running Speed and Agility and Strength Subtests

Nr.	Name	*Scale Score*			
		Bilateral Coordination	*Balance*	*Running Speed and Agility*	*Strength*
1.	A.G	16	14	16	18
2.	A.Z.	12	13	15	21
3.	M.M.	14	15	16	21
4.	R.S.	12	12	15	20
5.	H.D.	15	13	14	18
6.	D.F.	19	18	19	24
7.	F.F.	17	19	17	22
8.	T.M.	16	16	14	21
9.	M.T.	14	13	13	23
10.	C.R.	15	18	17	20
11.	B.R.	18	17	18	24
12.	N.M.	16	15	15	19
13.	D.C.	17	12	13	21
14.	M.A.	15	12	15	22
15.	P.G.	18	18	17	23
16.	S.I.	15	15	13	23
17.	P.D.	19	17	19	24
18.	G.C.	14	13	18	22
19.	O.M.	13	14	15	20
20.	R.D.	18	16	18	24

Table 3. Descriptive Categories Corresponding to Scale Scores Results

Nr.	Name	*Descriptive Categories*			
		Bilateral Coordination	*Balance*	*Running Speed and Agility*	*Strength*
1.	A.G	Average	Average	Average	Average
2.	A.Z.	Average	Average	Average	Above Average
3.	M.M.	Average	Average	Average	Above Average
4.	R.S.	Average	Average	Average	Above Average
5.	H.D.	Average	Average	Average	Average
6.	D.F.	Average	Average	Average	Above Average
7.	F.F.	Average	Average	Average	Above Average
8.	T.M.	Average	Average	Average	Above Average

9.	M.T.	Average	Average	Average	Above Average
10.	C.R.	Average	Average	Average	Above Average
11.	B.R.	Average	Average	Average	Above Average
12.	N.M.	Average	Average	Average	Average
13.	D.C.	Average	Average	Average	Above Average
14.	M.A.	Average	Average	Average	Above Average
15.	P.G.	Average	Average	Average	Above Average
16.	S.I.	Average	Average	Average	Above Average
17.	P.D.	Average	Average	Average	Above Average
18.	G.C.	Average	Average	Average	Above Average
19.	O.M.	Average	Average	Average	Above Average
20.	R.D.	Average	Average	Average	Above Average

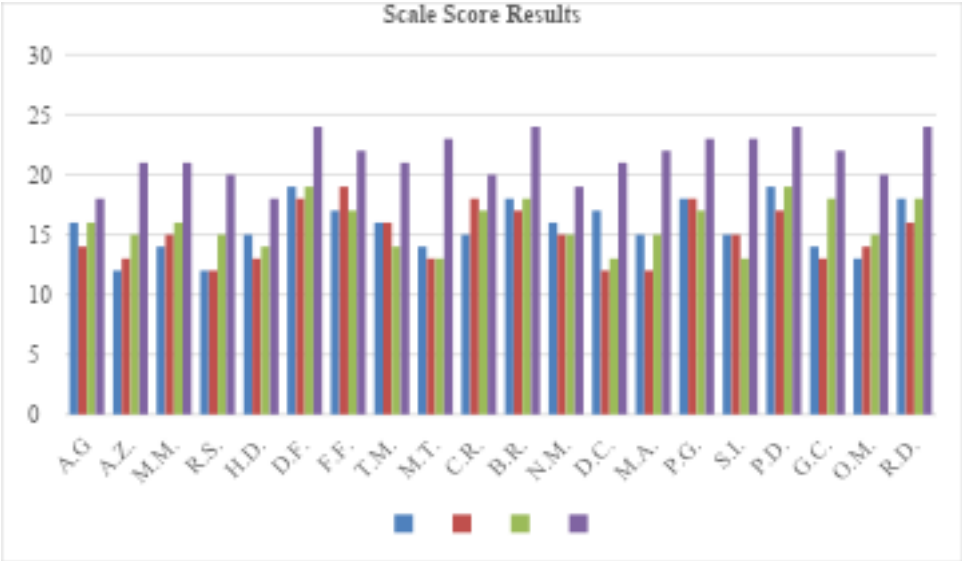

Figure 1. Scale Score Results on the Bilateral Coordination, Balance, Running Speed and Agility and Strength Subtests

Conclusions

As shown by the tables and the chart presented above, the results obtained from the subtests assessing Running Speed and Agility, Bilateral Coordination and Balance, while relatively homogeneous, predominantly fell within the average range when compared to the specific sample, which necessitates a prioritized training approach aimed at the targeted enhancement of performance indicators specific to each subtest. In contrast, the scores obtained in the Strength subtest were, in the majority of cases, above the average for the specific sample of participants in the assessment, the specific objective of this component, pursued during training, being related to maintaining high performance levels and, where applicable, further enhancing them.

The results obtained from the current research, despite being subject to certain limitations primarily related to the number of participants and the absence of the logistical resources required for the full implementation of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, affirm the significance and necessity of understanding the psychomotor profile of the students who are members of the University of Bucharest's Representative Football Team.

Authors' contributions

The authors have equally contributed to this study.

References

Bruininks, R.H., Bruininks, B.D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency, Second Edition Manual*. NCS Pearson , Inc., Minneapolis, 1–72

Ciolcă, S., M. (2006). *Fotbal – Curs de aprofundare. Pregătire antrenori*. Editura Fundației România de Mâine

Deepak, S., H., Navaraj, C., R., Yuni, A., Nirmal, M., S., Debajit, K., Masilamani, E., Soumya, J., Ethiraj, B., Bekir, E., O. (2024). *Effects of 12 Weeks Core Strength Training on Bio-motor Fitness Abilities among College Level Soccer Players.* International Journal of Human Movement and Sports Sciences, 12(6), 899 - 908. DOI: 10.13189/saj.2024.120602

Gozu, B. (2023). *Fotbal – Fundamente teoretice și practico-metodice pentru studenți.* Editura Discobolul, 17–19

Hun-Hee, L., Suk-Jun, L., Hyun-Wook, K. (2024). *Exploring of Improvement Plans for College Soccer Team Operation System.* Journal of Korean Leisure Sciences, 15(4), 53–65. 10.37408/kjls.2024.15.4.53

Seitmuratov, T., S. (2021). *Planning the annual training cycle of football students of sports improvement groups*. Eurasian Journal of Sport Science 2021; 1(2): 155–159 https://eajss.uz

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 33-36
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-4

THE IMPACT OF THE PANDEMIC PERIOD ON STUDENTS' PHYSICAL ENDURANCE: A LONGITUDINAL STUDY ON MOTOR PARAMETERS

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Abstract. *Background.* The COVID–19 pandemic had a significant impact on various aspects of daily life, including children's physical activity levels. The restrictions imposed during this period led to a considerable decrease in movement and physical exercise among students, which may be correlated with stagnation or even regression in motor development and overall physical fitness.
Objectives. The aim of this study was to assess the evolution of students' physical endurance in lower secondary education by analyzing specific motor parameters measured over three consecutive school years: 2019–2020 (pre-pandemic period), 2020–2021 (pandemic period), and 2021–2022 (recovery period).
Methodology. A group of 25 students (11 girls and 14 boys) was evaluated using four motor tests: 25-meter sprint, sit-ups, back extensions from a prone position, and standing long jump. Each parameter was recorded at the beginning and end of each school year. The Friedman test and Dunn-Bonferroni post-hoc analysis were used to evaluate statistical differences between the three time points.
Results. Most motor parameters showed statistically significant decreases in the 2020–2021 school year compared to the pre-pandemic period. In 2021–2022, notable improvements were observed, particularly in sprint performance and long jump. Running speed and explosive strength declined during the pandemic but showed a positive recovery trend in the following year, without fully reaching initial values. Trunk strength followed a more constant trajectory, yet also improved post-pandemic.
Conclusions. The results highlight a significant decrease in students' motor capacity during the pandemic. In the future, it is necessary to develop and implement a structured educational program in the coming school years to support students in regaining and improving their physical endurance.

Keywords: motor capacity, physical endurance, students, pandemic, longitudinal study.

Introduction

The COVID–19 pandemic caused unprecedented effects across all dimensions of social, economic, and educational life. One of the most deeply affected domains was physical education and motor activity among students. The sudden transition to online learning, restrictions imposed by authorities, and social isolation led to a drastic decrease in physical activity levels among children and adolescents, negatively impacting their effort capacity.
Several international studies have addressed the same phenomenon. For example, Dunton et al. (2020) highlight that children's physical activity levels decreased substantially during lockdown periods, particularly moderate to vigorous activity. Similarly, López-Bueno et al. (2020) emphasize that confinement led to a notable reduction in physical activity and a simultaneous increase in

sedentary behavior among youth populations. Moreover, Xiang et al. (2020) show that children and adolescents engaged less in outdoor activities and more in screen-based behaviors, which negatively influenced their physical and mental health. These findings reinforce the importance of investigating the pandemic's impact at the local level and contextualizing results within broader global trends.

In Romania, the lack of access to sports fields and gyms, combined with a deficient digital infrastructure for online physical education, amplified the negative effects of the pandemic on students' motor capacity. Although fewer in number, national studies confirmed this trend, showing a decline in performance in speed and endurance motor tests, correlated with the reduced physical activity levels during the pandemic.

Maintaining an adequate level of physical activity among children is essential, and global health guidelines recommend at least 60 minutes of daily physical activity for this age group. This study aims to analyze the evolution of motor capacity in middle school students from 2019 to 2022, with a focus on the changes that occurred during the pandemic.

Objectives

– To evaluate the impact of the COVID-19 pandemic on students' motor capacity;
– To compare motor performances over three consecutive school years;
– To identify statistically significant changes between years;
– To propose educational measures to improve effort capacity.

Methodology

Twenty-five students (14 boys and 11 girls) from middle school were evaluated over three consecutive school years. The measured parameters were: 25 m sprint (speed), abdominal crunches (abdominal strength), back extensions (back strength), and standing long jump (explosive strength). Tests were conducted at the beginning and end of each school year. Statistical analysis included the Shapiro-Wilk test, Friedman test, and Dunn-Bonferroni post-hoc test, with significance set at $p<0.05$.

Results and Statistical Interpretation

Table 1 – *Comparison of motor parameters, 5th grade*

Parameter/Measurement		2019–2020	2020–2021	2021–2022
T.I. – 25 m sprint	**Mean ± SD**	6.1 ± 0.25	6.33 ± 0.25	6.53 ± 0.25
	Median (IQR)	6.06 (5.9–6.3)	6.29 (6.14–6.51)	6.52 (6.32–6.73)
	p*	**<0.001**		
T.F. – 25 m sprint	**Mean ± SD**	5.87 ± 0.18	6.07 ± 0.17	6.28 ± 0.19
	Median (IQR)	6.06 (5.9–6.3)	6.29 (6.14-6.51)	6.52 (6.32–6.73)
	p*	**<0.001**		
T.I. – Trunk raise lying supine	**Mean ± SD**	8.2 ± 2.18	8.88 ± 2.14	10.16 ± 1.52
	Median (IQR)	8 (7–9.5)	9 (7–10)	10 (9–12)
	p*	**<0.001**		

T.F. – Trunk raise lying supine	**Mean ± SD**	10.16 ± 2.46	10.88 ± 2.58	12.48 ± 2.02
	Median (IQR)	10 (8–12)	11 (8.5–13)	12 (11–14)
	p*	**0.014**		
T.I. – Trunk Extension Face Lie	**Mean ± SD**	9.72 ± 2.05	10.28 ± 2.07	10.76 ± 1.16
	Median (IQR)	10 (7.5–11.5)	10 (8–12)	11 (9.5–12)
	p*	0.444		
T.F. – Trunk Extension Face Lie	**Mean ± SD**	11.8 ± 1.78	12.6 ± 1.84	12.92 ± 1.38
	Median (IQR)	12 (10.5–13)	13 (11–14)	13 (11.5–14)
	p*	0.134		
T.I. – Long jump from the spot	**Mean ± SD**	1.16 ± 0.04	1.21 ± 0.05	1.27 ± 0.05
	Median (IQR)	1.15 (1.15–1.2)	1.2 (1.15–1.25)	1.25 (1.23–1.3)
	p*	**<0.001**		
T.F. – Long jump from the spot	**Mean ± SD**	1.21 ± 0.04	1.25 ± 0.05	1.32 ± 0.05
	Median (IQR)	1.2 (1.2–1.25)	1.25 (1.2–1.3)	1.3 (1.28–1.35)
	p*	**<0.001**		

***Related-Samples Friedman's Two-Way Analysis of Variance by Ranks Test**

The data in the table represent the evolution of measured parameters among 5th-grade students. The distribution of investigated parameters was non-parametric according to the Shapiro-Wilk test ($p<0.05$). According to the Friedman tests, most parameters analyzed showed significant differences between intervals ($p<0.05$), and Dunn-Bonferroni post-hoc tests showed:

– Initial and final values for 25 m sprint were significantly higher in 2021–2022 compared to 2019–2020 and 2020–2021 ($p<0.001$);

– Initial values for abdominal crunches were significantly higher in 2021–2022 compared to previous years ($p<0.001$);

– Final values for abdominal crunches were also significantly higher in 2021–2022 compared to 2019–2020 ($p=0.022$);

– Jump distances were significantly better in 2021–2022 than in both previous years ($p<0.001$ and $p=0.002$).

Conclusions

The statistical analysis confirms a significant impact of the pandemic on students' motor capacity, with a general performance decline in 2020–2021 followed by partial recovery in 2021–2022. The need for structured intervention becomes evident given the statistically significant differences across years, which may have long-term consequences on students' health and physical development**.**

Authors' Contributions

All authors have equally contributed to this study.

References

Chen, P., Mao, L., Nassis, G. P., Harmer, P., Ainsworth, B. E., & Li, F. (2020). *Coronavirus disease (COVID–19): The need to maintain regular physical activity while taking precautions*. *Journal of Sport and Health Science*, *9*(2), 103–104. https://doi.org/10.1016/j.jshs.2020.02.001

Dunton, G. F., Do, B., & Wang, S. D. (2020). *Early effects of the COVID–19 pandemic on physical activity and sedentary behavior in children living in the U.S. BMC Public Health*, *20*(1), 1351. https://doi.org/10.1186/s12889-020-09429-3

Guerrero, M. D., Vanderloo, L. M., Rhodes, R. E., Faulkner, G., Moore, S. A., & Tremblay, M. S. (2020). *Children's movement behaviours during the COVID-19 pandemic: A comparison based on parent reports from Canada, the US, and Australia*. *Child: Care, Health and Development*, *47*(5), 681–689. https://doi.org/10.1111/cch.12852

Moore, S. A., Faulkner, G., Rhodes, R. E., Brussoni, M., Chulak-Bozzer, T., Ferguson, L. J., Mitra, R., & Tremblay, M. S. (2020). *Impact of the COVID–19 virus outbreak on movement and play behaviours of Canadian children and youth: A national survey*. *International Journal of Behavioral Nutrition and Physical Activity*, *17*, 85. https://doi.org/10.1186/s12966-020-00987-8

Mureşan, M., Iacob, S., & Tudor, A. (2021). *Evaluarea influenței pandemiei asupra activității fizice a elevilor din ciclul gimnazial*. *Revista de Educație Fizică și Sport*, *21*(2), 115–122.

Okely, A. D., Kariippanon, K. E., Guan, H., Taylor, E. K., Suesse, T., Cross, P. L., Chong, K. H., & Reilly, J. J. (2021). *Global effect of the COVID–19 pandemic on physical activity, screen time, and sleep among children and adolescents: A systematic review*. *Obesity Reviews*, *22*(S1), e13219. https://doi.org/10.1111/obr.13219

Orgilés, M., Morales, A., Delvecchio, E., Mazzeschi, C., & Espada, J. P. (2020). *Immediate psychological effects of the COVID–19 quarantine in youth from Italy and Spain*. *Frontiers in Psychology*, *11*, 579038. https://doi.org/10.3389/fpsyg.2020.579038

Pietrobelli, A., Pecoraro, L., Ferruzzi, A., Heo, M., Faith, M., Zoller, T., Antoniazzi, F., Piacentini, G., Fearnbach, N., & Heymsfield, S. (2020). *Effects of COVID–19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: A longitudinal study*. *Obesity*, *28*(8), 1382–1385. https://doi.org/10.1002/oby.22861

World Health Organization (WHO). (2020). *WHO Guidelines on Physical Activity and Sedentary Behaviour*. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789240015128

Xiang, M., Zhang, Z., & Kuwahara, K. (2020). *Impact of COVID–19 pandemic on children and adolescents' lifestyle behavior larger than expected*. *Progress in Cardiovascular Diseases*, *63*(4), 531–532. https://doi.org/10.1016/j.pcad.2020.04.013

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 37-43
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-5

THE RELATIONSHIP BETWEEN PHYSICAL FITNESS AND ACADEMIC PERFORMANCE IN UNIVERSITY STUDENTS: A CORRELATIONAL STUDY

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Abstract*. Background.* In recent years, increasing attention has been paid to the connection between physical activity and cognitive performance, especially in the academic context. The sedentary lifestyle of university students has raised concerns regarding both physical health and academic success. Previous research suggests that regular physical activity can enhance cognitive functions such as memory, attention, and executive control.
Objectives. The purpose of this study was to explore the relationship between physical fitness and academic performance among undergraduate students from the University of Bucharest. The research aimed to determine whether higher fitness levels are associated with better academic outcomes.
Methods. The study was conducted on a sample of students aged 19–21 who attended mandatory physical education classes. Physical fitness was assessed at the end of the first semester using standardized field tests: the Harvard Step Test (cardiorespiratory endurance), push-ups in 30 seconds (upper-body strength), sit-ups in 30 seconds (core endurance), and the Sit & Reach test (flexibility). Academic performance was measured based on students' final grade point averages (GPA). A lifestyle questionnaire regarding sleep, study habits, and perceived energy levels was also applied. Statistical analyses included descriptive statistics and correlation tests (Pearson/Spearman) between physical fitness scores, questionnaire responses, and GPA.
Results. Preliminary observations indicate that the overall fitness levels of participants were below the age-related average, particularly in cardiorespiratory endurance. A positive correlation is expected between higher physical fitness scores and higher academic performance, particularly in students who reported regular physical activity outside of class and better sleep habits.
Conclusion. This study highlights the potential impact of physical fitness on students' academic success. Promoting physical activity within university curricula may contribute to improved cognitive functioning and better academic outcomes. Further analysis will determine the strength and significance of these associations.

Keywords*:* physical fitness, academic performance, university students, cardiorespiratory endurance, cognitive function.

Introduction

In the current context, marked by increasing levels of sedentary behavior among the younger population, physical activity within higher education has gained strategic importance. Students are increasingly exposed to a sedentary lifestyle, with negative effects not only on physical health but also on cognitive functioning and academic performance.

Numerous recent studies indicate that physical activity influences not only somatic health but also cognitive abilities such as attention, working memory, and information processing speed. Despite this, in many Romanian universities, physical education remains undervalued in the educational process, and the relationship between fitness levels and academic success is rarely explored (Trudeau & Shephard, 2008; Donnelly et al., 2016).

This study aims to analyze this relationship among students at the University of Bucharest, using validated physical fitness testing tools and objective academic indicators.

Theoretical Foundation

Physical activity has a direct impact on the central nervous system by stimulating the release of neurotransmitters (dopamine, serotonin, norepinephrine) and neurotrophic factors (such as BDNF – Brain-Derived Neurotrophic Factor) that support cognitive processes (Ratey, 2008; Chaddock et al., 2011). Through mechanisms of neuroplasticity, physical exercise contributes to the formation of new synaptic connections, thereby enhancing learning capacity and executive functions.

According to research (Erickson et al., 2019; Singh et al., 2019), moderate to vigorous physical activity has been shown to improve working memory, sustained attention, and processing speed. Studies conducted on young populations (Torrijos-Niño et al., 2014; Van Dusen et al., 2011) have revealed a significant correlation between fitness level and academic performance, particularly in subjects such as mathematics and foreign languages.

Furthermore, according to Jean Piaget's theory of cognitive development, motor activity is essential in the construction of intelligence, and learning skills are fundamentally based on active interaction with the environment (Diamond & Ling, 2016).

The research organization

The purpose of the paper

The purpose of this research is to explore the relationship between physical fitness and academic performance in undergraduate students enrolled at the University of Bucharest. This paper aims to determine whether students with higher levels of general physical preparedness–assessed through standardized fitness tests–achieve better academic outcomes, as measured by their semester GPA.

By combining objective data from physical fitness evaluations (muscular strength, endurance, flexibility, and cardiorespiratory capacity) with academic results and lifestyle indicators (such as sleep, study habits, and self-reported energy levels), the study seeks to contribute to a better understanding of how physical health may influence cognitive functioning and educational success. The findings may support the integration of physical activity into higher education curricula as a means of enhancing student performance and well-being.

The hypothesis of the research

The research hypothesizes that there is a significant relationship between students' physical fitness level and their academic performance.

The objectives and the tasks of the research

Objective:

The main objective of this research is to analyze the relationship between physical fitness and academic performance in university students, by assessing various components of physical fitness and comparing them with academic outcomes.

Research tasks:

1. To assess the physical fitness level of students using field-based tests:
   – push-ups (upper body muscular strength),
   – sit-ups (core endurance),
   – Harvard Step Test (cardiorespiratory fitness),
   – Sit and Reach (flexibility).
2. To collect and centralize academic performance data (semester GPA).
3. To administer a lifestyle questionnaire covering study habits, sleep, perceived energy, and the subjective impact of physical activity on concentration.
4. To perform statistical analyses to determine correlations between fitness test results, academic performance, and lifestyle indicators.
5. To interpret the findings in the context of existing literature and highlight potential implications for educational and physical activity policies in higher education.

The research stages

The research was conducted during the first semester of the 2024–2025 academic year, within the Department of Physical Education at the University of Bucharest. The study involved a total of 60 undergraduate students enrolled in physical education classes, covering various sport disciplines such as fitness, aerobics, and table tennis.

Out of the 60 participants, 36 were female and 24 were male, aged between 19 and 21 years. All participants voluntarily took part in the research and were in good health, without physical limitations that could affect their performance during testing.

The research was structured in the following stages:

– *Initial organization and participant selection* – students were informed about the purpose and confidentiality of the study, and consent was obtained.

- Fitness testing phase – the following tests were administered during scheduled practical classes:
- Push-ups in 30 seconds (upper body muscular strength),
- Sit-ups in 30 seconds (core endurance),
- Harvard Step Test (cardiorespiratory fitness),
- Sit and Reach (flexibility).

– *Collection of academic performance data* – semester Grade Point Averages (GPA) were recorded based on self-reporting, cross-validated when possible.

– *Lifestyle questionnaire* – participants filled out a short online questionnaire regarding their sleep duration, study habits, physical activity frequency, daily energy levels, and their perception of how physical activity affects academic focus.

– *Data processing and statistical analysis* – results were organized in spreadsheets and analyzed using descriptive statistics and correlation tests (Pearson).

The research methods

In our approach we used the following research methods:

a. *The study of specialized literature*, in order to understand the theoretical relationship between physical activity and cognitive performance, and to identify validated fitness assessment tools;

b. *The statistical-mathematical method*, for processing and interpreting the quantitative data collected from the physical fitness tests and academic performance;
c. *The experimental method*, by organizing and applying a set of physical fitness tests in real-life educational conditions;
d. *The graphical method*, used to visually represent the statistical results and trends observed;
e. *The questionnaire-based survey method*, in order to gather information on students' lifestyle, daily energy levels, sleep habits, study time, and the subjective impact of physical activity on concentration.

The questionnaire was developed using Google Forms and was administered online via email, ensuring accessibility and anonymity. Responses were automatically recorded and exported for analysis.

The spectrum of questions in our questionnaire included aspects related to:

- frequency and type of physical activity practiced outside the physical education class,
- average hours of individual study per day,
- average hours of sleep per night,
- perceived daily energy level,
- and the self-reported impact of physical activity on academic focus and mental clarity.

Results and interpretation

The research involved 60 students (36 female and 24 male) who were assessed through a series of standardized physical fitness tests: push-ups (30 seconds), sit-ups (30 seconds), the Harvard Step Test (cardiorespiratory endurance), and the Sit and Reach test (flexibility). Academic performance was evaluated based on students' self-reported semester GPA. Additionally, data from a lifestyle questionnaire provided insight into habits related to study, sleep, and perceived energy levels.

Table 1 summarizes the average performance of participants across all physical fitness tests and their academic results.

Table 1. Descriptive statistics of the study variables

Variable	Mean	Min	Max	Std. Deviation
Push-ups (30 sec)	17.4	10	26	4.15
Sit-ups (30 sec)	19.4	13	27	3.57
Harvard Step Test (score)	75.3	54	112	13.45
Sit & Reach (cm)	18.7	11	24	3.02
Academic GPA	7.92	5.00	9.80	1.17

Descriptive analysis revealed that the average academic performance was 7.92, with values ranging from 5.00 to 9.80. In terms of physical performance, students averaged 17.4 push-ups, 19.4 sit-ups, 75.3 points on the Harvard Step Test, and 18.7 cm in the Sit and Reach test.

Statistical correlation analysis (Pearson) (table 2 and figure 1) showed the following:

• A very strong positive correlation between flexibility (Sit and Reach) and academic performance (r = 0.82)

• A strong positive correlation between cardiorespiratory fitness (Harvard Step Test) and GPA (r = 0.76)

• Moderate correlations for sit-ups (r = 0.37) and push-ups (r = 0.20) in relation to GPA

These results suggest that students with higher general physical fitness, particularly in flexibility and cardiovascular endurance, tend to achieve better academic outcomes.

Table 2. *Correlation matrix*

	Push-ups	Sit-ups	Harvard Test	Sit & Reach	Academic GPA
Push-ups	1.00	0.88	0.39	0.07	0.20
Sit-ups	0.88	1.00	0.51	0.23	0.37
Harvard Step Test	0.39	0.51	1.00	0.70	0.76
Sit & Reach	0.07	0.23	0.70	1.00	**0.82**
Academic GPA	0.20	0.37	0.76	**0.82**	1.00

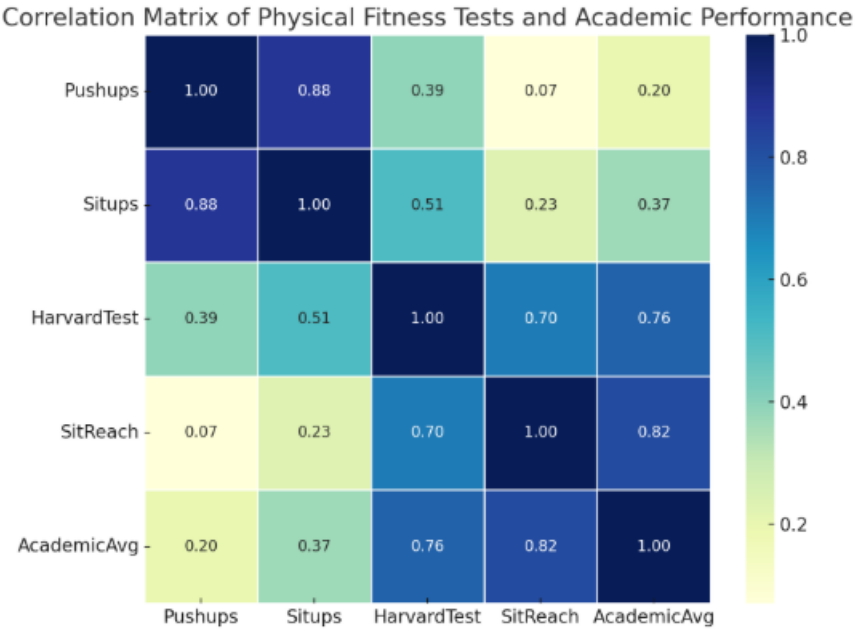

Figure 1. Correlation Matrix.

Conclusions and proposals

The findings of this research support the existence of a significant relationship between physical fitness and academic performance in university students. Among the physical tests administered, flexibility (Sit and Reach) and cardiorespiratory endurance (Harvard Step Test) showed the strongest positive correlations with academic achievement.

While muscular endurance (sit-ups) and upper-body strength (push-ups) also displayed positive relationships with GPA, their correlations were more moderate. These results suggest that physical components related to oxygen intake, circulation, and general mobility may have a closer connection with cognitive functioning and learning outcomes.

Furthermore, data collected through the lifestyle questionnaire revealed that most students maintain average study and sleep habits, and that a majority perceive physical activity as beneficial to their academic focus–supporting the hypothesis indirectly.

Proposals:

1. To promote and integrate regular aerobic and flexibility-based physical activities within the university curriculum, as they appear to be associated with better cognitive performance (Fedewa & Ahn, 2011; Tomporowski et al., 2008).

2. To encourage interdisciplinary research and programs that highlight the benefits of physical activity on academic and mental performance in higher education.

3. To use lifestyle questionnaires and simple field tests as screening tools in student populations, helping identify those who might benefit from increased physical activity.

4. To raise awareness among both students and faculty about the role of physical fitness not only in health, but also in educational success.

Limitations of the study:

- While the results are promising and support the initial hypothesis, certain limitations must be acknowledged. The sample consisted exclusively of students from the University of Bucharest, and the findings may not be generalizable to other academic or cultural contexts. Additionally, the academic performance data was self-reported, which may introduce bias or inaccuracy.
- Another limitation is the cross-sectional design of the study, which captures only a snapshot in time and does not account for possible changes in fitness or academic performance over a longer period. Moreover, while the questionnaire provided useful subjective insights, it relied on self-assessment, which may not always reflect objective behavior or psychological states.
- Future research could address these limitations by incorporating larger and more diverse student samples, verifying academic data institutionally, and applying a longitudinal approach to monitor progress over time.

References

Erickson, K. I., Hillman, C. H., & Kramer, A. F. (2019). *Physical activity, brain, and cognition*. Current Opinion in Behavioral Sciences, 29, 89–95.

Torrijos-Niño, C., et al. (2014). *Physical fitness and academic achievement in adolescents: a systematic review*. Journal of Pediatrics, 165(6), 1170–1178.e1.

Shephard, R. J. (1997). *Curricular physical activity and academic performance*. Pediatric Exercise Science, 9(2), 113–126.

WHO. (2010). *Global Recommendations on Physical Activity for Health*. World Health Organization.

Singh, A. S., et al. (2019). *Effects of physical activity interventions on cognitive and academic performance in children and adolescents: A meta-analysis*. BJSM, 53(10), 640–647.

American College of Sports Medicine (ACSM). (2018). *ACSM's Guidelines for Exercise Testing and Prescription* (10th ed.).

Donnelly, J. E., et al. (2016). *Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review*. Medicine & Science in Sports & Exercise, 48(6), 1197–1222.

Diamond, A., & Ling, D. S. (2016). *Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not*. Developmental Cognitive Neuroscience, 18, 34–48.

Ratey, J. J. (2008). *Spark: The Revolutionary New Science of Exercise and the Brain*. Little, Brown.

Chaddock, L., Pontifex, M. B., Hillman, C. H., & Kramer, A. F. (2011). *A review of the relation of aerobic fitness and physical activity to brain structure and function in children*. Journal of the International Neuropsychological Society, 17(6), 975–985.

Fedewa, A. L., & Ahn, S. (2011). *The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: A meta-analytic review*. Research Quarterly for Exercise and Sport, 82(3), 521–535.

Tomporowski, P. D., et al. (2008). *Exercise and children's intelligence, cognition, and academic achievement*. Educational Psychology Review, 20(2), 111–131.

Trudeau, F., & Shephard, R. J. (2008). *Physical education, school physical activity, school sports and academic performance*. International Journal of Behavioral Nutrition and Physical Activity, 5(1), 10.

Van Dusen, D. P., et al. (2011). *Associations of physical fitness and academic performance among schoolchildren*. Journal of School Health, 81(12), 733–740.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 44-47
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-6

ANALYZING DIFFERENCES IN ANTHROPOMETRIC AND BODY COMPOSITION AMONG ACADEMIC STUDENTS BASED ON GENDER AND AGE CHARACTERISTICS

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Abstract. *Background*. The relationship between physical and mental health creates a cycle that supports or hinders academic achievement. Students who prioritize healthy body composition through balanced nutrition, regular exercise, and developing positive body image through self-acceptance and realistic expectations often find themselves better equipped to handle academic pressures. Understanding body composition metrics is essential, as they provide valuable insights into health status while considering gender, age, lifestyle, and physical activity levels.
Objective. This study explored gender-specific differences in body composition among active students aged 20–25.
Methods. A longitudinal approach was used with a sample of 144 males (50.8%) and 139 females (49.2%). Key body composition metrics included height, weight, BMI, fat mass, muscle mass, bone mass, and water mass. Measurements were collected with a Tanita Health Monitor and an electronic stadiometer. Statistical analysis employed ANOVA with significance set at $p < 0.05$.
Results. Significant differences were observed among male students in BMI and muscle mass ($p < 0.05$). Female students displayed significant variations in fat mass across age groups. Other parameters showed no significant gender-based variation. Trends remained within reference norms.
Conclusions. Findings emphasize the importance of monitoring gender- and age-specific differences in student populations. Such insights can help develop health strategies and university wellness programs promoting holistic student well-being.

Keywords: anthropometrics; body mass index; fat mass; muscle mass; bone mass; water mass.

Introduction

University students often undergo lifestyle transitions that significantly impact their physical and psychological health. Balancing academic responsibilities with maintaining healthy habits can be challenging, yet it is crucial for long-term well-being and academic success (Harris, 2024). Body composition and anthropometric measurements are reliable indicators that help to identify health risks and physical development trends among young adults. Numerous studies have emphasized the role of gender and age in shaping differences in body composition, with males typically showing greater lean body mass, while females present higher body fat percentages (Russel et al., 2020; Martinez & Zhou, 2023).

This study focuses on Romanian university students aged 20–25, aiming to analyze gender- and age-related differences in key body composition variables. By investigating these differences, the research contributes to developing targeted health promotion strategies and university wellness programs that can support both physical and academic performance.

Methods

Design. The study employed a cross-sectional design. Measurements were collected during scheduled physical education classes under standardized conditions.

Participants. A total of 283 students participated (144 males, 139 females), aged between 20 and 25 years. Participants were recruited voluntarily from the University of Bucharest. Inclusion criteria were: (a) enrollment as a full-time student, (b) participation in at least two weekly physical education sessions, and (c) absence of chronic diseases. Exclusion criteria included recent injuries, acute illness, or refusal to provide informed consent.

Measurements. Anthropometric and body composition variables included height, weight, BMI, fat mass, muscle mass, bone mass, and water mass. Height was measured with an electronic stadiometer (accuracy 0.1 cm). Body composition metrics were assessed using a Tanita Health Monitor. All participants were measured barefoot, in light sportswear, and instructed to avoid food and intense exercise 3 hours prior to assessment.

Statistical Analysis. Descriptive statistics (mean ± SD) were calculated. Group comparisons were performed using ANOVA and independent-samples t-tests. Statistical significance was set at $p < 0.05$. Effect sizes were calculated (Cohen's d for t-tests, η^2 for ANOVA) to assess the magnitude of observed differences.

Results

Analysis revealed statistically significant gender- and age-specific differences. Male students aged 23–25 had higher BMI and muscle mass compared to the 20–22 group, while female students aged 23–25 had higher fat mass compared to younger peers. No significant differences were found for bone mass or water mass. Descriptive statistics and inferential results are presented in Table 1.

Table 1. Descriptive statistics (M ± SD) and significance tests for anthropometric and body composition parameters. n.s. = not significant

Parameter	Male 20–22	Male 23–25	Female 20–22	Female 23–25
BMI (kg/m^2)	23.4 ± 2.1	24.8 ± 2.0*	21.8 ± 1.9	22.6 ± 2.1
Muscle Mass (kg)	39.5 ± 3.8	42.2 ± 4.1*	28.7 ± 3.0	29.1 ± 3.2
Fat Mass (kg)	15.2 ± 2.4	15.7 ± 2.3	20.1 ± 2.8	22.5 ± 3.0*
Bone Mass (kg)	3.6 ± 0.3	3.7 ± 0.4	2.8 ± 0.2	2.9 ± 0.2
Water Mass (kg)	45.1 ± 4.2	46.0 ± 4.3	36.8 ± 3.6	37.1 ± 3.7

* $p < 0.05$ indicates significant difference between age groups.

Discussion

The present study provides robust evidence of gender – and age-related variations in body composition among university students. Male students aged 23–25 demonstrated higher BMI and muscle mass, which can be attributed to continued physiological development and possible engagement in resistance-based training. This result aligns with Williams & Clarke (2023), who reported a strong correlation between muscle mass and metabolic health outcomes in young adults. The increased fat mass among older female students reflects potential metabolic changes and lifestyle influences, consistent with Martinez & Zhou (2023), who highlighted age-related shifts in fat distribution among women in their early twenties.

The absence of significant changes in bone mass and hydration suggests stability in these indicators during early adulthood, supporting Anderson (2022). These results emphasize the necessity for tailored health promotion strategies within universities. Male students would benefit from structured strength and conditioning programs, while female students may require enhanced nutritional education and interventions focused on healthy body fat management. Furthermore, integrating psychological counseling on body image can help mitigate risks of negative self-perceptions and enhance overall student well-being.

Conclusions

This study demonstrates clear gender- and age-specific differences in anthropometric and body composition measures among Romanian university students. Older male students displayed higher BMI and muscle mass, while older female students showed increased fat mass. These findings support the implementation of university-based health promotion programs that integrate physical activity, nutritional counseling, and psychological support. By adopting such strategies, universities can contribute to healthier lifestyles, improved academic performance, and long-term well-being. Future studies involving larger and more diverse student cohorts will be essential to validate and expand these results.

Limitations

Several limitations should be noted. First, the study sample was restricted to a single university, limiting generalizability to broader student populations. Second, lifestyle variables such as diet, sleep, and stress were not assessed, although they play important roles in body composition. Third, the cross-sectional design precludes causal interpretations of observed associations. Future research should adopt longitudinal designs, include multiple institutions, and incorporate lifestyle and psychosocial factors for a more comprehensive analysis.

Conflict of interests

There is nothing to declare.

Acknowledgment

The author acknowledges the University of Bucharest, Department of Physical Education and Sport, for academic support.

Authors' contributions

Florin Marin Liţoi designed the study, simulated data, analyzed results, and wrote the manuscript.

References

Harris, J. (2024). Teaching health-related exercise at key stages 1 and 2. USA: Human Kinetics.

Kosslyn, S. M. (2023). Image and brain: The resolution of the imagery debate. MIT Press.

Russel, F. D., Coppell, A. L., & Davenport, A. P. (2020). In vitro enzymatic processing of radiolabeled big ET–1 in human kidney. Biochemical Pharmacology, 55(5), 697–701.

Wager, T. D., Rilling, J. K., Smith, E. E., Sokolik, A., Casey, K. L., Davidson, R. J., & Cohen, J. D. (2021). Placebo-induced changes in FMRI in the anticipation and experience of pain. Science, 303(5661).

Publication manual of the American Psychological Association. (2001). Washington DC: APA.

Liţoi, F. M. (2023). Physical activity and health outcomes among Romanian students: A comparative analysis. Journal of Physical Education and Sport, 23(4), 112–120.

Language Development in Middle Childhood. (2024). Retrieved from http://www.education.com/reference/article/language-development-middle-childhood/

Smith, A., & Johnson, K. (2022). Body image and self-perception in young adults. International Journal of Health Studies, 15(3), 45–57.

Martinez, L., & Zhou, Y. (2023). Gender differences in body composition: A cross-cultural study. Journal of Human Kinetics, 34(2), 55–67.

Brown, P. (2024). The role of hydration in student health. Nutrition & Fitness Review, 12(1), 77–84.

Anderson, T. (2022). BMI trends in European student populations. European Journal of Sport Science, 18(5), 201–210.

Chen, W., & Park, S. (2021). Body composition and academic achievement: Correlational findings. Asian Journal of Physical Health, 9(2), 99–108.

Liţoi, F. M. (2022). The impact of lifestyle factors on Romanian students' performance. Proceedings of the National Conference on Sport and Education, Bucharest.

Nguyen, H., & Patel, R. (2024). Body composition and stress management in university students. Global Health Research, 17(1), 33–42.

Williams, D., & Clarke, J. (2023). Muscle mass and metabolic health in student populations. Journal of Exercise Physiology, 25(6), 87–96.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 48-55
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-7

METHODS AND MEANS RELATED TO RUGBY TAG IN SECONDARY SCHOOL CASE STUDY

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Abstract Background**.** Physical inactivity among school-aged children has become a growing concern, particularly during the sensitive period of puberty, where sedentary behaviors threaten the physical, psychological, and intellectual development of youth. Schools play a vital role in addressing this issue, offering structured physical education lessons that promote long-term engagement in movement and sport. One promising avenue for increasing motivation and participation in physical education is through team sports that combine playfulness with social interaction. Tag rugby, a non-contact version of rugby, offers an ideal introduction to the game, particularly for middle school students, by combining fun, dynamic gameplay with the development of motor, cognitive, and social skills.
In recent years, several studies have highlighted the educational value of tag rugby in schools, demonstrating its capacity to foster teamwork, enhance tactical understanding, and support the holistic development of children. Despite the growing international attention, the popularity and application of tag rugby remain limited in Romania, underscoring the need for targeted pedagogical research and innovation. This study was motivated by the desire to explore and optimize the teaching methods and tools used for introducing tag rugby to middle school students, aiming to increase their enthusiasm for physical activity and contribute to the promotion of this sport within the Romanian educational system.
Objectives.The purpose of this paper was to dentify the teaching-learning methods and means used for the initiation of pupils in rugby-tag at the gymnasium level.
Methods. Bibliographic study method, observation method, case study method, statistical-mathematical method.
Results.The intervention programme is practical and can be successfully applied since there were significant differences from the initial to the final test at the level of arithmetic means, namely, in test 1 the difference is 2.4 and 1.95 points, in test 2 it is 2.9 and 1.55 points, in test 3 the value is 2 and in the last test the difference is 2 points and 1.43 seconds.
At the initial test the group of students obtained low results in conditions of moderate homogeneity presented by the minimum value 0.10% and maximum 0.19%, later after the application of the intervention programme by the specialist teacher, the students have gained significant progress in conditions of homogeneity with high degree, which is represented by the coefficient of variability minimum 0.06% and maximum 0.1 and than in test 3, the value is 0.11%, which tells us that in the results in view of the technical detriment of rugby tag, the group presented homogeneity with moderate character.
Conclusion. Research has shown that initiation into tag rugby at middle school level is most effective through the combined use of the global method, the playful method, the small-sided and isolated game phases method, and the global-analytical-global algorithm. It has also been confirmed that heuristic methods, based on personal investigation and problem solving in game situations, are essential for the development of technical and tactical skills and analytical thinking. In addition, the use of specific exercises, preparatory games, and the actual game of tag rugby proved to be practical and effective, leading to significant progress in the motor, cognitive, and affective performance of students.

Keywords: Tag rugby, teaching-learning methods and means, physical education, middle school, motor skills, teamwork.

Introduction

According to Dreve (2019), rugby is a long-lasting sport, with interruptions in play due to set pieces or penalties imposed by the rules. The actions encountered in any game are extremely varied and involve the use of all motor skills.

The introduction of rugby-tag within the middle school physical education framework offers an opportunity to diversify instructional approaches and increase lesson attractiveness, particularly in a period when students' motivation for structured physical activity often declines. As a non-contact and simplified variant of rugby, rugby-tag promotes active participation in a controlled environment, where the focus shifts from contact-based skills to tactical understanding, spatial awareness, teamwork, and cognitive engagement. These elements are essential in physical education settings, where the goals extend beyond physical conditioning to include social, psychological, and educational dimensions.

According to Dreve (2017), like any other sport, rugby has several fundamental components that define it: technique, tactics, physical, psychological, and other components. Understanding how these are combined leads to performance. Currently, most coaches closely monitor the development of the physical component, as the technical and tactical components cannot be maintained at a high level without good conditioning.

Rugby-tag has been increasingly recognized in educational research as a sport that stimulates not only the learning of basic motor patterns (such as running, passing, and evasion techniques) but also the acquisition of decision-making skills, cooperative strategies, and the capacity to apply learned techniques within game contexts. Importantly, the non-contact nature of rugby-tag reduces barriers to participation for a wide range of students, making it a suitable and inclusive option within the school setting.

In light of growing concerns about physical inactivity and its long-term health consequences, schools have a critical role in promoting physical literacy, defined not only by movement capacity but also by confidence, motivation, and understanding of game dynamics. This study investigates how the systematic application of methodological strategies – including preparatory games, algorithmic teaching, and heuristic methods – can enhance the technical-tactical learning process in rugby-tag and contribute to improving both the physical and cognitive engagement of middle school students.

Subjects and research

As part of the research, a group of 20 fifth-grade students participated, consisting of 12 girls and 8 boys. It is important to note that these students had already developed a set of fundamental and sport-specific motor skills and abilities related to rugby-tag during their primary school years.

Organisation of research

The period during which the scientific research was organized and conducted was from February 20 to May 11, 2023. The case study involving the fifth-grade class took place at "Sfântul Andrei" Gymnasium School in Bucharest, Romania. The fifth-grade students participated in two weekly physical education lessons focused on rugby – tag - specific themes.

Instruments used in the study

In our scientific research, we used the following tools: four assessment tests, the fifth-grade learning unit for tag rugby, and observation protocols.

At the beginning and end of the case study, we conducted an initial test and a final test at the fifth-grade level. Both tests consisted of four tests through which we assessed the level of technical and tactical preparation of the students.

We note that in tests 1, 2, and 4, students were evaluated twice, with the first grade representing their technical preparation level and the second grade illustrating their success in performing the given exercise, represented by the number of successful passes out of 10 in tests 1 and 2, and the time taken to complete the course in test 4. Test 3 evaluates the level of tactical preparation by means of a grade.

Test 1 – Passing from a standing position

Objective: To evaluate passing technique from a standing position, level of execution (position, hands, arms) and number of successful passes out of 10.

Description: Two students face each other (5 meters apart), passing the ball from a standing position, at hip level.

Dosage: 1 set, 10 repetitions each.

Materials: 10 balls, stopwatch, whistle, 20 cones.

Test 2 – Passing while running "in the tunnel"

Objective: to evaluate the technical process of passing the ball while running from the hip level. The correctness of the execution of the process from a technical and regulatory point of view (passing backwards) as well as the number of passes executed while running, out of the total number: 10, are taken into account.

Description: The subjects form two columns (they will remain in place during the exercise) facing column number 3 (which will be running). The students in the first two columns are 7-8 meters apart. The subjects in column number 1 each have a balloon in their hands. One by one, the students in column 3 start running. They perform the following: catch the balloon (from the front), run with the balloon held in both hands, and pass the balloon backwards.

Methodological instructions: there will be 5 students in columns 1 and 2 (10 in total), and the remaining 10 students will stand in column 3. Column 3 will be tested in the given exercise. The first series will be carried out to understand the exercise, as the test is complex and completely unknown to the students; the results obtained in the next 2 series will then be recorded. After 3 series, column 3 will be changed, with the students from the other 2 columns.

Materials: 11 cleats, 5 balls;

Test 3 – The big square

Objective: to assess the technical and tactical skills of the students. Each student will be graded on their tactical conduct.

Description: a square with sides measuring 10 meters will be formed, with two defenders positioned on each side. Four students will attack from the center of the square with the aim of scoring a try on any of the sides of the square. The try is not scored if the ball carrier crosses the goal line and is touched with two hands by a defender. Defenders will move strictly sideways to the right or left along the length of their own side. The attackers can move freely within the square.

Methodological instructions: after the 5-minute half, the attackers will switch with 4 defenders and the exercise will resume.

Teaching materials: 4 cones, 1 ball;

Dosage: 1 series, 5 minutes.

Test 4 – Technical course

Objective: To assess and grade the technical skills specific to tag rugby and record the time taken to complete the course.

Description: One at a time, with the ball in their hands, students will perform the following: running forward (distance of 5 meters), running backward (distance of 3 meters), running with a change of

direction between 6 cones–passing the ball from a standing position with both hands–catching the ball–running with the ball in their hands.
Methodological instructions: students will form a line and take turns performing the given route twice. The first time, students will familiarize themselves with the exercise, and on the second attempt, the results will be recorded.
Teaching materials: 1 balloon, 6 cones;
Dosage: 2 sets.

Results and Discussions

Table 1. Initial Testing Results

Student	Test 1 Note	Test 1 Passes	Test 2 Note	Test 2 Passes	Test 3 Note	Test 4 Time (seconds)
A.B.	7	7	5	8	7	15
A.C.	6	7	5	8	6	17.05
A.E.	6	8	5	8	6	15.55
B.A.	5	6	6	7	5	15.32
C.A.	6	7	5	7	5	14.20
C.C.	5	8	5	8	6	14.10
D.A.	6	7	6	7	6	18.10
D.O.	6	5	6	8	5	17.05
E.E.	6	5	6	8	6	18
E.H.	7	8	7	8	8	17.10
E.V.	8	8	7	7	9	14.10
F.G.	6	7	7	7	7	15.40
F.M.	9	10	7	9	9	15.30
G.A.	7	9	6	9	8	18
I.K.	6	5	6	7	6	19
I.M.	7	9	8	7	7	15
L.L.	8	7	8	8	7	19.05
L.M.	5	6	6	7	6	19.30
M.E.	5	7	6	6	5	18.10
M.V.	6	7	6	6	6	16.45

Table 2. Final testing results

Student	Test 1 Note	Test 1 Passes	Test 2 Note	Test 2 Passes	Test 3 Note	Test 4 Time (seconds)
A.B.	9	10	10	10	9	14.45
A.C.	8	10	10	10	8	16
A.E.	8	10	10	10	8	15
B.A.	9	9	8	9	7	14.50
C.A.	8	10	8	9	7	14
C.C.	9	9	8	9	8	13.50
D.A.	9	9	7	9	8	16.30
D.O.	8	8	10	9	8	16
E.E.	8	9	9	9	8	16.20
E.H.	9	9	10	9	10	15.1
E.V.	10	9	9	8	10	14
F.G.	9	10	9	8	9	14

F.M.	10	10	10	10	10	14.05
G.A.	9	9	9	10	10	15
I.K.	8	7	9	9	9	15.50
I.M.	10	9	10	9	8	14.3
L.L.	10	9	10	10	8	17
L.M.	8	8	8	9	9	16.5
M.E.	7	9	8	7	8	16
M.V.	9	9	9	8	9	15

Table 3. Statistical Analysis of Initial Testing Results

Test	Passing the ball from a standing position		Passes from running „in the tunnel"		The big square	Technical route	
Expression of assessment through:	Note – execution technique	Number – passes out of 10	Note – execution technique	Number – passes out of 10	Note – tactical baggage	Note – technique	Completion time in seconds
Mean	6.35	7.15	6.15	7.5	6.5	6.5	16.55
Standard deviation	1.08	1.34	0.93	0.87	1.23	0.88	1.73
Variability coefficient	0.17%	0.18%	0.15%	0.11%	0.19%	0.13%	0.10%
Min.	5	5	5	6	5	5	19.30
Max.	9	10	8	9	9	9	14.10

Table 4. Statistical Analysis of Final Testing Results

Test	Passing the ball from a standing position		Passes from running „in the tunnel"		The big square	Technical route	
Expression of assessment through:	Note – execution technique	Number – passes out of 10	Note – execution technique	Number – passes out of 10	Note – tactical baggage	Note – technique	Completion time in seconds
Mean	8.75	9.1	9.05	9.05	8.5	9.4	15.12
Standard deviation	0.85	0.78	0.94	0.82	0.94	0.59	1.01
Variability coefficient	0.09%	0.08%	0.1%	0.09%	0.11%	0.06%	0.06%
Min.	7	7	7	7	7	8	17
Max.	10	10	10	10	10	10	13.5

According to tables 3 and 4, for the Passing the Ball from a Standing Position test, the arithmetic mean for technical execution improved from 6.35 in the initial phase to 8.75 in the final phase, reflecting a shift from modest to strong results. For the number of successful passes out of 10, the average rose from 7.15 to 9.1, indicating a transition from moderate to excellent performance. In the Passes from Running "in the Tunnel" test, the average technical execution increased from 6.15 to 9.05, showing clear improvement. The average number of successful passes also improved from 7.5 to 9.05, reflecting the group's significant advancement in practical execution.

The Big Square tactical test showed a rise in the arithmetic mean from 6.5 to 8.5, moving from weak to good tactical understanding and application. For the Technical Route test, the execution

score increased from 6.5 to 9.4, while the average course completion time improved from 16.55 seconds to 15.12 seconds, indicating enhanced technical precision and speed.

Across all tests and assessment forms, the final phase showed not only higher arithmetic means but also lower variability and standard deviations, demonstrating improved group consistency and cohesion. The comparison confirms that the intervention positively impacted students' technical, tactical, and execution-related capacities.

Table 5. Wilcoxon test results

	Test 1		Test 2		Test 3	Test 4	
Assessment	1.1	1.2	2.1			4.1	4.2
W value	0	0	0	0	0	0	0
Z value	–3.91	–3.62	–3.91	–3.72	–3.82	–3.91	–3.91
p	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Effect size (r)	0.87	0.80	0.87	0.83	0.85	0.87	0.87

Given that the Wilcoxon test value is 0, the significance threshold is less than 0.05 ($p<0.05$), the effect size for tests 1.1, 2.1, 4.1, and 4.2 is 0.87, for test 1.2=0.80, and test 3=0.85, the null hypothesis is rejected and it appears that the training program is highly applicable.

Conclusions

Rugby tag, with its playful, original, and novel approach, diversifies the teaching - learning process and, as a result, makes physical education and sports classes particularly appealing to children.

The main methods and means of initiation into tag rugby are the global method, the playful method, the method of using phases of the game in a restricted and isolated setting, combined with the following means: exercises, preparatory games, and the actual game of tag rugby.

The use of the global-analytical-global algorithm method within the means that involve specific exercises for learning technical and tactical elements is beneficial. However, when it comes to learning-play means, heuristic methods prove to be the most appropriate. These methods encourage personal investigation and give the subject the freedom to choose how to solve situations encountered on the field. Through play, students develop analytical and rational thinking, implicitly gaining emotional, motor, and somato-functional benefits.

Through preparatory games, students gradually become familiar with the rules and understand the logic of the game. In addition, the competitive element creates an incentive to participate and develop a passion for this fascinating sport.

The intervention program is practical and can be applied successfully, as significant differences were recorded between the initial and final tests in terms of arithmetic means, namely, in test 1 the difference is 2.4 and 1.95 points, in test 2 it is 2.9 and 1.55 points, in test 3 the value is 2 and in the last test the difference is 2 points and 1.43 seconds.

In the initial test, the group of students achieved low results in conditions of moderate homogeneity, with a minimum value of 0.10% and a maximum of 0.19%. Subsequently, after the intervention program was implemented by the specialist teacher, the students made significant progress in conditions of high homogeneity, represented by a minimum coefficient of variability of

0.06% and a maximum of 0.1. In test 3, the value is 0.11%, which tells us that in terms of the technical detriment of tag rugby, the group showed moderate homogeneity.

We propose, within the middle school cycle, an algorithm for initiation into the technical and tactical basics of tag rugby: start the lesson with an introductory-thematic game that aims to: capturing the attention and engaging the students emotionally, continuing with individual exercises, then group exercises in easy and very easy conditions, gradually increasing the difficulty, and ending the lesson with a game of tag rugby, as this team sport is best learned through playing tag rugby itself.

Authors' Contributions

Both authors played an important role in shaping and finalizing this research.

Murza Vasiluţa oversaw the conceptualization and design of the research, coordinated data collection, and contributed to the statistical processing and interpretation of the results.

Badea Dan contributed to the critical assessment, supported the literature review, formatted the final version, and coordinated the referencing.

References

Badea, D. (2001). Rugby: fundamente teoretice şi metodice, Ed. Fest, Bucureşti.

Badea, D. (2004). Rugby-Curs de bază, Ed. Universitară, Bucureşti.

Borokov, A. A. (1999). Mathematical statistics. Boca Raton, FL: CRC Press.

Bota, A., Stănescu, M., Teodorescu, S., Şerbănoiu, S. (2006). Educaţie fizică şi sport. Teorie şi didactică, Ed. Fest, Bucureşti.

Cerghit, I. (2006). Metode de învăţământ, Ed. Polirom, Bucureşti.

Dreve, A. A., Marinescu, G., Jecu, D. (2017). Theoretical aspects of strenght training periodization in rugby. *Discobolul – Physical Education, Sport and Kinetotherapy Journal,* Vol. XIII no.4(50).

Dreve, A. A., Marinescu, G., Stoica, M., Ticală, L. (2019). How the GPS Monitoring System Helps Us in Conducting Training and Improving Performance in Rugby. *International Scientific Conference eLearning and Software for Education*, Vol. 3, DOI:10.12753/2066-026X-19-202.

Korolev, A. (2021). Тег-Регби Как Способ Формирования Познавательных Учебных Действий У Обучающихся На Уроках Физической Культуры. Проблемы И Пути Совершенствования Физической Культуры В Системе Образования, 93–95.

Lee, M.-A. (2009). Generalization of tactics in tag rugby from practice to games in middle school physical education, Physical Education and Sport Pedagogy, 14(2), 289–207.

Liese, F., Miescke, K. J., (2008). Statistical decision theory: Estimation, testing, and selection, New York: Springer Science & Business Media.

Nestrova, M., Elistratova, D. (2019). Tag Rugby As A Means Of Educating The Team Spirit In Younger Students, 10(35), 24–27.

Oprean, A., Pelczer, A. (2019). Aspects of rugby-tag applicability in Romanian rural school system. Sciences Of Human Kinetics, 12(61), 169–172.

Penny, J., Ribeiro, J., Silva, P., Soares, T., Pinheiro, E. (2023). Rugby tag in school physical education: contributions from training. Educação: Teoria e Prática, 33(66), 1–20.

Predoiu, A. (2021). Metodologia cercetării ştiinţifice, Ed. Discobolul, Bucureşti.

Roman, F. R. (2020). Utilizarea mijloacelor şi metodelor specifice jocului de rugby-tag în creşterea performanţelor elevilor, în lecţia de educaţie fizică la ciclul primar, Educaţia azi, 7(7), 1–3.

Stănescu, M. (2012). Didactica educaţiei fizice, Ed. Universitară, Bucureşti.

Verza, E. (1993). Psihologia vârstelor, Ed. Hyperion, Bucureşti.

Verza, E., Verza F.E. (2000). Psihologia vârstelor, Ed. Pro Humanitate, Bucureşti.

Zvereva, S., Moghili, P. (2022) Инновации В Подходах К Организации Физического Воспитания Учащихся (На Примере Тег-Регби, Стратегии Исследования В Общественных И Гуманитарных Науках, 134–138.

TFG–B.865.pdf (uva.es) (ultima accesare 23.01.2023, ora 19:09)

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Probleme actuale ale teoriei şi practicii culturii fizice - Ediţia a 23-a, 13 aprilie 2020 .pdf (idsi.md) (ultima accesare 23.01.2023, ora 22:00)
S-RUGBY_TAG_-_REGULAMENT_actualizat__septembrie_2016_1.doc (live.com) (ultima accesare 28.01.2023, ora 22:10)
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UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 56-64
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-8

BOOSTING STUDENT ENGAGEMENT IN UNIVERSITY PHYSICAL ACTIVITIES: SECOND STUDY

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Abstract. *Background*. Physical activity is a critical component of a healthy lifestyle, contributing to the prevention of chronic diseases, supporting mental health, and promoting overall well-being (Neumark-Sztainer, 2010; Iconaru, 2023; Burciu & Stoica, 2025). Despite these benefits, lifestyle changes in post-communist Romania have led to rising overweight and obesity rates, particularly among urban youth (Roman, 2019; Lăzărescu & Popa, 2015; Geantă, 2021). This study focuses on the University of Bucharest (UniBuc) to explore reasons behind students' participation in university-organized physical activities (Puiu, 2020).The lack of participation in sports and physical activities exhibited by young people is addressed in the academic environment, specifically in the University of Bucharest, which makes the subject of the present study.
Objectives. This research focuses on the University of Bucharest to explore the reasons behind students' low participation in university-organized physical activities. This research effort aims to lay the groundwork of an extended research effort centered on identifying the main reasons why young students (roughly aged 18-35) don't participate – or only participate sporadically, or only because of the mandatory component – in physical activities organized by the university they are enrolled in, and, in subsidiary, in physical activities overall.
Methods. By employing a structured questionnaire distributed electronically, this study aims to collect comprehensive data on student demographics, participation levels, motivations, barriers, and suggestions for improvement. The quantitative analysis component of the study aims to identify participation trends and barriers, while qualitative insights will provide nuanced perspectives on students' experiences. The findings will inform targeted strategies to promote physical activity among students, contributing to their immediate and long-term health.
Results. Data collected from the survey will be analyzed using various statistical methods to identify prevalent trends and correlations, while thematic analysis will be applied to the qualitative responses of the UniBuc students in order to extract common themes and insights.
Conclusion. Overall, this exploratory study seeks to lay the groundwork for future research on enhancing physical activity participation in academic settings, ultimately supporting the holistic development of young adults. Understanding the factors that influence students' engagement in physical activity will contribute significantly to the process of building the necessary conditions for their future participation, which represents the main point of this exploratory study, and, in line with its results, other potential research efforts focused on this pressing issue.

Key words: *Sports, physical activity, exercise, health, mental health, depression, anxiety, youth, academia, overweight, obesity.*

EDITURA UNIVERSITĂȚII DIN BUCUREȘTI
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Introduction

Physical activity is widely recognized as a key component of a healthy lifestyle, contributing significantly to physical and mental health (Neumark-Sztainer, 2010; Caciula, 2020; Iconaru, 2023). Post-communist lifestyle changes, including sedentary behaviors and shifts in nutrition, have contributed to an excess weight epidemic in Romania, beginning in childhood and continuing into young adulthood (Roman, 2019; Geantă, 2021; Lăzărescu & Popa, 2015). Establishing healthy habits in young adulthood is essential for lifelong wellness (Neumark-Sztainer, 2010; Burciu & Stoica, 2025).
Despite these benefits, university students often face barriers to participation, including academic pressure, lack of time, and limited access to facilities (Silva, 2022; Sapsani & Karampelas, 2017).

Understanding these barriers within a university context is critical for promoting sustainable physical activity habits (Neumark-Sztainer, 2010; Cunningham, 2015). Regular exercise positively affects mental health by reducing stress, anxiety, and depression, and stimulates neuroplasticity and hippocampal neurogenesis (Caciula, 2020; Gao & Zhao, 2020; Iconaru, 2023).

This study explores students' engagement in university-organized physical activities, aiming to identify patterns, motivations, barriers, and opportunities for improvement, ultimately guiding interventions to enhance participation.

Methodology

A structured questionnaire was distributed electronically to 92 UniBuc students, from freshmen to seniors, to ensure wide coverage and representativeness (Burciu & Stoica, 2025). The survey combined quantitative questions measuring participation levels, motivations, and barriers, and qualitative questions capturing personal experiences, suggestions, and nuanced insights (Burciu & Stoica, 2025; Puiu, 2020).

Quantitative data were analyzed using statistical methods to identify trends, correlations, and demographic differences, while thematic analysis was applied to qualitative responses to extract common themes (Burciu & Stoica, 2025; Silva, 2022). This mixed-methods approach provides a holistic understanding of student engagement and informs strategies to improve participation (Alhassan, 2018; Shameli & Kim, 2017).

Results and Discussion

Table 1 summarizes students' participation in university-organized physical activities, motivations, barriers, and suggestions for improvement.

Table 1. Student Participation, Motivations, Barriers, and Suggestions for University Physical Activities (n = 92 total respondents)

Category	Details	Percentage (%)
Participation in at least one sport	Aerobics	64.1
	Other sports	35.9
Attendance in sports classes	Regularly	45.0
	Occasionally	25.6
	Rarely/Never	29.4

Motivations for attending sports classes	Academic grades	65.2
	Health improvement	51.1
	Stress reduction	31.5
Barriers to participation	Packed schedule	32.6
	Work or other commitments	20.7
	Class overlaps	19.6
Personal exercise habits	Daily	5.4
	Weekly	23.9
	Occasionally	32.6
	Rarely/Never	23.9
Student suggestions for boosting participation	Improved scheduling	59.8
	More diverse sports options	30.4
	Better promotion and facilities	25–27

Note: Percentages reflect survey responses; multiple selections were allowed for motivations, barriers, and suggestions (Burciu & Stoica, 2025).

Below we will analyze the most relevant answers to several questions from the questionnaire.

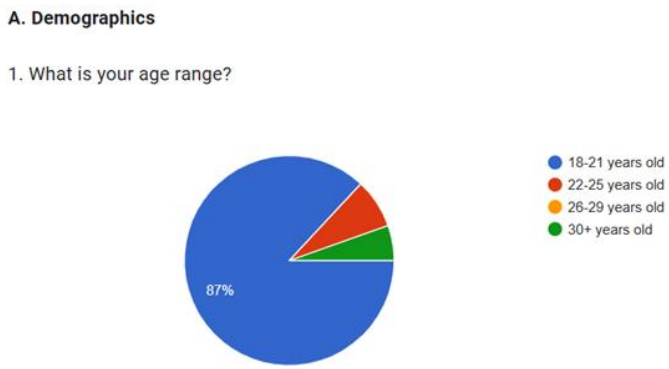

Figure 1. The answers to the question "What is your age range?"

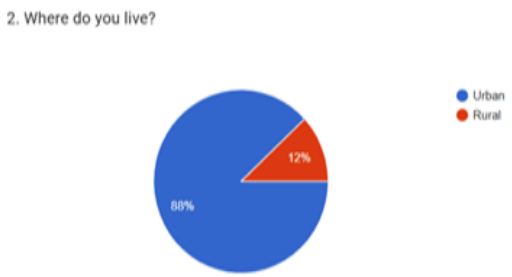

Figure 2. The answers to the question "Where do you live?"

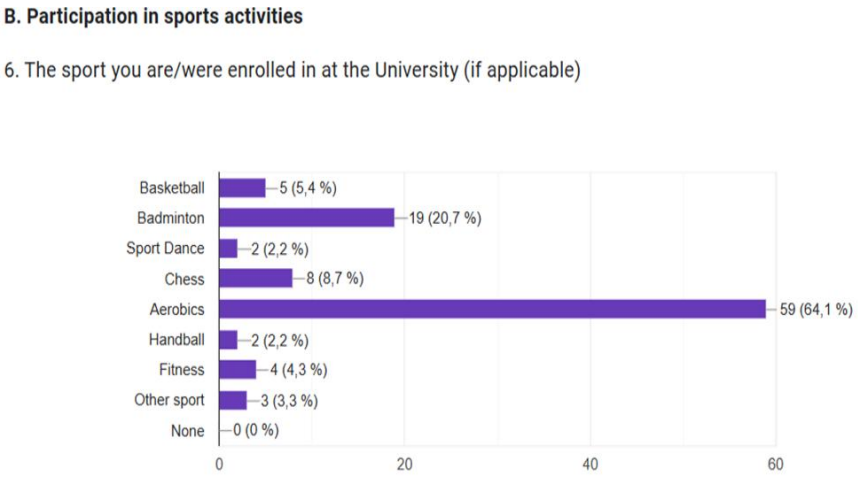

Figure 3. The answers to the question "The sport you are/were enrolled in at the University?"

- Aerobics dominates as the most chosen sport, suggesting it may be the most accessible, popular, or well-promoted.
- Badminton and Chess also show notable engagement.
- No one reported not participating, which could reflect a strong culture of sports involvement or a sample bias toward active students.

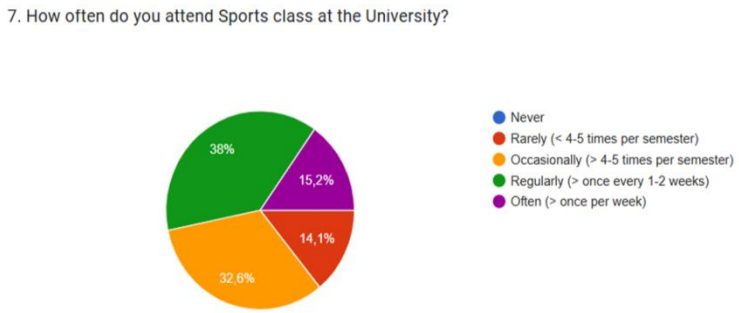

Figure 4. The answers to the question "How often do you attend Sports class at the University?"

- Over 85% of respondents attend at least occasionally, showing a generally high level of participation.
- The largest group attends regularly, suggesting that sports classes are a routine part of student life for many.
- Very few students attend rarely or not at all, reinforcing the idea of a strong sports culture.

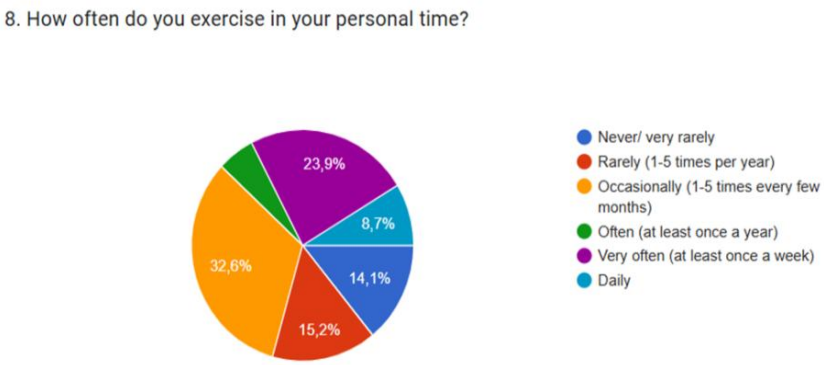

Figure 5. The answers to the question "How often do you exercise in your personal time?"

- The most common response is occasional exercise, suggesting that while many students are not inactive, they may not have a consistent routine.
- Only 5.4% exercise daily, and 23.9% do so weekly, indicating a smaller group of highly active individuals.
- A combined 23.9% (Never + Rarely) exercise very infrequently, which could be a concern for overall student wellness.

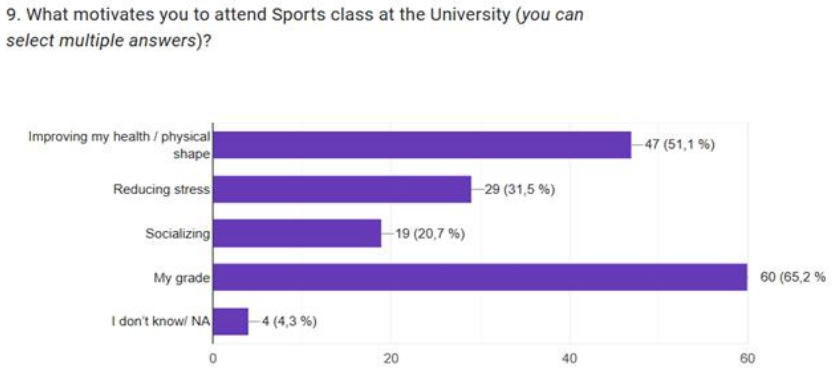

Figure 6. The answers to the question "What motivates you to attend Sports class at the University?"

- Grades and health are the primary motivators, indicating both extrinsic (academic) and intrinsic (well-being) reasons.
- Stress reduction and socializing are secondary but still relevant, highlighting the broader benefits of sports participation.
- Very few respondents are unsure of their motivation.

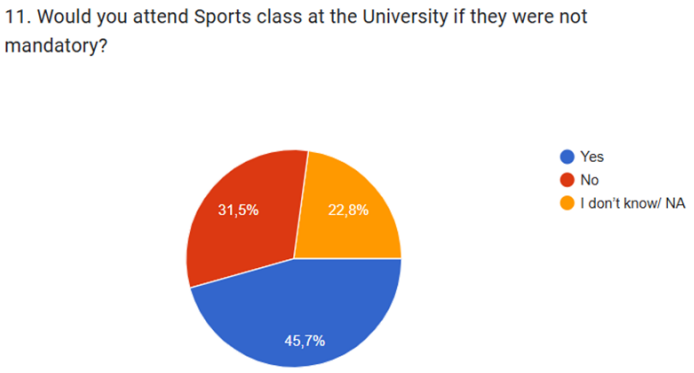

Figure 7. The answers to the question "Would you attend Sports class at the University if they were not mandatory?"

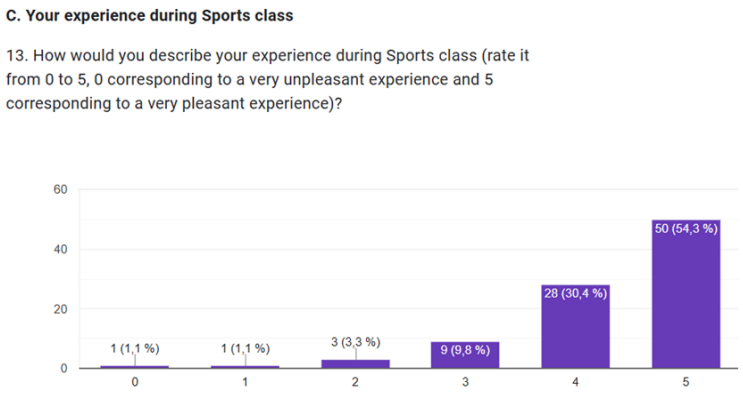

Figure 8. The answers to the question "How would you describe your experience during Sports class?"

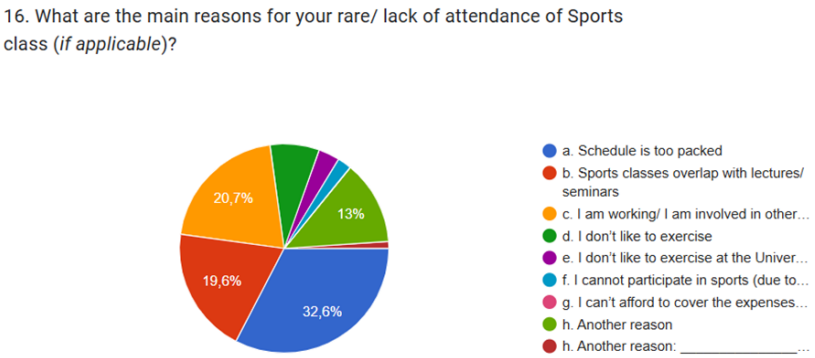

Figure 9. The answers to the question "What are the main reasons for your rare/lack of attendance in Sports class?"

- Time constraints (packed schedules, overlapping classes, and other commitments) are the dominant reasons for low attendance.
- Personal preferences and logistical/financial/medical barriers also play a role, though less frequently.

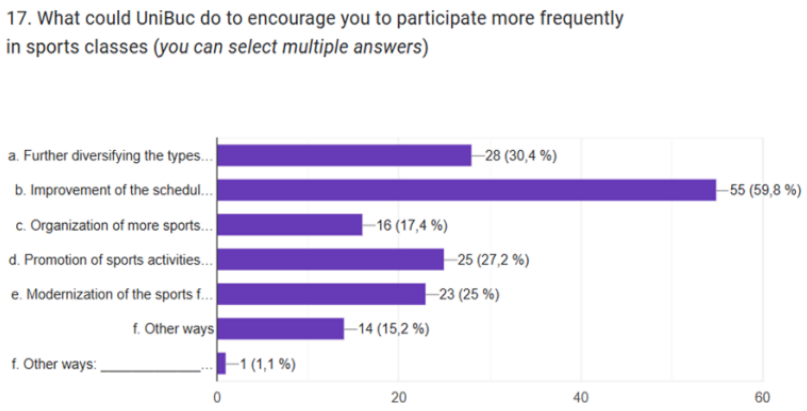

Figure 10. The answers to the question "What could UniBuc do to encourage you to participate more frequently in sports classes?"

- Scheduling improvements are the top priority for increasing participation.
- Students also value variety, promotion, and facility upgrades.
- A small number of respondents suggested other or personalized solutions.

Discussions

1. High Participation, But Room for Improvement

All respondents reported participating in at least one sport, with aerobics being the most popular (64.1%). Most students attend sports classes regularly or occasionally (70.6%), indicating generally positive engagement.

2. Motivation Is Both Academic and Personal

Grades were the top motivator for attending sports classes (65.2%), followed by health improvement (51.1%) and stress reduction (31.5%). This indicates a blend of extrinsic (academic) and intrinsic (well-being) motivations.

3. Time Constraints Are the Main Barrier

The most cited reasons for low attendance were packed schedules (32.6%), work or other activities (20.7%), and class overlaps (19.6%). These suggest that logistical conflicts are a major hurdle rather than a lack of interest in physical activity.

4. Personal Exercise Habits Vary Widely

While 23.9% of students exercise weekly and 5.4% daily, the largest group (32.6%) exercises only occasionally. A combined 23.9% rarely or never exercise, highlighting the need for more personal motivation or structural support.

5. Students Want Better Scheduling and Variety

To boost participation, students suggested improved scheduling (59.8%), more diverse sports options (30.4%), and better promotion and facilities (25–27%). These responses align with the barriers identified earlier and suggest that structural improvements can significantly enhance engagement.

Final Thoughts

There is a strong foundation of student engagement, but addressing logistical conflicts, emphasizing the personal benefits of sports beyond academic grades, and increasing variety in activities may help reach less active students.

Conclusion and Future Research Directions

The study highlights the importance of addressing both intrinsic and extrinsic factors influencing student engagement in university physical activities.

While overall participation is positive, logistical barriers and limited variety restrict engagement. Strategies such as flexible scheduling, diverse activity options, peer support, and digital tools can enhance participation and promote long-term health habits (Alhassan, 2018; Shameli & Kim, 2017; Gao & Zhao, 2020).

Universities play a critical role in shaping lifestyle behaviours and fostering well-being. Future research should evaluate interventions' effectiveness, explore socio-demographic influences and test innovative engagement strategies to strengthen the culture of physical activity.

Authors' contributions

All authors have an equal contribution to the publication.

References

Alhassan, S. (2018). *Physical activity interventions and their impact on student health*. Journal of Physical Activity & Health, 15(3), 182–190.

Bartolucci, A., & Smith, J. (2021). *How distant? An experimental analysis of students' COVID–19 exposure and physical distancing in university buildings*. arXiv. https://arxiv.org/abs/2107.06890

Burciu, D., & Stoica, A.-M. (2025). *Boosting student engagement in university physical activities: An exploratory study*. University of Bucharest Journal. https://journals.unibuc.ro/index.php/ua/article/view/613

Caciula, M. (2020). *A comparative study of mental health, body composition, and physical activity among university students*. Journal of Exercise and Nutrition, 7(1), 1–15. https://journalofexerciseandnutrition.com/index.php/JEN/article/view/171

Cunningham, S. A. (2015). *Global health perspectives on physical activity and student engagement*. American Journal of Public Health, 105(7), 1393–1399.

Dominguez et al. (2021). Nutrition, Physical Activity, and Other Lifestyle Factors in the Prevention of Cognitive Decline and Dementia. *Nutrients 13 (11)* , 1-60.

Gao, N., & Zhao, Y. (2020). *n-Gage: Predicting in-class emotional, behavioural, and cognitive engagement in the wild*. arXiv. https://arxiv.org/abs/2007.04831

Geantă, V. (2021). *Health-related physical fitness of Romanian university students*. PMC. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC12385996/

Kandola et al. (2018). Moving to Beat Anxiety: Epidemiology and Therapeutic Issues with Physical Activity for Anxiety. *Curr Psychiatry Rep.* , 20-63.

Iconaru, E. (2023). *The relationship between physical activity level and socio-demographic factors in post-pandemic Romania*. Sustainability, 15(18), 13488. https://www.mdpi.com/2071-1050/15/18/13488

Ilić, V., & Petrović, M. (2023). *Physical activity levels among university students in Eastern Europe*. European Journal of Sport Science, 23(4), 525–536.

Lăzărescu, R., & Popa, D. (2015). *Urban youth and obesity in Romania: A cross-sectional study*. Romanian Journal of Public Health, 25(3), 55–62.

Leuciuc, F. V. (2020). *Social and educational sustainability of physical education among Romanian students*. Sustainability, 12(21), 9231. https://www.mdpi.com/2071-1050/12/21/9231

Leslie, E., Sparling, P., & Owen, N. (2001). University campus settings and the promotion of physical activity in young adults: lessons from research in Australia and the USA. *Health Education*

Neumark-Sztainer, D. (2010). *Project EAT: Longitudinal studies on eating and activity among teens and young adults*. Journal of Nutrition Education, 42(2), 1–9.

Pop TL, M. D. (2021). Prevalence of Underweight, Overweight and Obesity in School-Aged Children in the Urban Area of the Northwestern Part of Romania. *Int J Environ Res Public Health 18 (10)*, 51–76.

Popescu, V. (2021). *The relationship between physical activity, eating attitudes, and body image dissatisfaction of Romanian students*. Progress in Nutrition, 23(2), 145–158.
https://www.mattioli1885journals.com/index.php/progressinnutrition/article/download/9467/9118/56883
Portugal et al. (2013). Neuroscience of Exercise: From Neurobiology Mechanisms to Mental Health. *Neuropsychobiology 68*, 1–14.
Puiu, S. (2020). *Students' well-being and academic engagement in Romania*. PMC.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11311661/
Roman, G. (2019). *Eating patterns, physical activity, and their relationship to obesity in Romania*. PMC. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6586759/
Sapsani, G., & Karampelas, P. (2017). *Facebook use, personality characteristics, and academic performance: A correlational study*. arXiv. https://arxiv.org/abs/1703.04095
Shameli, A., & Kim, Y. (2017). *How gamification affects physical activity: Large-scale analysis of walking challenges in a mobile application*. arXiv. https://arxiv.org/abs/1702.07437
Silva, A. (2022). *Enhancing high school students' engagement in physical education*. EFSUPIT. https://www.efsupit.ro/images/stories/december2024/Art%20303.pdf
Stephens, T. (2002). *Physical activity trends and health in young adults: A longitudinal perspective*. Preventive Medicine, 34(1), 1–8.
Stephens, R. (2002). *Social Cognitive Determinants of Physical Activity in Young Adults: A Prospective Structural Equation Analysis.* Virginia Tech University.
***Agenția Națională pentru Sport - https://sport.gov.ro/

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 65-71
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-9

ORIGINAL ASPECTS REGARDING THE MONITORING AND DIRECTING OF THE EFFORT OF STUDENTS OF THE UNIVERSITY OF BUCHAREST, WITHIN THE LESSONS OF NAUTICAL SPORTS ACTIVITIES

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Abstract. *Background*. Through its specific objectives and tasks, nautical sports activities contribute to the psycho-somatic and social development of practitioners, becoming a discipline beloved by students, they number increasing from year to year. This discipline, shortly introduced in the DEFS 'curriculum, responded to a need to diversify the socio-educational interests of University of Bucharest` students, the University of Bucharest being the only university in the country that does not have a sports profile, which offers such lessons to its students.
Objectives. The present paper, through its content and its approach, aims to highlight the main aspects of the specific effort, applied and recorded in kayak lessons. The subject is Dang Huan Fang, student at the Faculty of Geology and Geophysics, 1st place holder in two important competitions organized this year: the "Alexandru Bizim" University Cup and the Kayak Challenge 2025.
Methods. Our scientific approach aimed, mainly, at presenting some model trainings, specific to the preparatory period, with the objective of developing endurance through specific and non-specific means for the 1000m kayak race.
Results. The information provided by the Garmin Fenix 5 device used in this research contributes decisively to optimizing the planning and programming strategy of the practical activity of students enrolled in the nautical sports activities discipline, constituting essential feedback for those directly and indirectly involved in the training process.The obtained data are based on objective, efficient and modern monitoring, used for the first time at the level of non-profile higher education, thus providing an overview of the specific demand for these activities.
Conclusion. Through its content, our project emphasizes the importance and opportunity of using modern and efficient means of monitoring the parameters of the effort specific to the 1000m kayak race, all in the context of a general strategy for training UB students, practitioners of the race referred to previously, which should have as a starting point a particular training model, based on modern means, adapted to the particularities of the race and the motor profile of the practitioners.

Keywords: monitoring, nautical sports activities, students.

Introduction

In Romania, kayaking began to be practiced after the First World War, with our athletes being trained by Czechoslovak specialists. The first regatta in Romania took place in Arad in 1936. Later, Lake Snagov became the cradle of the country's greatest achievements in this sport, and to this day, it

offers modern nautical facilities equipped with high-performance equipment. It is also the main training site for the olympic teams.[1]

Kayaking is a sport that is rarely offered at universities. However, the University of Bucharest (UB) is an exception, being the only university in Romania that has recently introduced kayaking lessons into the DEFS' curriculum, offering students the opportunity to practice this sport. Due to its rarity, kayaking is becoming increasingly popular among UB students, with the number of enrolled students rising annually. In addition to its uniqueness, students appreciate the positive psycho-somatic and social effects that come with practicing kayaking.

Furthermore, the nautical sports activities discipline provides students with the opportunity to discover new skills and passions. This was the case for our subject, the UB student Dang Huan Fang (female, 24–25 years old), a student at the Faculty of Geology and Geophysics. She is an amateur athlete with no prior experience in sports, other than the kayaking lessons she began after enrolling in the course. She joined the nautical sports activities course in the academic year 2024/2025 and had her first experiences with kayaking in October 2024.

What is remarkable about our subject is the fact that, despite having no prior experience in kayaking or related disciplines, she achieved outstanding performance in a very short time (approximately five months). Her performance significantly exceeded those of other UB students who participated in the same course. She has developed a new passion for kayaking, which is the reason for her regular attendance at the kayak lessons. Thanks to her qualities and her high interest in kayaking, she was selected as the subject of this study. In February 2025, she agreed to participate at two important competitions for amateurs held in May 2025: the Kayak Challenge 2025 (1000 m race) and the "Alexandru Bizim" University Cup (200 m sprint), both of which require more advanced training.

In this paper we present the training process that prepared our subject for the 1000 m kayak race, using both specific and non-specific means and specific training models in order to improve endurance and strength. Furthermore, we aim to demonstrate that sufficient and modern monitoring of the subject's performance can improve her overall performance not only during the preparatory period, but also at the kayak competitions.

Motor skills in kayak-canoe

Kayaking and canoeing engage various motor skills depending on the specific event being performed. In long-distance races, endurance is the more important motor skill, while in short-distance races, strength – expressed in various forms – is emphasized.

To enhance understanding, the following are definitions of motor skills from different disciplines, including physical education theory and methodology, physiology and psychology.

Definitions of Motor Skills:

- After Ardelean, T. (1990)[2]:
  Motor skills are attributes of muscular activity, conditioned by psychological processes and capabilities, as well as by the structure and fundamental capabilities of different body systems and body parts. They are expressed through motor acts.
- Şerbănoiu, S. (2004)[3]:
  „Motor skills can be defined as innate characteristics of an individual's motor capacity, whose level evolves over time depending on multiple factors."

[1] Igorov M., Igorov A. (2017) Kaiac-canoe. Teoria Antrenamentului. Editura Discobolul. Bucureşti, pag. 6.
[2] Ardelean, T., (1990), Particularităţile dezvoltării calităţilor motrice în atletism, Editura IEFS, Bucureşti, pag. 4.
[3] Şerbănoiu S. (2004), Metodica Educaţiei Fizice, Editura Cartea Universitară, Bucureşti, pag. 19.

Speed

Pradet, M. (2001)[4] defines an athlete's speed as being his capability to move, or cause a part or all of their body to move, over the longest distance possible in the shortest possible time, facing only their own body weight.

Endurance

Endurance, as defined by Grigore, V. (2001)[5], is the motor skill that enables the body to sustain intense efforts over a prolonged period.

Strength

- Dragnea, A. (1996) defines strength as follows: "Human strength is achieved through the contraction of one or more muscle groups and represents the capability to overcome, resist, or yield to external or internal resistance."
- After Țifrea C. (2002)[6], strength is defined in the biomechanic point of view as the ability to overcome or resist external forces through muscular tension.

Skill (Coordinative Ability)

In the opinion of N. Alexe and V. Ludu (1993), cited by M. Teodoru (2004), a skill is the individual's ability to quickly and accurately select and perform motor actions appropriate to unexpected situations, with high efficiency.

All components of coordination are present in kayak-canoe disciplines, although in varying proportions. The most crucial component is balance.

Balance

Balance is a fundamental and complex element of human motor behaviour. Performing both simple and complex movements requires a highly developed sense of balance. After Horghidan, V., (2000)[7], "balance is the control element of energy", while Sbenghe, T., (2002)[8] describes balance as "the ability to maintain or move the body without falling". The authors Marcu, V., şi Chiriac, M., (2009)[9] state that "maintaining balance involves keeping the body's center of gravity above the base of support within a specific sensory context". "From a biomechanical perspective, balance refers mainly to internal forces generated by muscle contraction" (Gagea, A., 2002)[10].

According to Epuran, M., (1982)[11], balance involves several types of sensory perceptions:

- Verticality and tilt perception – Provides feedback on body and head position relative to the vertical axis, particularly via ankle joints and the soles of the feet.
- Linear motion perception – Felt at the start and end of linear body movements.

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[4] Pradet M. (2001). Pregătirea fizică, partea a II-a. Centrul de cercetări pentru probleme de sport. Bucureşti pag. 5.
[5] Grigore,V.,(2001), *Gimnastica artistică – Bazele teoretice ale antrenamentului sportiv*, Editura Semne, Bucureşti, pag. 38.
[6] Țifrea C. (2002). *Atletism. Efortul de antrenament şi de concurs*. Editura Dareco, Bucureşti. pag. 177.
[7] Horghidan, V., (2000), *Problematica psihomotricității*, Editura Globus, Bucureşti, pag. 129.
[8] Sbenghe, T., (2002), *Kinesiologie. Ştiința mişcării*, Editura Medicală, Bucureşti, pag. 18.
[9] Marcu, V., Chiriac, M., coord., (2009), *Evaluarea în cultură fizică şi sport*, Editura Universității din Oradea, pag. 183.
[10] Gagea, A., (2002), Biomecanică teoretică, Editura Scrisul Gorjean, Târgu-Jiu, pag. 137.
[11] Epuran, M., (1982), *Psihologia educației fizice*, Vol. I, Editura IEFS, Bucureşti, pag. 132.

- Rotational motion perception – Felt during changes in rotational motion at the start and end of a body movement, especially during acceleration or deceleration. Prolonged rotation can cause dizziness.

Although described separately, these sensations work in close coordination, resulting in proprioceptive sensitivity – a key component in motor control.

According to the authors Ciofu, I., Golu, M., Voicu, C., (1978), cited by Zaharie, N.V.,(2013)[12], "proprioception is essential for maintaining dynamic balance", which is a defining characteristic in all kayak-canoe events.

Maintaining balance requires the interaction of two movement centers: "the center of pressure (the force exerted on the ground via the feet), and the center of gravity (the point where gravitational force acts on the body)" (Alexe, D.I., 2009)[13].

Motor Structure of the 1000 m Kayak Event

The effort required in the 1000 m kayak race is mixed, combining both anaerobic and aerobic systems in the following proportions:

- Anaerobic: 40%
- Aerobic: 60%

The predominant motor skill in this event is forced in the endurance regime, which varies in form depending on the respective moment during the race. Alecu A. (2019)[14] outlines the race sequence as follows:

- S1 – Start (approximately 20-30 meters / 8-10 strokes): Explosive strength
- S2 – 30 to 300 meters (68-74 strokes): strength-speed-endurance
- S3 – 300 to 700 meters (88-90 strokes): endurance strength
- S4 – 700 to 1000 meters: strength-endurance-speed

Materials and Methods

The preparatory period before the first 1000 m kayak race at the 10th May 2025 lasted approximately two months (March-May 2025) in which the subject trained twice or three times per week with specific means. The subject's performance was monitored between the 23th April and 22th May 2025 with the Garmin Fenix 5 device which records the distance travelled in km, the maximum speed that was reached during a whole training session and the time in minutes and seconds. Additionally, the device calculates the average speed in km/h for preselected distances.

One training unit lasts around 60-75 minutes and includes the following:

- Warm-up onshore (gymnastic exercises)
- Warm-up offshore with the kayak (movements attentive to the technique)

Depending on the target of the respective training session, we present some examples of possible training models that were applied offshore with the kayak:

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[12]Zaharie, N.V., (2013), *Psihomotricitatea – factor determinant în realizarea obiectivelor pregătirii inițiale în Gimnastica Artistică Feminină*, Teză de doctorat, București, pag. 46.

[13]Alexe, D.I., (2009), *Manifestarea echilibrului la pubertate în funcție de dominanța emisferelor cerebrale, în vederea orientării în probele tehnice de atletism*, Teză de doctorat, București, pag. 249.

[14] Alecu A. (2019).Aspecte Metodologice în antrenamentul sportiv în kaiac canoe. Editura Universității din Pitești pag. 67.

- For more strength: 10 x 200 m, 1–2 minutes break in between
- For more endurance: 6 x 500 m, 3–4 minutes break in between or 3 x 1000m, 5–7 minutes break in between
- Possible combinations that train not only force, but also endurance, for example alternately 2 x 500m and1000m, 2 x 200 m, with breaks in between that are mentioned beforehand

We mention here that the training models were adapted depending on the collected data of the Garmin Fenix 5 device and the feedback of the subject. At the end of the training session, the subject cools-down offshore by exercising the technique.

Besides the kayak lessons, the subject prepared herself with non-specific means that were done irregularly, approximately once in one or two weeks. The physical exercises were carried out with resistance bands with which mostly the muscles of the upper part of the body were strengthened.

Results

The Garmin Fenix 5 (Garmin Connect)[15] device illustrates graphically the subject's performance during kayaking offshore and delivers exact numbers about the time, speed and distance travelled. We mention that the average speed of the whole recorded time during the kayak lesson shown in Fig. 1 – Fig. 6 is not representative due to the tracked warm-up, breaks and cool-down. Therefore, we utilized only the average speed of the subjects' active moments of the training, excluding warm-ups, breaks and cool-downs, to calculate afterwards the average speed performed on the kayak of the respective training session (see corresponding tables).

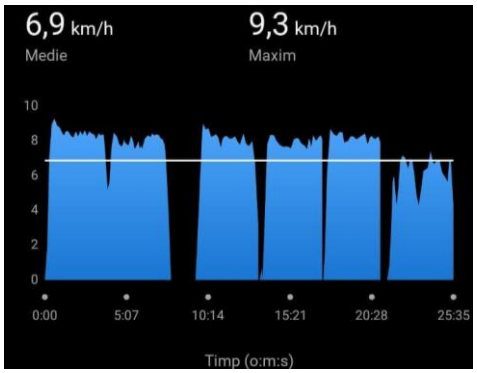

Figure 1. Performance on the 23th April.

23th April	
Distance (km)	Average Speed (km/h)
0,5	8,2
0,5	7,8
0,5	7,5
0,5	7,4
0,5	6,9
Average speed of the day	7,56

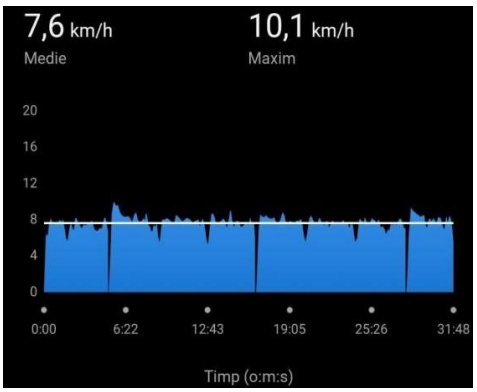

Figure 2. Performance on the 25th April.

25th April	
Distance (km)	Average Speed (km/h)
0,5	7,7
0,5	7,6
0,5	7,7
0,5	7,6
0,5	7,4
0,5	7,8
Average speed of the day	7,63

[15] https://play.google.com/store/apps/details?id=com.garmin.android.apps.connectmobile&pli=1

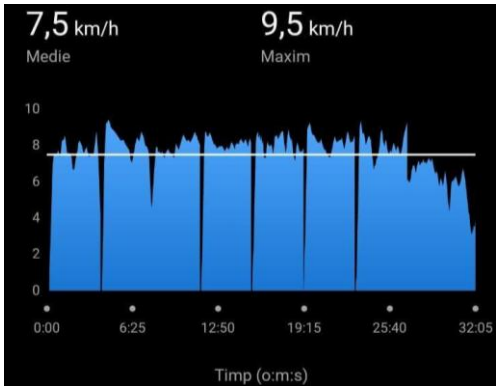

Figure 3. Performance on the 29th April.

29th April	
Distance (km)	Average Speed (km/h)
0,5	7,9
0,5	7,9
0,5	7,8
0,5	8,1
0,5	8,3
0,5	7,8
Average speed of the day	7,97

Figure 4. Performance on the 5th May.

5th May	
Distance (km)	Average Speed (km/h)
0,5	8,2
0,5	7,9
0,5	8,1
0,5	7,8
0,5	8,0
Average speed of the day	8,0

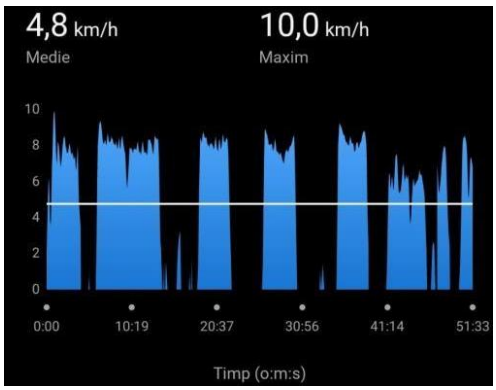

Figure 5. Performance on the 7th May.

7th May	
Distance (km)	Average Speed (km/h)
0,5	8,1
0,5	7,8
0,5	8,0
0,5	7,7
0,5	8,2
Average speed of the day	7,96

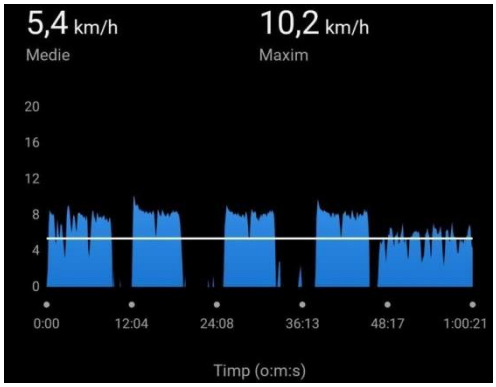

Figure 6. Performance on the 22th May.

22th May	
Distance (km)	Average Speed (km/h)
0,95	8,1
0,96	7,9
1,00	8,0
Average speed of the day	8,0

Based on the recorded data by the Garmin Fenix 5 device, the subject's average performance speed during kayaking has increased from 7.56 km/h in April to 8.0 km/h in May, which means an improvement of 0.44 km/h within one month. As for the maximum speed that was reached during each kayak lesson, an increase can be observed as well, from 9.3 km/h in April to 10.2 km/h in May.

It is very likely that the training sessions with specific means had a significant, positive influence on the subject's performance that led in the end to her success at both competitions in which she occupies twice the 1st place. Non-specific means may have contributed lesser to the overall performance, but their contribution should not be neglected. The constant monitoring and the subject's feedback were very helpful for adaptions of the training models according to the targets of the training units and the needs of the subject.

Conclusions

This paper has analysed the training of our subject for the 1000 m kayak race (Kayak Challenge 2025, 10th May 2025) by using specific and non-specific means. For the monitoring of the subject's performance during active kayaking on the lake, the Garmin Fenix 5 device has been utilized. It becomes clear that monitoring plays a key role for planning and improving training models in order to maximize the overall performance of the subject. Furthermore, monitoring provides a reference point and valuable feedback both for the trainer and the subject, and represents a powerful tool for performance improvements. Modern and efficient monitoring on a regular basis, like demonstrated in this paper, can be applied in any kind of sport in which an advanced training, for example for upcoming competitions, is required.

Authors' contributions

The authors have equally contributed to this study.

References

Alecu A. (2019).Aspecte Metodologice în antrenamentul sportiv în kaiac canoe. Editura Universităţii din Piteşti pag. 67.

Alexe, D.I., (2009), *Manifestarea echilibrului la pubertate în funcţie de dominanţa emisferelor cerebrale, în vederea orientării în probele tehnice de atletism*, Teză de doctorat, Bucureşti, pag. 249.

Ardelean, T., (1990), Particularităţile dezvoltării calităţilor motrice în atletism, Editura IEFS, Bucureşti, pag. 4

Epuran, M., (1982), *Psihologia educaţiei fizice*, Vol. I, Editura IEFS, Bucureşti, pag. 132.

Grigore,V.,(2001), *Gimnastica artistică – Bazele teoretice ale antrenamentului sportiv*, Editura Semne, Bucureşti, pag. 38.

Horghidan, V., (2000), *Problematica psihomotricităţii*, Editura Globus, Bucureşti, pag. 129.

https://play.google.com/store/apps/details?id=com.garmin.android.apps.connectmobile&pli=1

Igorov M., Igorov A. (2017) Kaiac-canoe Teoria Antrenamentului. Editura Discoblolul. Bucureşti. Pag. 6.

Marcu, V., Chiriac, M., coord., (2009), *Evaluarea în cultură fizică şi sport*, Editura Universităţii din Oradea, pag. 183.

Pradet M. (2001). Pregătirea fizică, partea a II-a. Centrul de cercetări pentru probleme de sport. Bucureşti pag. 5.

Sbenghe, T., (2002), *Kinesiologie. Ştiinţa mişcării*, Editura Medicală, Bucureşti, pag. 18.

Gagea, A., (2002), Biomecanică teoretică, Editura Scrisul Gorjean, Târgu-Jiu, pag. 137.

Şerbănoiu S. (2004), Metodica Educaţiei Fizice, Editura Cartea Universitară, Bucureşti, pag. 19.

Ţifrea C. (2002). *Atletism. Efortul de antrenament şi de concurs*. Editura Dareco, Bucureşti. pag. 177.

Zaharie, N.V., (2013), *Psihomotricitatea – factor determinant în realizarea obiectivelor pregătirii iniţiale în Gimnastica Artistică Feminină*, Teză de doctorat, Bucureşti, pag. 46.

SPORT PERFORMANCE

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 73-79
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-10

THE EVOLUTION OF WOMEN'S FOOTBALL: FROM PASSION TO PERFORMANCE

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Abstract. This article explores the historical trajectory and contemporary development of women's football, tracing its journey from marginalization to increasing recognition, with a special emphasis on the Romanian context. The origins of women's football date back to the late 19th century in the United Kingdom, where despite prevailing social resistance and restrictive gender norms, women organized informal matches and began to challenge traditional conceptions of femininity. The sport's popularity surged during World War I, when women's teams, such as the famous Dick, Kerr's Ladies, attracted significant public attention and large audiences.
However, the English Football Association's 1921 ban on women's football from official grounds severely limited the sport's growth for decades, a setback whose effects were felt internationally.
Globally, the professionalization of women's football gained momentum only in the latter half of the 20th century. The establishment of international competitions culminated with FIFA's inauguration of the Women's World Cup in 1991, which marked a pivotal moment in the sport's legitimacy and global visibility.
In Romania, the development of women's football was considerably delayed due to a combination of limited infrastructure, insufficient institutional support, and cultural attitudes that hindered female athletic participation. The foundation of the national women's league and the official creation of the Romanian women's national team in 1990 represented crucial milestones in overcoming these barriers.
Despite these advances, persistent disparities between women's and men's football remain stark, particularly regarding funding, media exposure, and societal recognition. Nevertheless, recent initiatives by the Romanian Football Federation (FRF), combined with the growing international success of Romanian female players, signal promising growth and potential.
This article emphasizes the importance of sustained institutional support, strategic investment, and cultural transformation to foster equitable opportunities and ensure the long-term development and professionalization of women's football both in Romania and globally.

Keywords: women's football, Romania, development, media, gender equality.

Context

Throughout the modern history of sport, football has been deeply entrenched as a male-dominated domain. Rooted in traditional gender roles and supported by institutions that prioritized men's athleticism, football excluded women from official spaces for much of its existence. Despite this, women began playing football as early as the late 19th century in the United Kingdom, defying societal norms and pushing against prevailing ideas of femininity and public propriety (Williams, 2003). These early activities, though marginal and often informal, signaled a burgeoning demand for female representation in competitive sports.

The First World War served as a pivotal moment in women's football history. As men were drafted into military service, women stepped into roles across society including the football pitch. Women's teams like the Dick, Kerr's Ladies drew crowds exceeding 50,000, illustrating public interest and the players' athletic capabilities (Lopez, 1997). However, this progress was abruptly halted by the English Football Association's 1921 decision to ban women's football from official grounds, deeming it "unsuitable for females." This institutional act of exclusion had far-reaching consequences, stunting the sport's growth for nearly half a century (Pfister, 2015).

The global evolution of women's football since the mid-20th century has been characterized by slow but steady progress. FIFA's official recognition of women's competitions, including the inaugural Women's World Cup in 1991, began to reverse decades of neglect. UEFA and other confederations gradually followed suit, introducing women's club tournaments and youth championships that provided pathways for female athletes. Professional leagues have since been established across Europe, North America, and parts of Asia, contributing to increased visibility and commercial investment. According to FIFA (2022), more than 13 million girls and women now play football globally, and the Women's World Cup has reached record-breaking audiences in recent editions, with the 2023 tournament drawing over 2 billion viewers worldwide.

Yet, despite these strides, structural inequities remain. Disparities in funding, infrastructure, and media coverage continue to reflect a gender imbalance in football (Cooky & Messner, 2018). For example, salary gaps between men's and women's professional players remain vast even in well-developed markets such as England or the United States. In many countries, women still struggle to access adequate training resources, medical support, and competitive platforms. These limitations are especially acute in Eastern Europe, including Romania, where cultural conservatism, limited state investment, and underdeveloped sport governance structures exacerbate inequality.

In Romania, women's football is still in a developmental phase, lagging behind Western European standards. Although the Romanian Football Federation (FRF) has initiated several programs to encourage youth participation such as the "Fotbal și Feminitate" campaign and the establishment of regional youth centers the sport remains underfunded and institutionally marginalized. The national league lacks competitive depth, and many clubs operate on minimal budgets, often relying on volunteers or mixed-gender coaching staff without specialized training in female athlete development. Research has shown that Romanian athletes, particularly in women's sports, face obstacles related to access, recognition, and competitive development (Rusu & Ionescu, 2021; Mănescu, 2025a; 2025b). These limitations are compounded by outdated perceptions of femininity in sport and a lack of media visibility issues that are further reinforced by the underrepresentation of women in leadership roles within federations and coaching structures.

Furthermore, the broader athletic ecosystem in Romania continues to struggle with structural asymmetries. Studies on motor performance and training asymmetry among athletes show differences between team sports, individual sports, and non-athletes, with implications for training models and developmental equity (Badau et al., 2023). These findings underline the necessity of tailoring training methodologies to support female athletes through inclusive and symmetrized programming critical elements missing from many Romanian women's football initiatives. Gender-specific physiological and psychological needs, such as injury prevention strategies (e.g., ACL injury risks), menstruation-aware training cycles, and mental health support, are often overlooked or inadequately addressed in existing programs.

Technological advancements, which have revolutionized athlete development in sports like handball, basketball, and volleyball (Badau et al., 2025), remain underutilized in Romanian women's football. Tools such as GPS-based movement tracking, performance analytics software, and fatigue monitoring systems are seldom accessible to women's teams outside of the national squad. The absence of sports science integration along with a lack of qualified personnel trained to work with female athletes continues to hinder performance optimization and long-term athlete development. By contrast, countries like the Netherlands, Germany, and Sweden have institutionalized sports

science in women's football through partnerships with academic institutions and centralized performance centers.

This research aims to explore the historical, socio-cultural, and institutional development of women's football, with an emphasis on the Romanian context. By examining the sport's global evolution and juxtaposing it with Romania's current landscape, this study seeks to uncover the barriers and opportunities within the sport's trajectory. The transformation of women's football from marginalized activity to an emerging professional field reveals a complex interplay between societal norms, institutional support, and athlete agency. Understanding this interplay is critical for shaping future interventions, policymaking, and educational frameworks that seek to promote equity and excellence in sport.

In conclusion, the path of women's football is emblematic of broader gender dynamics in sport. While international trends point to growing recognition and investment, national contexts like Romania remind us that progress is neither uniform nor guaranteed. A concerted effort from policymakers, federations, coaches, and educators is essential to build an ecosystem where female athletes can thrive from grassroots to elite levels. This includes addressing cultural attitudes, improving infrastructure, adopting evidence-based training practices, and ensuring equitable media representation. Only through such comprehensive and sustained efforts can women's football fulfill its transformative potential in Romania and beyond.

Research Objectives

- To analyze the historical evolution of women's football globally, focusing on key milestones that marked the sport's beginnings for women, such as the first matches in the 19th century, the popularity during World War I, and the 1921 ban imposed by the English FA, as outlined in the article.
- To highlight the specific development of women's football in Romania, from the lack of tradition and infrastructure to the establishment of the first national league and the national team in 1990, as well as recent programs initiated by the Romanian Football Federation (FRF) mentioned in the article.
- To compare the situation of women's football with men's football in terms of media coverage, funding, visibility, and investment, emphasizing persistent gaps and how these affect the sustainable development of women's football in Romania and globally.
- To analyze the social and cultural impact of women's football, considering gender based obstacles, stereotypes, and cultural shifts that influence the perception and acceptance of women's football in society.
- To identify factors and initiatives that can support the progress of women's football, such as development programs for girls and women, the role of successful players abroad, and the need for coherent public policies to support women's sport.

These objectives will guide the article's development, providing a clear framework for a comprehensive analysis of women's football evolution from its historical challenges to current and future prospects in both Romanian and global contexts.

Research Methods

To thoroughly investigate the evolution of women's football, both globally and within the Romanian national context, this study employs a multidisciplinary approach combining qualitative and quantitative methods. The research objectives, which aim to explore the historical trajectory, analyze

socio-cultural trends, and assess comparative differences between women's and men's football, require a diverse set of methods capable of providing a comprehensive and well-grounded perspective.

Thus, documentary and historical analysis will reconstruct the evolution of women's football, identifying key moments and major institutional barriers. In parallel, comparative statistical analysis will evaluate differences in participation, funding, and visibility between the two genders. Additionally, media content analysis will highlight how women's football is represented in public discourse, contributing to the understanding of stereotypes and the current level of promotion.

By integrating these methods, the research seeks to offer a clear and objective picture of the state of women's football, both in Romania and within the broader context of its global development.

Documentary and Historical Analysis – this method involves examining archives, official documents, and specialized literature to reconstruct the evolution of women's football, identifying key moments, institutional barriers, and legislative changes. For example, the 1921 FA ban and its repeal in 1971 were decisive events in this evolution (Williams, 2003). FIFA reports show a steady increase in the number of registered female players, exceeding 29 million globally in 2022 (FIFA, 2022). In Romania, FRF documents reflect the launch of programs such as "Football and Femininity" and "Football in Schools" to promote women's football (FRF, 2023).

Comparative Statistical Analysis – comparative analysis allows evaluating differences between women's and men's football in terms of player numbers, clubs, funding, and audience. According to FIFA (2022), salaries and budgets in women's football are still significantly lower than in men's football. In Romania, FRF reports approximately 1,900 registered female players and over 60 clubs participating in women's competitions, a significant contrast to men's football (FRF, 2023). UEFA data (2023) also show increasing audiences for women's competitions, although visibility remains lower compared to men's.

Media Content Analysis – this method examines the media coverage of women's football, highlighting disparities compared to men's football. Studies show that only 13% of global sports media content was dedicated to women's sports in 2019, despite record viewership at the FIFA Women's World Cup (Cooky, Messner & Musto, 2020). In Romania, coverage remains limited, but social media initiatives have started to increase visibility (MediaFactBook Romania, 2022). Content analysis helps identify stereotypes and proposes strategies for improving public perception.

Results

Reconstruction of the Historical Evolution of Women's Football – documentary analysis shows that although women began playing football as early as the 19th century, the sport was systematically marginalized. The ban imposed by the English Football Association in 1921 limited the development of women's football for nearly 50 years, a fact confirmed by historical research (Williams, 2003). After this ban was lifted in 1971, there was a steady increase in interest and the number of female players, culminating in the first edition of the FIFA Women's World Cup in 1991 (FIFA, 2022).

*Socio-Cultural Trends and Comparisons between Women's and Men's Football – s*tatistical data reveal a significant gap in participation and funding. Globally, only about 29 million women are registered players, compared to hundreds of millions in men's football (FIFA, 2022). In Romania, for example, there are around 1,900 registered female players and 60 clubs, which shows growing interest but remains modest compared to men's football (FRF, 2023). Salaries and budgets dedicated to women's football remain much lower, a situation documented in the specialized literature as well (UEFA, 2023).

Media Visibility and Social Impact – content analysis indicates an underrepresentation of women's football in traditional media. A study by Cooky, Messner, and Musto (2020) shows that only 13% of total global sports media content is dedicated to women's sports, despite increasing audiences, as seen in the 2019 Women's World Cup which recorded a viewership record of over 250 million for the final. In Romania, the press continues to give limited coverage to this segment, but social and online initiatives are beginning to counterbalance this trend (MediaFactBook Romania, 2022).

Impact of Development Initiatives and Programs in Romania – FRF programs such as "Football and Femininity" and "Football in Schools" have had a positive effect, leading to an increase in the number of young participants and the gradual professionalization of the sport (FRF, 2023). Romanian players like Olivia Oprea and Teodora Meluță, who compete in foreign leagues, have become inspirational role models, contributing to the popularization of women's football in Romania.

To illustrate the evolution and current state of women's football globally and in Romania, we present a series of relevant charts and tables below. These visuals highlight the steady increase in the number of female players, the significant disparities in participation and funding compared to men's football, as well as media visibility levels. Additionally, they showcase specific trends in Romania, indicating notable progress alongside ongoing challenges in the sport's development.

1. Evolution of the Number of Registered Female Football Players Worldwide (2000–2023)

Year	Number of Players (millions)
2000	8
2005	12
2010	18
2015	23
2020	27
2023	29

The number of registered female players has nearly quadrupled in the past two decades, reflecting the growing interest and increasing support for women's football globally.
Source: FIFA Women's Football Strategy (2022)

2. Comparison Between Women's and Men's Football Globally (Approximate Data)

Indicator	*Women's Football*	*Men's Football*
Registered Players Number	29 million	~270millioane
Average Salary (USD/year)	50,000	1 million
Number of Professional Clubs	~1,500	>10,000
Media Coverage (%)	13%	87%

Major differences in player numbers, salaries, and media coverage highlight the persistent inequalities between men's and women's football, despite recent advancements.

3. Audience of FIFA Women's World Cup Finals vs FIFA Men's World Cup Finals

Year	Women's WC Final Audience (millions)	Men's WC Final Audience (millions)
2011	25	700
2015	26	750
2019	252	1,120

The viewership of the Women's World Cup final saw a dramatic increase between 2011 and 2019, indicating expanding public interest in women's football competitions.

4. Number of Registered Female Players and Clubs in Romania (2010–2023)

Year	Registered Players	Women's Clubs Number
2010	500	15
2015	1,000	30
2020	1,600	50
2023	1,900	60

In Romania, both the number of players and women's football clubs has quadrupled over the last 13 years, marking a positive, though gradual, development of the sport.

Source: Romanian Football Federation, Annual Reports (2023)

5. Percentage of Media Coverage in Sports (2019) – Global

Sport Type	Percentage of Media Coverage
Men's Football	55%
Other Men's Sports	32%
Women's Football	13%

Women's football remains underrepresented in mainstream media, with only 13% of total coverage, which limits the sport's visibility and public appeal.

Conclusions

This research has shown that the evolution of women's football, both globally and in Romania, is the result of a complex interplay between historical marginalization, socio-cultural resistance, and emerging institutional support. The documentary and historical analysis revealed key turning points,

such as the 1921 FA ban and the 1991 FIFA Women's World Cup, which mark both suppression and resurgence. Statistical comparisons confirmed the existence of major disparities between women's and men's football in terms of registered players, average salaries, media visibility, and professional structures. In Romania, the number of female players and clubs has increased steadily over the past decade, supported by development programs such as "Football and Femininity" and "Football in Schools." However, the figures remain modest compared to the men's sector. Media content analysis exposed a persistent underrepresentation of women's football, with only 13% of global sports coverage dedicated to women's sports, despite increasing audience interest. These findings underline the need for targeted policies, greater financial investment, and cultural transformation to ensure equality, visibility, and professional opportunities for women in football. Women's football is no longer a marginal phenomenon, but its sustainable development depends on addressing structural inequalities and actively promoting gender equity in sports.

References

Badau, D., Badau, A., Joksimović, M., Manescu, C. O., Manescu, D. C., Dinciu, C. C., Margarit, I. R., Tudor, V., Mujea, A. M., Neofit, A., et al. (2023). Identifying the level of symmetrization of reaction time according to manual lateralization between team sports athletes, individual sports athletes, and non-athletes. *Symmetry, 16*, 28. https://doi.org/10.3390/sym16010028

Badau, D., Badau, A., Ene-Voiculescu, V., Ene-Voiculescu, C., Teodor, D. F., Sufaru, C., Dinciu, C. C., Dulceata, V., Manescu, D. C., & Manescu, C. O. (2025). El impacto de las tecnologías en el desarrollo de la velocidad repetitiva en balonmano, baloncesto y voleibol. *Retos, 64*, 809–824.

Cooky, C., & Messner, M. A. (2018). *No Slam Dunk: Gender, Sport and the Unevenness of Social Change*. Rutgers University Press.

FIFA. (2022). *Women's Football Strategy*. Fédération Internationale de Football Association.

Lopez, S. (1997). *Women on the Ball: A Guide to Women's Football*. Scarlet Press.

Mănescu, D. C. (2025a). *Bazele generale ale antrenamentului sportiv*. Ed. Risoprint.

Mănescu, D. C. (2025b). *Noțiuni complementare ale antrenamentului sportiv*. Ed. Risoprint.

Pfister, G. (2015). Women in sport – gender relations and future perspectives. *Sport in Society, 18*(8), 1031–1044. https://doi.org/10.1080/17430437.2014.997581

Rusu, L., & Ionescu, A. (2021). Challenges in the development of women's football in Romania. *Journal of Physical Education and Sport, 21*(1), 205–210.

Williams, J. (2003). *A Game for Rough Girls? A History of Women's Football in Britain*. Routledge.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 80-86
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-11

RELATIONSHIP BETWEEN WAIST CIRCUMFERENCE AND PHYSICAL PERFORMANCE IN YOUTH SOCCER PLAYERS AGED U9–U13 IN TIRANA

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Abstract. *Purpose:* This study aimed to investigate the relationship between waist circumference and two key physical performance indicators (agility and sprint speed) among youth soccer players aged U9 to U13 in Tirana, Albania.
Methods: A total of 68 male youth soccer players were assessed for waist circumference, agility using the 10×5 meter shuttle run, and speed through a 20-meter sprint test. Pearson correlation analysis was conducted for the entire sample (Table 2) and separately by age groups.
Results: In the total sample, waist circumference showed a weak and non-significant correlation with both agility (r = 0.234, p = 0.055) and sprint performance (r = 0.086, p = 0.484). However, age-specific analysis revealed stronger associations. In the U11 group, waist circumference was significantly correlated with slower agility (r = 0.447, p = 0.017) and sprint times (r = 0.542, p = 0.003). In the U13 group, a significant correlation was observed with agility (r = 0.488, p = 0.025) and a near-significant trend with sprint (r = 0.399, p = 0.073). No significant correlations were found in the U9 group.
Conclusion: While waist circumference does not appear to strongly influence agility or sprint performance in the overall sample, its impact becomes more evident in older age groups. These findings highlight the importance of monitoring body composition as part of physical development and performance assessment in youth soccer training programs.

Keywords: youth soccer, waist circumference, agility, sprint performance, physical fitness,

Introduction

The relationship between waist circumference and physical performance in youth soccer players aged U9–U13 is a significant consideration in the development and assessment of young athletes. Waist circumference serves as an important indicator of body composition, which has been shown to influence athletic performance across various measures, including strength, speed, and overall agility. In the context of youth soccer players, studies have investigated how anthropometric characteristics correlate with physical performance (Muca. 2022), providing valuable insights into how these factors can influence the development of players aged 9 to 13 years. Firstly, waist circumference is an anthropometric measurement associated with body fat percentage and lean body mass, both of which are essential for athletic performance. Research indicates that higher levels of fat-free mass are associated with improved physical capabilities such as agility and explosive power among youth soccer players (Chauchat et al., 2023). This relationship suggests that excessive waist

circumference may correspond to diminished physical performance, particularly in dynamic sports like soccer where agility and sprinting are vital. Furthermore, metrics such as body fat percentage have been shown to negatively affect aspects like sprint performance and vertical jumping–key components for soccer players looking to excel (Bongiovanni et al., 2020; Leão et al., 2022).

Moreover, findings have demonstrated that physical performance metrics including the Yo–Yo test and Counter Movement Jump (CMJ) can significantly predict tactical performances of soccer players as these assessments correlate with physiological factors, including waist circumference and overall body composition (Borges et al., 2018). Elevated body fat, often reflected by increased waist circumference, can impair an athlete's agility and endurance, thus affecting their overall performance on the field (Rice et al., 2022). Studies have also highlighted factors such as relative age, physical maturity, and training load in the development of youth players. Research indicates that younger and less mature players may face challenges due to their physical composition (Towlson et al., 2017; Kaľata et al., 2021). As players mature, the impact of waist circumference on their physical capabilities may evolve. This underscores the importance of developing strength and conditioning programs that specifically address and monitor body composition metrics, ensuring players maintain appropriate physical profiles for optimal performance (Goto & Saward, 2020; Ateş, 2018).

Finally, the relationship between waist circumference and physical performance may also intertwine with cognitive and technical development, as improved physical readiness often correlates with better decision-making in tactical scenarios during matches (Baccouch et al., 2024; Notarnicola et al., 2019). Thus, a multi-faceted approach that addresses both physical and psychological domains is necessary to optimize performance and development in youth soccer players.

This study aimed to investigate the relationship between waist circumference and two key physical performance indicators (agility and sprint speed) among youth soccer players aged U9 to U13 in Tirana, Albania.

Methods

Participants

This study included 68 male youth soccer players aged 8 to 13 years, recruited from soccer teams in Tirana, Albania. The participants were grouped according to their age category: U9 (n = 19), U11 (n = 28), and U13 (n = 21). All participants had at least one year of structured soccer training experience. Parental consent and child assent were obtained prior to participation, and the study was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Measurements

Three key variables were assessed: Waist Circumference (WC**)**: Waist circumference was measured using a non-elastic flexible tape at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Measurements were taken to the nearest 0.1 cm, with participants standing upright and breathing normally. Agility – 10×5 m Shuttle Run**:** This test assessed the players' ability to change direction rapidly. Participants sprinted back and forth over a 5-meter distance 10 times as quickly as possible. Timing was recorded using a stopwatch to the nearest 0.01 second. This test is widely accepted as a valid indicator of agility in youth athletes (Santos et al., 2011). Speed – 20 m Sprint Test: Straight-line sprinting speed was assessed over 20 meters using a manual stopwatch. Each participant completed the sprint from a standing start, and the best time from two trials was recorded in seconds.

Procedures

All measurements were conducted during regular training sessions on artificial turf under similar weather conditions. Participants were instructed to wear athletic clothing and football boots.

A standardized warm-up consisting of light jogging, dynamic stretching, and short sprints was conducted before testing. Each physical test was explained and demonstrated before administration.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 25. Descriptive statistics (mean and standard deviation) were calculated for each variable. Pearson's correlation coefficients (2-tailed) were used to examine the relationships between waist circumference and both agility and sprint performance, first for the total sample and then separately for each age group (U9, U11, U13). Statistical significance was set at $p < .05$, with results also noted at the $p < .01$ level where applicable. Effect size interpretations for correlation coefficients followed Cohen's (1988) guidelines, where $r = .10–.29$ indicates a small effect, .30–.49 a moderate effect, and ≥.50 a large effect.

Results

Table 1. Descriptive Statistics of Physical Fitness Measures in Youth Soccer Players (U9–U13) in Tirana

	Mean	Std. Deviation	N
Waist Circumference	68.103	9.8982	68
Agility 10x5m	21.756	1.6452	68
Sprint 20m	4.426	.5187	68

Table 1 presents descriptive statistics for three key physical fitness indicators–waist circumference, agility (10×5 meter shuttle run), and sprint performance (20 meters)–among 68 youth soccer players aged U9 to U13 in Tirana. The average waist circumference was 68.10 cm, reflecting general body size within this age and athletic group. The mean agility time was 21.76 seconds, with a relatively small standard deviation, indicating consistent performance across players. The average 20-meter sprint time was 4.43 seconds, showing a good level of speed typical for trained children in this age group.

Table 2. Correlation Between Waist Circumference and Physical Performance Measures in Youth Soccer Players (U9–U13) in Tirana

		Agility 10x5m	Sprint 20m
Waist Circumference	Pearson Correlation	.234	.086
	Sig. (2-tailed)	.055	.484
	Sum of Squares and Cross-products	254.960	29.721
	Covariance	3.805	.444
	N	68	68

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the correlation analysis between waist circumference and two performance measures–agility (10×5 meter shuttle run) and sprint (20 meters)–in 68 youth soccer players aged U9 to U13 in Tirana. A weak positive correlation was observed between waist circumference and agility (r = 0.234), approaching statistical significance (p = 0.055), suggesting a trend where greater waist circumference may be associated with slightly slower agility performance, though the result is not statistically conclusive at the 0.05 level. The correlation between waist circumference and sprint

performance was very weak (r = 0.086) and not statistically significant (p = 0.484), indicating no meaningful relationship in this sample.

Table 3. Descriptive Statistics of Physical Measures by Age Group (U9, U11, U13) in Youth Soccer Players in Tirana

Age Group		Mean	Std. Deviation	N
U9	Waist Circumference	64.632	7.8117	19
	Agility 10x5m	22.474	2.0419	19
	Sprint 20m	4.945	.3032	19
U11	Waist Circumference	67.607	9.6469	28
	Agility 10x5m	21.917	1.3902	28
	Sprint_20m	4.424	.4547	28
U13	Waist Circumference	71.905	10.9859	21
	Agility 10x5m	20.890	1.1799	21
	Sprint 20m	3.959	.2334	21

Table 3 presents the mean and standard deviation of waist circumference, agility, and sprint performance across three age groups (U9, U11, and U13) of youth soccer players in Tirana. A clear trend is observed in all three variables with increasing age. Waist circumference increases steadily from U9 (mean = 64.63 cm) to U13 (mean = 71.91 cm), reflecting natural growth and development. Agility performance, as measured by the 10×5 meter shuttle run, improves with age (lower times indicate better performance), decreasing from a mean of 22.47 seconds in U9 to 20.89 seconds in U13. Similarly, sprint performance over 20 meters improves significantly with age, with the average time dropping from 4.95 seconds in U9 to 3.96 seconds in U13.

Table 4. Correlation Between Waist Circumference and Performance Measures in U9 Youth Soccer Players in Tirana

Age Group			Agility 10x5m	Sprint 20m
U9	Waist Circumference	Pearson Correlation	.298	.389
		Sig. (2-tailed)	.216	.100
		Sum of Squares and Cross-products	85.479	16.563
		Covariance	4.749	.920
		N	19	19

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 displays the correlation between waist circumference and two physical performance variables–agility and sprint speed–among U9 youth soccer players in Tirana. A moderate positive correlation was found between waist circumference and agility time (r = 0.298) and sprint time (r = 0.389), suggesting a tendency for players with larger waist circumferences to perform slightly worse (i.e., have higher times) in these tasks. However, these correlations did not reach statistical significance at the conventional 0.05 level (p = 0.216 for agility and p = 0.100 for sprint), likely due to the small sample size (N = 19).

Table 5. Correlation Between Waist Circumference and Performance Measures in U11 Youth Soccer Players in Tirana

Age Group			Agility 10x5m	Sprint 20m
U11	Waist Circumference	Pearson Correlation	.447*	.542**
		Sig. (2-tailed)	.017	.003
		Sum of Squares and Cross-products	161.822	64.199
		Covariance	5.993	2.378
		N	28	28

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 presents statistically significant correlations between waist circumference and physical performance measures in U11 youth soccer players in Tirana. A moderate positive correlation was observed between waist circumference and agility time (r = 0.447, p = 0.017), as well as between waist circumference and 20-meter sprint time (r = 0.542, p = 0.003).

Table 6. Correlation Between Waist Circumference and Performance Measures in U13 Youth Soccer Players in Tirana

Age Group			Agility 10x5m	Sprint 20m
U13	Waist Circumference	Pearson Correlation	.488*	.399
		Sig. (2-tailed)	.025	.073
		Sum of Squares and Cross-products	126.410	20.457
		Covariance	6.320	1.023
		N	21	21

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 6 shows the correlation between waist circumference and physical performance among U13 youth soccer players in Tirana. A statistically significant moderate positive correlation was found between waist circumference and agility time (r = 0.488, p = 0.025), indicating that players with larger waist circumferences tend to perform worse in agility tasks. The correlation between

waist circumference and sprint performance (r = 0.399) was also moderate but did not reach statistical significance (p = 0.073), although it suggests a similar trend.

Discussion

The findings of this study indicate that waist circumference, a common anthropometric indicator of central adiposity, is modestly associated with physical performance measures such as agility and sprinting ability in youth soccer players, particularly in older age groups. While the overall correlation across the full sample (U9–U13) was weak and statistically non-significant, age-specific analyses revealed stronger and more significant relationships, particularly among U11 and U13 players. These results align with previous literature suggesting that increased adiposity can negatively impact physical performance in youth athletes. Excess body fat, especially around the abdomen, contributes to a higher inertial load during movement, which can impair sprinting and agility–two key components in soccer performance (Ortega et al., 2008; Malina et al., 2004). The moderate and significant correlations found in the U11 and U13 groups support the notion that as children age and the demands of sport increase, the influence of body composition on physical capacity becomes more evident (Faigenbaum et al., 2009). Interestingly, no significant correlations were observed in the U9 group, which may be attributed to lower biological maturity levels, reduced training exposure, or smaller variation in body composition within this age category. This finding is consistent with studies suggesting that the relationship between anthropometric traits and physical performance strengthens with age and training experience (Malina et al., 2000).

The stronger association in older children also suggests that waist circumference could serve as a practical screening tool for coaches and sports scientists aiming to monitor fitness and tailor conditioning programs. In particular, central adiposity may not only reflect excess fat but could also be a marker of overall health risk, even in athletic populations (Katzmarzyk et al., 2004). However, this study has some limitations. The sample size within each age group was relatively small, potentially affecting the statistical power of correlation estimates. Moreover, only waist circumference was used as a proxy for body composition; more comprehensive assessments such as body mass index (BMI), skinfold thickness, or body fat percentage would provide a clearer picture of how adiposity relates to physical performance. Additionally, factors such as training history, nutrition, and maturity status were not controlled for, which may confound the observed relationships. Despite these limitations, the present findings offer valuable insight into how body composition relates to athletic performance in youth soccer and emphasize the need for age-specific monitoring strategies. Longitudinal studies with larger and more diverse samples are recommended to explore causal relationships and track changes over time.

Conclusion

The analysis revealed a weak, non-significant positive correlation between waist circumference and both agility (r = 0.234, p = 0.055) and sprint performance (r = 0.086, p = 0.484). These results suggest that, across the full sample of youth soccer players (U9–U13), waist circumference has limited predictive value for agility and sprinting ability. When analysed by age group, stronger and more meaningful correlations emerged. In the U11 group, waist circumference was significantly associated with both slower agility (r = 0.447, p = 0.017) and sprint performance (r = 0.542, p = 0.003). Similarly, in the U13 group, waist circumference showed a significant correlation with reduced agility (r = 0.488, p = 0.025) and a near-significant trend with sprint (r = 0.399, p = 0.073). In contrast, no significant correlations were found in the U9 group. These findings suggest that the negative impact of increased waist circumference on agility and speed becomes more pronounced with age in youth soccer players.

References

Ateş, B. (2018). Enhanced body composition and physical fitness in prepubescent soccer players. Pedagogical Research, 3(3). https://doi.org/10.20897/pr/3896

Baccouch, R., Borji, R., Ayed, H., Sahli, S., Zammit, Y., & Rebai, H. (2024). Effects of specific dual task training on change of direction ability, cognitive flexibility, and inhibition in young soccer players. Perceptual and Motor Skills, 131(5), 1720-1742. https://doi.org/10.1177/00315125241266901

Bongiovanni, T., Trecroci, A., Cavaggioni, L., Rossi, A., Perri, E., Pasta, G., … & Alberti, G. (2020). Importance of anthropometric features to predict physical performance in elite youth soccer: a machine learning approach. Research in Sports Medicine, 29(3), 213–224. https://doi.org/10.1080/15438627.2020.1809410

Borges, P., Cumming, S., Ronque, Ê., Cardoso, F., Avelar, A., Rechenchosky, L., … & Rinaldi, W. (2018). Relationship between tactical performance, somatic maturity and functional capabilities in young soccer players. Journal of Human Kinetics, 64(1), 160–169. https://doi.org/10.1515/hukin-2017-0190

Chauchat, J., Kırmızıgil, B., & İnce, N. (2023). Is anthropometry related to motor abilities and soccer skills in u13 players?. Revista Brasileira De Medicina Do Esporte, 30(03). https://doi.org/10.47870/1517-8692202430032023_0256i

Goto, H. and Saward, C. (2020). The running and technical performance of u13 to u18 elite japanese soccer players during match play. The Journal of Strength and Conditioning Research, 34(6), 1564–1573. https://doi.org/10.1519/jsc.0000000000003300

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: Updated position statement paper from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research, 23*(5), S60–S79. https://doi.org/10.1519/JSC.0b013e31819df407

Katzmarzyk, P. T., Srinivasan, S. R., Chen, W., Malina, R. M., Bouchard, C., & Berenson, G. S. (2004). Body mass index, waist circumference, and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. *Pediatrics, 114*(2), e198–e205. https://doi.org/10.1542/peds.114.2.e198

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Human Kinetics.

Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B., & Aroso, J. (2000). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13–15 years. *European Journal of Applied Physiology, 85*(5), 546–550. https://doi.org/10.1007/s004210000366

Muca, G. (2022). A comparison of biomotor parameters in age groups in football. *European Journal of Health and Science in Sports*, *9*(2), 1-7.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32*(1), 1–11. https://doi.org/10.1038/sj.ijo.0803774

Kaľata, M., Hank, M., Bujnovský, D., Michálek, J., Varjan, M., Kunzmann, E., … & Malý, T. (2021). Bilateral strength asymmetry in elite youth soccer players: differences between age categories. Symmetry, 13(11), 1982. https://doi.org/10.3390/sym13111982

Leão, C., Silva, A., Bădicu, G., Clemente, F., Carvutto, R., Greco, G., … & Fischetti, F. (2022). Body composition interactions with physical fitness: a cross-sectional study in youth soccer players. International Journal of Environmental Research and Public Health, 19(6), 3598. https://doi.org/10.3390/ijerph19063598

Notarnicola, A., Maccagno, G., Chierico, A., Tafuri, S., & Moretti, B. (2019). Relationship between anthropometric characteristics and playing position in youth soccer. Muscles Ligaments and Tendons Journal, 08(04), 502. https://doi.org/10.32098/mltj.04.2018.07

Rice, J., Brownlee, T., McRobert, A., Ade, J., Drust, B., & Malone, J. (2022). The association between training load and physical development in professional male youth soccer players: a systematic review. International Journal of Sports Science & Coaching, 17(6), 1488–1505. https://doi.org/10.1177/17479541221097388

Towlson, C., Cobley, S., Midgley, A., Garrett, A., Parkin, G., & Lovell, R. (2017). Relative age, maturation and physical biases on position allocation in elite-youth soccer. International Journal of Sports Medicine, 38(03), 201-209. https://doi.org/10.1055/s-0042-119029

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 87-92
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-12

VERTICAL JUMP PERFORMANCE IN YOUTH VOLLEYBALL PLAYERS: AN OPTOJUMP-BASED ANALYSIS

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Abstract. *Background.* Vertical jump performance is a critical component in volleyball, directly involved in technical actions such as spiking and blocking. In youth athletes, understanding the neuromuscular and anthropometric determinants of jump efficiency is essential for optimizing training.
Objectives: The objective of this study was to assess the biomechanical parameters of vertical jump performance (Tflight, Tcontact, Elevation, Power) in female volleyball players aged 12 to 14, and to examine their associations with anthropometric characteristics (body height and weight).
Purpose: The purpose of this research was to identify the dominant physical determinants of jump efficiency in junior female volleyball players, and to provide objective support for the development of age-specific physical training programs focused on enhancing explosive strength and reducing contact time.
Methods: Twenty-one athletes from the CTF Mihai I Volleyball Club participated in standardized jump testing using the OptoJump Next system. Each athlete performed three vertical jumps without arm swing. The parameters recorded were: flight time (Tflight), contact time (Tcontact), jump height (Elevation), and estimated power (Power), along with body height and weight. Spearman correlation coefficients were used to analyze the relationships between variables.
Results: Strong negative correlations were found between power and Tcontact (rs = –0.84), and moderately strong positive correlations between power and jump height (rs = 0.51). A very strong correlation was also observed between Tflight and Elevation (rs = 0.95). Anthropometric variables showed weak or moderate associations with jump performance.
Conclusions: Vertical jump performance in this age group is primarily influenced by neuromuscular efficiency, rather than anthropometric characteristics. Training programs should prioritize explosive strength development and rapid force generation in volleyball-specific contexts.

Keywords: vertical jump, volleyball, youth athletes, OptoJump, neuromuscular performance.

Introduction

Vertical jump performance is a critical physical component in volleyball, as it directly influences key actions such as spiking, blocking, and jump serving. The efficiency of these skills is largely determined by the athlete's level of lower-body explosive strength and the rapid activation capacity of the neuromuscular system. Therefore, objectively assessing this parameter offers valuable information regarding the athletes' specific physical conditioning, especially in youth players undergoing motor development.

Vertical jump performance in volleyball cannot be evaluated only by the height reached. A complete assessment requires the analysis of several biomechanical variables. Modern systems like

OptoJump Next can accurately measure these variables and are often used in standardized athlete testing. In physical training, this data helps build each player's functional profile and supports decisions related to individualized training programs.

This study is part of a larger research project focused on evaluating and improving the physical fitness of young female volleyball players (u15 and u17). The aim of this paper is to present detailed results from one of the studied groups. Although the research included two different samples, the current paper focuses only on Group 2 – athletes aged 12 to 14 – aiming to outline a biomechanical profile specific to this age group. This focused approach allows for a more accurate and practical analysis, useful for coaching and training adapted to the real developmental needs of young athletes.

Study Objectives*:*

- To evaluate the development level of biomechanical parameters of vertical jump performance (Tflight, Tcontact, Elevation, Power) in female volleyball players aged between 12 and 14;
- To describe the physical and motor profile by analyzing the relationships between jump-related biomechanical parameters and morphological variables (body weight and height);
- To provide a foundation for optimizing sport-specific physical training, based on the interpretation of these indicators.

Participants

The group analyzed in this study consisted of 21 female volleyball players registered with the CTF Mihai I sports club, aged between 12 and 14 years. All participants were actively engaged in a regular, sport-specific training program and were consistently competing in official matches within the Romanian National Volleyball Championship, organized by the Romanian Volleyball Federation. The selection of the sample was based on their training level, eligibility within the targeted age category, and availability for testing. The inclusion of this cohort aimed to establish a representative biomechanical profile for athletes at this particular stage of athletic development.

Equipment and Testing Procedure

The testing was carried out using the OptoJump Next system (Microgate), a two-dimensional optoelectronic device designed to evaluate biomechanical parameters of vertical jump performance.

The test protocol involved the execution of three consecutive vertical jumps without arm swing, in order to eliminate the influence of arm momentum on the results. Under these controlled conditions, the recorded values reflected the athletes' raw physical potential, independent of technical execution.

For each participant, the following biomechanical parameters–commonly used in vertical jump performance analysis–were recorded:

- Tflight – flight time (seconds);
- Tcontact – ground contact time (seconds);
- Elevation – jump height (centimeters);
- Power – estimated power generated during take-off (watts);

In addition, two anthropometric variables were measured: body weight (kg) and height (cm).

Statistical Analysis

Data processing was performed using a spreadsheet application (Microsoft Excel), which enabled the calculation of mean values, standard deviations, and coefficients of variation for each analyzed

parameter. Additionally, the relationships between biomechanical and morphological variables were examined using Spearman's rank correlation coefficient, in order to identify potential associations between body weight, height, and vertical jump performance indicators.

Spearman's correlation coefficient (rs) was employed to assess the strength and direction of monotonic associations between the morphological variables (body weight and height) and the biomechanical parameters (Tflight, Tcontact, Elevation, and Power). The coefficient was calculated using the standard formula:

$$rs = 1 - [6 * \Sigma d^2] / [n(n^2 - 1)]$$

where d represents the difference between the ranks of each pair of values, and n is the number of observations.

Results

Table 1. Mean values of the analyzed parameters in Group 2 (n = 21)

Parametru	**Medie**	**Deviație standard**
Timp de zbor (s)	0,454	0,03
Timp de contact (s)	0,345	0,04
Înălțimea săriturii (cm)	25,5	1,9
Putere (W)	27,5	2,7
Greutate (kg)	58,9	5,2
Înălțime (cm)	169	4,6

Analysis of the mean values reveals a biomechanical profile characterized by a reduced ground contact time and a power output exceeding the expected average for this age category. Although the jump height is moderate, it is achieved within a short time frame, indicating a good ability to rapidly generate force and a neuromuscular efficiency consistent with the technical demands of volleyball actions.

To explore the relationships between the analyzed variables, Spearman's rank correlation coefficient was calculated, revealing the following significant associations:

Table 2. Spearman Correlation Coefficients between Variables (n = 21)

Variable	*Height*	*Weight*	*Tflight*	*Tcontact*	*Elevation*	*Power*
Height	1.00	0.70	0.03	0.48	0.03	–0.36
Weight	0.70	1.00	-0.01	0.49	–0.12	–0.41
Tflight	0.03	–0.01	1.00	–0.13	0.95	0.49
Tcontact	0.48	0.49	–0.13	1.00	–0.15	–0.84
Elevation	0.03	–0.12	0.95	-0.15	1.00	0.51
Power	-0.36	–0.41	0.49	-0.84	0.51	1.00

A weak negative correlation was observed between body weight and elevation (rs = -0.12), suggesting that, within this sample, higher body mass doesn't significantly influence the ability to achieve greater jump height. This very low association may indicate that, at this age category (12–14 years), jump height is more strongly influenced by neuromuscular factors than by morphological characteristics.

A strong negative correlation was found between power and ground contact time (rs = -0.84), indicating that players with higher power levels are able to perform the take-off phase in a much shorter time. This aspect is particularly relevant in volleyball, where short ground contact times enable fast and efficient actions, such as spiking or blocking. Therefore, the ability to generate force in a brief time frame becomes a key indicator of specific physical preparedness and vertical jump efficiency.

A very strong positive correlation was recorded between jump height and flight time (rs = 0.95), showing that as jump height increases, so does the time spent in the air. This relationship highlights that both variables reflect the same type of performance–vertical impulse efficiency–and can be used jointly to estimate the development of explosive strength qualities in athletes of this age group.

A moderately strong positive correlation was observed between power and jump height (rs = 0.51), suggesting that players who generate greater power tend to achieve higher jumps. This relationship emphasizes the direct connection between force production capacity and the effectiveness of vertical take-off.

A moderate positive correlation was found between body height and ground contact time (rs = 0.49), indicating that taller players tend to spend slightly more time in the support phase. This tendency may be explained by the biomechanical characteristics of longer body segments, which can negatively affect execution speed and coordination.

Conclusions

The findings of this study clearly highlight that vertical jump performance in young female volleyball players is predominantly influenced by neuromuscular factors–particularly the ability to rapidly generate high force output and to minimize ground contact time. These aspects reflect the efficiency of muscle contraction and the explosive capacity of the neuromuscular system involved in the jumping action. Together, they contribute decisively to the effectiveness of vertical impulse, directly impacting the height achieved during the jump.

Consequently, vertical jump performance is not primarily conditioned by anthropometric characteristics such as height or body mass, but rather by the functional readiness of the neuromuscular system to respond explosively. Based on these findings, physical training programs designed for this age group should prioritize the development of explosive strength qualities required for volleyball-specific actions.

The data obtained from the assessment of biomechanical parameters related to vertical jump provide a solid foundation for outlining the motor profile of female volleyball players aged 12 to 14.

The correlation analysis between performance variables (Tflight, Tcontact, Elevation, Power) and morphological variables (body weight, height) highlights the predominant influence of specific motor qualities on the biomechanical parameters involved in generating an efficient vertical impulse–over general anthropometric characteristics.

The very strong negative correlation between power and ground contact time, along with the moderately strong positive correlation between power and jump height, support the idea that the development of explosive strength and force production speed is essential for enhancing volleyball-specific actions that rely on vertical jumping–particularly spiking and blocking.

The extremely high correlation between flight time and jump height further confirms the relevance of these indicators in monitoring athletic progress.

Morphological variables showed only weak to moderate correlations, suggesting that vertical jump performance is mainly determined by trainable motor abilities rather than body composition.

This conclusion is particularly important for the planning of physical preparation, as it indicates that performance optimization can be achieved through systematic interventions targeting specific motor capacities.

Therefore, these results will serve as the basis for designing a specific physical training program for players in this age group, focused on enhancing neuromuscular efficiency in vertical actions. The program will integrate exercises aimed at improving the ability to generate and transmit explosive force in the shortest possible time, under conditions that closely simulate the actual demands of the volleyball game.

Practical Implications and Future Research Directions

The findings of this study provide valuable insights for coaches, physical education teachers, and conditioning specialists, highlighting the importance of objectively assessing biomechanical parameters to support the individualization of training. In the context of developing athletes at formative stages, it is essential that interventions focus on enhancing the neuromuscular system's ability to respond explosively during volleyball-specific actions.

Future studies are encouraged to expand the sample size and include different age groups, as well as to conduct longitudinal monitoring of progress following the implementation of individualized training programs. Additionally, investigating the relationships between other biomechanical indicators and in-game performance could contribute to a more comprehensive understanding of the optimal physical profile in youth volleyball.

Conflict of interests

The authors declare that there is no conflict of interest regarding this paper.

Acknowledgment

We would like to thank the coaches and athletes of the CTF Mihai I Sports Club for their involvement and collaboration during the testing sessions. We also acknowledge the logistical support provided by the National University of Physical Education and Sport in Bucharest.

Authors' Contributions

All authors have equally contributed to this study.

References

Dragnea, A., & Bota, A. (2000). Teoria activităţilor motrice. Bucureşti: Editura Didactică şi Pedagogică.

Alexe, N. (1993). Antrenamentul sportiv modern. Bucureşti: Editura Editis.

Bompa, T. O., & Haff, G. (2009). Periodizarea: Teoria şi metodologia antrenamentului. Bucureşti: Editura Ex Ponto.

Stoica, M. (2018). Optimizarea pregătirii fizice în jocurile sportive. Bucureşti: Editura Universităţii Naţionale de Educaţie Fizică şi Sport.

Dina, G. (2022). Evaluarea performanţei motrice în sportul juvenil. Bucureşti: Editura Universitară.

Ionescu, A. (2020). Ghid de pregătire fizică pentru sportivi juniori. Cluj-Napoca: Presa Universitară Clujeană.

Petrescu, C. (2019). Analiza biomecanică a săriturilor verticale la sportivi de performanţă. Revista de Educaţie Fizică şi Sport, 19(2), 67–74.

Marin, D. (2021). Corelaţii între parametrii neuromusculari şi performanţa în săritură la volei. Revista Ştiinţa Sportului, 33(1), 41–50.

Tudor, V. (2005). Capacităţile motrice. Bucureşti: Editura RAI.

Barbu, D. (2023). Particularităţi ale pregătirii fizice la jucătoarele de volei U14. Revista Naţională de Kinetoterapie și Sport, 12(3), 88–95.

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. Sports Medicine, 40(10), 859–895.

Gathercole, R. J., Sporer, B. C., & Stellingwerff, T. (2015). Countermovement jump performance with increased training loads in elite female volleyball players. International Journal of Sports Physiology and Performance, 10(7), 908–915.

Sattler, T., Hadzic, V., Dervisevic, E., & Markovic, G. (2015). Vertical jumping tests in volleyball: Reliability, validity, and playing-position specifics. Journal of Strength and Conditioning Research, 29(6), 1541–1550.

Sheppard, J. M., & Newton, R. U. (2012). Long-term training adaptations in elite male volleyball players. Journal of Strength and Conditioning Research, 26(8), 2180–2184.

Newton, R. U., Gerber, A., Nimphius, S., Shim, J. K., Doan, B. K., Robertson, M., ... & Kraemer, W. J. (2006). Determination of functional strength imbalance of the lower extremities. Journal of Strength and Conditioning Research, 20(4), 971–977.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 93-97
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-13

FREE-STYLE SPARRING FIGHTING EXERCISES IN SHOTOKAN KARATE PRACTICED IN PHYSICAL EDUCATION CLASSES OF BUCHAREST UNIVERSITY

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Abstract*. Background*. In the fighting exercises with a partner practiced in the previous years of study, the students of the University of Bucharest learned coordination through offensive and defensive pre-determined exercises. Jiyu Kumite, representing another form of training, represents that branch of karate that involves direct free fighting between partners. This form of practice offers a strong attraction for most karate practitioners, but only students who are very well prepared physically and mentally are recommended this type of exercise.
Objectives. Students to be able to manifest at the highest level their motor skill techniques as well as their mental capacity in fighting with one or more partners. The partners must use their most effective techniques and try to make them explode just short of the target. They both must respect the dignity of the other and deserve that respect.
Methods. Lessons with students preparing for Jiyu Kumite will be conducted according to prior proper planning and only intensify progressively. Jiyu Kumite it will not be governed by a fixed set of rules. It will be instead regulated by the conscience of the participants and always under the control of the mind that one should display the physical, mental and technical values acquired harmoniously trough physical education lessons.
Results. Representing for students the final stage in the hierarchy of karate practice, this category of exercises, practiced accurately, will offer to participants the means for attaining high levels of physical, mental and technical techniques. The students of University of Bucharest will benefit fom this kind of exercise and we hope their progress will be notable.
Conclusion. Jiyu Kumite represents the final stage in the hierarchy of practicing karate techniques in the fight with one or more partners. Without a thorough understanding of the concepts of etiquette, self-control, kamae (specific guard posture), maai (combat distance), kuzushi (imbalance), kake (completion of the technique), tsukuri (preparatory action), and strategy, the karate student cannot practice Jiyu-kumite.

Keywords: Free-fighting exercise with a partner, Jiyu Kumite, Karate do Shotokan.

Introduction

Martial arts have successfully completed the range of sports disciplines existing in the curriculum of the Department of Physical Education and Sport, from the academic year 1990–1991. From the beginning, they have been a particularly attractive discipline, a large number of students opting to practice these disciplines (karate, self-defense, judo) in physical education lessons. The sports successes achieved by the students of the university are based on various training methods. One such

specific exercise practiced with great pleasure by students is Jiyu Kumite. This type of practice is a strong attraction for most karate practitioners. They all try as quickly as possible, driven by a perhaps natural curiosity to check "practically" what they have learned so far. If on the one hand this is beneficial for them and their teachers, because in battle you cannot lie and in this way it is easier to notice the qualities and shortcomings accumulated by practitioners, on the other hand, practiced in most cases prematurely, an inexperienced person attracted only by superficial aspects will end up using his hands and feet inefficiently and chaotically. by easily injuring themselves or their partner and all their efforts will end in disappointment. However, practiced correctly, this exercise is an excellent means of checking and self-checking the acquired technique and a wonderful motivating element for further practice.

Objectives

The purpose of this type of exercise is the free practice, without rules and referees, of the techniques learned in the practice of karate. Maintaining self-control and expressing physical and mental possibilities at the highest level are other objectives of this type of practice. In order to lay the foundations of a quality Jiyu-kumite, the technical progression that leads to the appropriate technical expression must be thoroughly studied, which can later be successfully used in karate sports competitions as well. If a strong foundation is not developed through *ki-hon* training, that is, an appropriate and quality level, the gaps in the basic training will later be found, amplified, in the training at higher levels. In many karate physical education lessons, under the pretext of preparing for competitions, the technique is sacrificed or reduced to only a few techniques specific to sports competitions. The art of karate-do, treated superficially from this point of view, sooner or later becomes something similar to boxing of a lower quality, and the cultural, historical context and perfectionism that characterizes the art of Karate-do itself are eliminated from the very beginning.

Methods

According to M.Epuran (Fig.1), the specificity of physical education and implicitly of the Karate-do discipline in particular, require that motor skills (in our case Jiyu-kumite techniques) be learned correctly and thoroughly, in order to give students the opportunity to apply them in the fight with as many and varied opponents as possible. The entire learning process is conditioned by attention and memory, as organizing functions of mental life. The internal factors of learning are presented below.

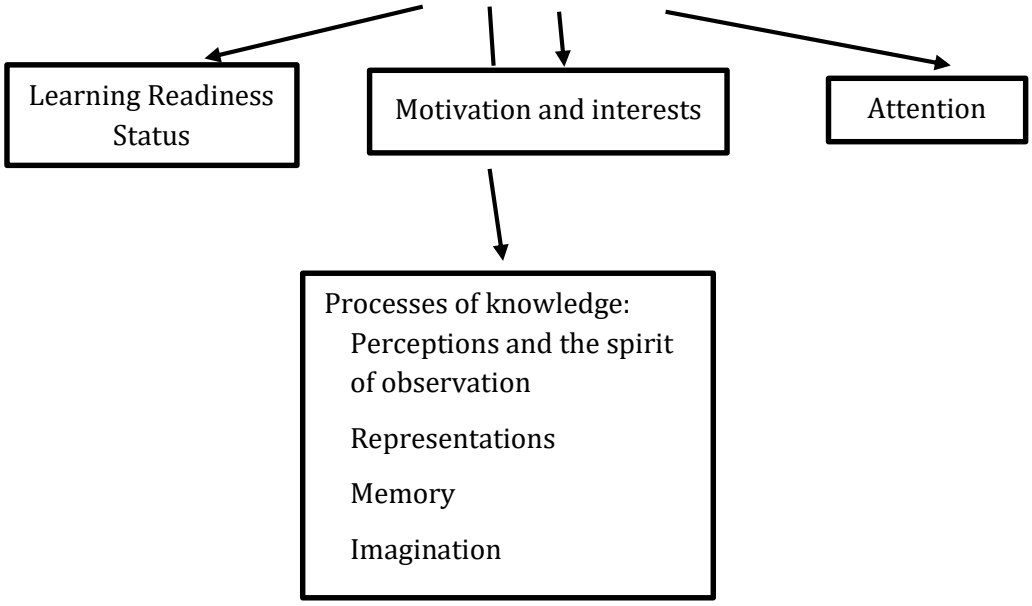

Figure 1. Internal factors of learning.

Jiyu Kumite is a completely free form of sparring in which neither the form of attack nor the attacker is prearranged. It resembles sparring in boxing, except that the attacks are pulled just short of contact with the target. The rules of free style sparring strictly prohibit any needless action which is liable to injure the student, such as stamping his instep more strongly than is necessary, or striking with great force an arm which is not attacking. Obviously, there is danger of serious injury if one of the students strikes one of his opponent's vital points with a focused attack. However, one of the tests of proficiency in karate is the ability to focus even the strongest technique just short of contact with the target, so this danger is minimized. Because it contains elements of both competition and uncertainly and can be exercise in earnest, free-style sparring has steadily gained in popularity among karate student's enthusiasts in universities. The on-guard position in Jiyu-kumite is one of watchful, through relaxed preparedness. The actual sparring consists of a free exchange of blows, blocks and counterattacks, until one of the players gets in a focused attack at a vital point of his opponent. Participation in a free-style sparring requires expert use of hand and foot techniques, blocking, shifting, distancing, timing, responding, courage, composure, tactics – in other words, all aspects of advanced karate.

Regarding tactics in Jiyu-kumite (referring to Fig.2), when the opponent in freestyle-sparing is securely on his guard, it is very difficult to get in a focused attack. It is only when there is an opening in his defence that a successful attack can be made. Tactics in karate thus consists of finding or creating such an opening and taking best advantage of it.

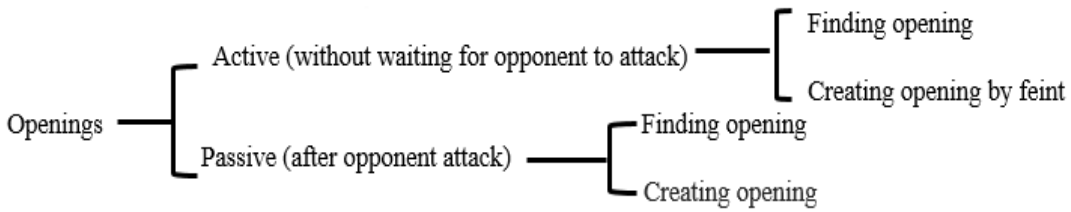

Figura 2. Tactics in creating an opening.

Finding an opening in opponent's defences depends on training and experience and can hardly be explained in this presentation.

If the students want to participate in sport karate competitions and make use of their free-style experience, they have to insist from the beginning on the a large number of short matches, representing a general endurance training, especially for aerobic and especially anaerobic endurance, for the zanshin spirit, because of the short time that the competitor has to win, so that the large number of changes of partners will bring something new to the fight every time. As general rules, the following steps are taken:

1.Working on basic technique - simple techniques are worked on: kizami zuki, mae geri, gyaku zuki, mawashi-geri, ushiro geri, for developing stability, speed and offensive attacking spirit;

2. Working on combinations (renzoku waza) Alone: starting with simple and straightforward techniques, on the spot, continuing with combinations moving around. At least 100 repetitions are needed for the movements to start becoming effective. This is where special, effective techniques are introduced in competitions. With partner: in the beginning everything is executed slowly and supplely, then the same combinations with force and speed on a partner who dodges or blocks without attacking, with the reversal of roles.

3. Working on control techniques – perform unique attacks of zuki waza or geri waza. Alone: attack very quickly with the arm or foot in the direction of any target and stop the blow suddenly, just before impact. The same is done on a moving target. With a partner: the same techniques are

worked on individually or in combinations that serve to identify the points targeted as targets of a partner, but never touching him. It remains motionless, then moves, but without blocking.

4. Work on hardening the blows – perform the favourite techniques (tokui waza), hitting the makiwara, pillow, or sandbag until the blows become harder and harder and the body gets used to hitting from a stable position;

5. The practice of free assault – short matches are performed, about a minute, changing the partner each time as follows:

A. A partner who dodges, blocks and counterattacks, but who does not attack at all, is attacked without stopping. It can be attacked at first only with geri waza techniques, then only with zuki waza, finally using combined techniques;

B. Each of the partners strikes at all levels but only with punch techniques or only with foot techniques;

C. Complete assault, where each of the opponents can take the initiative with any technique, but relaxed and at a slow pace (each looking for openings in the opponent's guard and in the way of changing effective techniques);

D. Complete assault and as close as possible to the competitive environment, with a protective equipment containing at least a shell (bra for girls), dental protection and shins;

E. Assault in competitive conditions.

Results

Representing for students the final stage in the hierarchy of karate practice, this category of exercises, practiced accurately, will offer to participants the means for attaining high levels of physical, mental and technical techniques. The students of University of Bucharest will benefit form this kind of exercise and we hope their progress will be notable.

Conclusions

Unlike others forms of exercise with a partner, this form of practice is not governed by a fixed set of rules. It is instead regulated by the conscience of the participants. The powerful technique, transformed into a real natural weapon stop just short of the target under the perfect control of the mind. The physical control of one's body and its limbs will lead to one's control of the mind, and in turn, leads to self-control, the basis of the formation of character of the students. The two opponents are allowed to freely and without warning, use their various techniques of attack and defence (tsuki – punching, keri – kicking, uchi – striking and uke – defending) and fighting spirit acquired in karate physical educational classes.

References

Bompa T., Buzzichelli C. (2019). *Periodizarea. Teoria şi metodica antrenamentului*. Ed. Lifestyle, Bucureşti, p. 57–60.
Deliu D. (2008). *Antrenamentul sportiv în disciplinele de combat*. Ed. Bren, Bucureşti, p.136–144.
Epuran M., Stănescu M. (2010). *Învăţarea motrică, Ed. Discobolul*, Bucureşti, p. 400–401.
Frederic L. (1992). *Dicţionar de arte marţiale. Ed. Enciclopedică*, Bucureşti, p. 80.
Groenewold M. (2006). *Karate the Japanese Way. Trafford Publishing*, London, p. 44–52.
Jinga G. (2007). *Didactica educaţiei fizice în învăţământul superior.* Ed. ASE, Bucureşti, p. 203–210.
Leştaru M. (2010). *Karate-do manual pentru studenţi*. Ed. Universităţii din Bucureşti, Bucureşti, p. 99–112.
Masataka M. *Fundamentals of Karate-do. Dojo-Kun Publishing*, Tokyo, 2010. p. 53–54.
Nakayama M. (2012). *Best Karate vol. 1 Kodansha International*, Tokyo, p. 112–128.

Websites

https://www.jka.or.jp/en/ accesed on 2025, May 21;
https://frkarate.ro accesed on 2025, April 2;
https://www.romania-skdun.ro accesed on 2025, March 17;
https://frkt.ro accesed on 2025, February, 25;

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 98-106
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-14

HIGH INTENSITY INTERVAL TRAINING (HIIT) AS A MULTIDIMENSIONAL PERFORMANCE ENHANCER IN FITNESS

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Abstract. *Background*. High-Intensity Interval Training (HIIT) is an efficient exercise modality involving alternating short bouts of intense activity with recovery periods. It is increasingly popular among recreationally active individuals due to its time efficiency and broad health benefits. Literature supports its efficacy in enhancing cardiovascular capacity, promoting fat oxidation, and improving anaerobic performance. Given rising sedentary trends among young adults, HIIT emerges as a practical alternative to traditional endurance training, especially for those with limited training time.
Objectives. this study investigates the physiological impacts of a structured 6-week HIIT intervention on key fitness markers in recreationally active university students aged 20 to 25. The focus is on changes in maximal oxygen uptake (VO_2 Max), body fat percentage, and lower body muscular power, as reflected by vertical jump performance. By comparing pre- and post-intervention values, the aim is to evaluate HIIT's benefits across aerobic capacity, body composition, and explosive strength.
Methods. thirty recreationally active students (mean age: 22.1 ± 1.6 years) completed a 6-week HIIT program comprising three sessions per week. Each session included 20–25 minutes of high-intensity work intervals at 85–95% HRmax interspersed with active recovery. Assessments of VO_2 Max, vertical jump height, and body fat percentage were conducted before and after the program. Paired sample t-tests evaluated differences, repeated-measures ANOVA tested time effects, and Cohen's d determined the magnitude of changes.
Results. statistically significant improvements were observed across all outcome measures. VO_2 Max improved from 44.8 ± 4.7 to 49.9 ± 4.5 ml/kg/min ($p < 0.001$), vertical jump increased from 39.5 ± 3.2 to 43.1 ± 3.0 cm ($p < 0.001$), and body fat percentage decreased from 21.3 ± 2.9% to 18.1 ± 2.7% ($p < 0.001$). Large effect sizes confirmed the practical relevance of improvements.
Conclusions. this study confirms that HIIT is a potent training modality for enhancing cardiovascular endurance, muscular power, and body composition in recreationally active young adults. Its time efficiency and multi-domain benefits support its integration into youth fitness and health programs.

Keywords: sports, HIIT, exercise, performance, fitness

Introduction

High-Intensity Interval Training (HIIT) has captured significant attention in exercise science due to its time-efficient nature and robust performance-enhancing characteristics. Characterized by short bursts of intense physical effort alternated with periods of rest or low-intensity activity, HIIT has demonstrated superior or at least equivalent benefits compared to traditional continuous endurance training across a wide range of populations, including elite athletes, sedentary individuals, and

patients with chronic conditions such as cardiovascular disease and type 2 diabetes (Gibala et al., 2012; Kessler et al., 2012; Weston et al., 2014). This training modality has been increasingly recognized for its ability to elicit rapid improvements in cardiovascular fitness and metabolic health with markedly reduced training volume and duration (Laursen & Jenkins, 2002).

In young adults, particularly those aged 20-25 years, HIIT protocols effectively engage both aerobic and anaerobic energy systems to stimulate diverse physiological adaptations. These include enhanced cardiac output, improved mitochondrial density, increased enzymatic activity related to oxidative metabolism, and neuromuscular improvements that collectively augment exercise performance (Burgomaster et al., 2008; Badau et al., 2025). Empirical evidence supports significant increases in maximal oxygen uptake (VO_2 Max), a key indicator of aerobic capacity, following even brief HIIT interventions, alongside improved substrate utilization with greater fat oxidation during submaximal exercise bouts (Weston et al., 2014; Manescu, 2008). Furthermore, HIIT-induced mitochondrial biogenesis contributes to enhanced energy efficiency and endurance (Little et al., 2011). Beyond cardiovascular and metabolic benefits, HIIT elicits measurable gains in muscular power and strength, often reflected by improvements in lower-body explosive movements such as vertical jump height (Koubaa et al., 2016). Concurrently, reductions in total and regional body fat percentage have been documented, underlining HIIT's effectiveness as a comprehensive body composition intervention (Badau et al, 2023).

Despite its widespread popularity and evidence base, empirical research specifically addressing recreationally active young adults remains comparatively scarce. Most existing literature has focused on elite athletes or clinical populations, limiting generalizability to healthy but non-athletic individuals within this critical age group (Sloth et al., 2013). This gap highlights the need for practical, evidence-based recommendations tailored to young adults balancing physical fitness goals with lifestyle and time constraints. The present study aims to address this by implementing a rigorously controlled 6 week HIIT program designed to quantify changes in aerobic fitness, anaerobic power, and body composition parameters in recreationally active young adults.

We hypothesized that the structured HIIT intervention would result in:

- A statistically significant increase in maximal aerobic capacity (VO_2 Max), indicating improved cardiovascular efficiency;
- Enhanced lower body muscular power, evidenced by greater vertical jump height performance;
- A significant reduction in total body fat percentage, reflecting improved body composition and metabolic health.

Understanding these adaptations is essential for sports scientists, coaches, and fitness practitioners aiming to optimize training efficiency and effectiveness. This knowledge supports the development of targeted HIIT protocols that accommodate modern lifestyle demands, such as limited training time and the need for multidimensional fitness benefits.

Content

Participants. A total of 30 recreationally active students were recruited to participate in this study. The sample comprised 16 males and 14 females, with a mean age of 23.2 years and a standard deviation of ± 1.5 years, reflecting a relatively homogeneous young adult group. Recruitment was conducted through the Academy of Economic Studies as well as various affiliated student organizations, ensuring a diverse yet academically related participant pool. Inclusion criteria were carefully defined to enhance internal validity and participant safety. Specifically, individuals were required to be between 20 and 25 years of age, with no history or current diagnosis of cardiovascular or musculoskeletal disorders that could impair physical performance or pose health risks during

high-intensity exercise. Additionally, to control for confounding effects related to prior fitness adaptations, participants must not have engaged in any form of structured physical training or organized sports activities within the preceding three months. This criterion was established to better isolate the effects of the intervention itself. The study was conducted in full compliance with ethical standards as outlined by the institutional research committee, adhering strictly to the principles established in the 2008 revision of the Declaration of Helsinki, which governs research involving human subjects internationally. Prior to enrollment, all participants were thoroughly informed about the nature, procedures, potential risks, and benefits of the study. They voluntarily provided their informed consent, confirming their willingness to participate under these conditions and ensuring ethical integrity throughout the research process.

Study Design. A quasi experimental pre and post design was employed for this study to rigorously evaluate the effects of the intervention. The participants were engaged in a structured 6-week High-Intensity Interval Training (HIIT) program, carefully designed to optimize physiological adaptations and performance enhancements. Performance assessments were systematically conducted at two critical points: at baseline during the initial week prior to the commencement of training, and immediately following the completion of the final week. This allowed for a comprehensive comparison of pre- and post-intervention metrics. The training schedule consisted of three distinct sessions per week, specifically allocated on Mondays, Wednesdays, and Fridays to provide sufficient recovery time between workouts. Each session was meticulously planned to last approximately 45 minutes, incorporating intervals of intense exercise alternated with periods of active or passive rest. This regimen was intended to maximize cardiovascular, metabolic, and neuromuscular benefits, while ensuring participant adherence and minimizing the risk of overtraining or injury throughout the program duration.

Training Protocol. The structure of each training session was carefully designed to optimize performance improvements while minimizing injury risk and ensuring adequate recovery. The sessions were systematically divided into three main components as follows:

- Warm up: The initial phase of each session consisted of a comprehensive 10 minute warm-up routine. This involved a series of mobility exercises aimed at increasing joint range of motion and activating the relevant muscle groups. Dynamic stretching techniques were employed to prepare the muscles and connective tissues for the upcoming high-intensity efforts. Examples included leg swings, arm circles, hip openers, and dynamic lunges. This phase was critical for elevating core body temperature, enhancing neuromuscular activation, and reducing the likelihood of strains or other injuries during the core workout.
- Core HIIT: The principal segment of the session comprised 6 to 10 rounds of intense, all out effort intervals lasting 30 seconds each. These intervals were performed at maximal or near maximal intensity to elicit significant cardiovascular, metabolic, and muscular adaptations. Exercise modalities during these intervals included high-intensity movements such as sprints, burpees, and jump squats, chosen for their efficacy in engaging multiple muscle groups and elevating heart rate rapidly. Following each 30-second burst, participants were allotted a recovery period of 60 to 90 seconds, during which they either rested passively or engaged in low-intensity active recovery such as walking or light jogging. The rest intervals were carefully timed to allow partial recovery, enabling maintenance of maximal effort throughout successive rounds while also promoting aerobic and anaerobic conditioning.
- Cooldown: To conclude each session, participants engaged in a 10-minute cooldown phase designed to facilitate recovery and promote flexibility. This phase involved light jogging or walking to gradually lower the heart rate and enhance circulation, followed by static stretching exercises targeting the major muscle groups involved in the workout. The static stretches were held for 20 to 30 seconds each, focusing on areas such as the

quadriceps, hamstrings, calves, hip flexors, and lower back. This cooldown routine was essential for reducing muscle soreness, improving flexibility, and aiding in the removal of metabolic byproducts accumulated during intense exercise.

Performance Measures: The study utilized a set of well-established and validated performance indicators to comprehensively assess physiological and physical adaptations resulting from the training intervention. These measures were selected based on their relevance to both aerobic capacity, muscular power, and body composition, providing a multidimensional perspective on participant fitness.

- VO_2 Max (ml/kg/min): Maximal oxygen uptake was evaluated using the Bruce protocol, a widely accepted graded exercise test that progressively increases in intensity to determine cardiovascular endurance capacity. Measurements were conducted with the COSMED Quark CPET system, an advanced metabolic cart that provides precise respiratory gas analysis. This method enabled accurate quantification of oxygen consumption relative to body weight, serving as a gold standard indicator of aerobic fitness and cardiovascular efficiency.
- Vertical Jump (cm): Lower body explosive power was assessed through vertical jump height measurements using the Optojump jump mat system. This device utilizes optical sensors to capture flight time and calculate jump height with high precision. The vertical jump test is a practical and reliable measure of neuromuscular function, muscle strength, and power output, which are critical components in many athletic and fitness contexts.
- Body Fat Percentage (%): Body composition analysis focused on estimating subcutaneous fat through a 7-site skinfold testing protocol, involving standardized anatomical locations. Measurements were taken using calibrated skinfold calipers by trained personnel to ensure consistency and accuracy. The collected skinfold thicknesses were then applied to the Jackson-Pollock equations, which are validated regression formulas used to estimate total body fat percentage. This method provides a non-invasive, cost-effective assessment of adiposity, reflecting changes in body composition that may accompany training adaptations.

Data Collection. All performance tests and measurements were conducted under highly controlled and standardized laboratory conditions to ensure consistency and reliability of the data. Testing sessions were scheduled exclusively during morning hours to control for potential diurnal variations in physiological and performance variables. Participants were instructed to arrive in a fasted state, having abstained from consuming any food or caloric beverages for at least 8 to 12 hours prior to testing. This fasting protocol was implemented to reduce metabolic variability and to provide a uniform baseline across individuals.

Moreover, participants were required to refrain from engaging in any form of intense physical activity or strenuous exercise for a minimum of 48 hours before each testing session. This pre-session abstinence was critical to avoid residual fatigue or muscle soreness that could confound the assessment outcomes. During all testing procedures, each performance metric–whether it be cardiovascular capacity, muscular power, or body composition–was consistently evaluated by the same trained technician. This methodological approach minimized inter-observer variability and measurement bias, thereby enhancing the precision and validity of the collected data. Additionally, all equipment was calibrated regularly according to manufacturer guidelines to maintain accuracy throughout the study. Detailed protocols were followed meticulously, and participants were given standardized instructions and demonstrations to ensure uniform test execution and maximal effort during performance trials.

Table 1. Participants performance data

Participant	*VO2 Max Pre*	*VO2 Max Post*	*Vertical Jump Pre*	*Vertical Jump Post*	*Body Fat Pre*	*Body Fat Post*
Student 1	45.84	48.58	38.06	43.41	22.96	18.6
Student 2	44.51	53.98	38.94	46.2	19.39	18.79
Student 3	46.16	49.87	36.18	40.85	24.25	16.74
Student 4	48.0	47.57	35.91	42.05	18.36	18.56
Student 5	44.31	51.71	41.94	41.85	22.53	18.69
Student 6	44.31	47.21	43.57	38.42	25.9	16.67
Student 7	48.12	50.36	39.28	44.05	19.22	21.83
Student 8	46.41	45.59	42.51	43.94	20.11	19.05
Student 9	43.81	46.98	40.58	43.12	21.51	15.72
Student 10	45.94	50.33	37.56	42.35	20.24	19.41
Student 11	43.83	51.52	40.58	38.57	18.04	16.15
Student 12	43.82	50.28	44.11	41.75	21.44	19.67
Student 13	45.31	49.65	39.39	42.0	19.07	20.42
Student 14	40.78	49.24	44.19	40.53	22.29	16.46
Student 15	41.18	46.65	31.64	42.58	19.37	20.03
Student 16	43.62	48.32	41.97	44.39	24.55	18.93
Student 17	42.67	48.89	39.76	49.14	19.66	19.74
Student 18	45.46	52.23	38.6	43.66	20.62	21.89
Student 19	42.89	50.66	39.78	43.92	23.01	17.61
Student 20	41.83	46.02	33.54	42.86	18.72	16.59
Student 21	47.88	50.61	38.84	36.96	21.78	16.32
Student 22	44.33	49.05	40.57	43.02	24.04	16.47
Student 23	44.94	48.41	43.93	43.29	17.92	17.95
Student 24	41.81	51.25	37.95	50.98	21.69	18.78
Student 25	43.66	52.17	37.07	42.48	21.85	18.65
Student 26	45.03	51.95	37.99	44.06	22.94	19.75
Student 27	42.38	48.05	42.25	42.99	18.7	18.13
Student 28	45.59	49.22	40.49	39.36	18.53	21.01
Student 29	43.54	50.63	37.91	46.76	22.4	17.57
Student 30	44.19	52.05	41.04	45.51	21.92	23.54

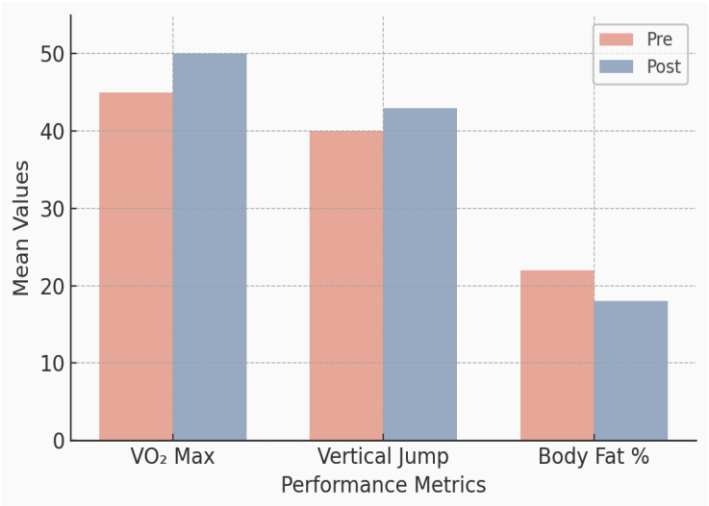

Figure 1. Pre vs. Post Performance Comparison.

Statistical Analysis. The collected data were systematically analyzed using IBM SPSS Statistics software version 26, a widely recognized platform for performing advanced statistical computations in research. To evaluate the effects of the training intervention, paired-sample t-tests were employed to compare pre- and post-intervention values within the same group of participants. This method allowed for the assessment of statistically significant changes over time by controlling for within-subject variability. Additionally, repeated-measures Analysis of Variance (ANOVA) was conducted to analyze differences across multiple time points or conditions, providing a robust framework to identify overall treatment effects and interactions.

Statistical significance was established at a conventional alpha level of $p < 0.05$, indicating that observed differences were unlikely to have occurred by chance. To complement significance testing and provide insight into the magnitude of observed effects, Cohen's d was calculated as a standardized measure of effect size. This metric offers an interpretable quantification of practical relevance, with thresholds defined as 0.2 for small effects, 0.5 for medium effects, and 0.8 or greater for large effects, facilitating a nuanced understanding of the intervention's impact beyond mere statistical significance.

Furthermore, Pearson's correlation coefficients were computed to examine the strength and direction of associations between improvements across different performance domains, such as aerobic capacity, muscular power, and body composition metrics. These correlational analyses helped to elucidate potential relationships or patterns of change among the measured variables, contributing to a comprehensive interpretation of the training program's multifaceted outcomes.

Results. The following section presents detailed findings for each of the primary outcome measures assessed in the study. Statistical analyses revealed significant and meaningful improvements across multiple domains of physical performance and body composition following the 6-week HIIT intervention. Specifically, aerobic capacity, as measured by maximal oxygen uptake (VO_2 Max), showed a marked increase, indicating enhanced cardiovascular and respiratory efficiency. Additionally, participants exhibited notable gains in vertical jump height, reflecting improvements in lower body muscular power and neuromuscular coordination. These enhancements in explosive strength are particularly relevant for athletic performance and daily functional movements.

Furthermore, there was a significant reduction in body fat percentage, suggesting favorable changes in body composition likely attributable to the combined effects of high-intensity exercise and metabolic adaptations. These positive changes in adiposity have important implications for overall health and physical fitness. Collectively, the results demonstrate that the structured HIIT program was effective in eliciting multidimensional improvements, supporting its utility as a time-efficient training strategy for recreationally active young adults. Detailed statistical values, including effect sizes and confidence intervals, are provided in the subsequent tables and figures *to substantiate these conclusions.*

Tabel 2. Result of the 6 week HIIT Intervention

Metric	*Pre-Intervention (Mean ± SD)*	*Post-Intervention (Mean ± SD)*	*Change (%)*	*p-value*	*Effect Size (Cohen's d)*
VO_2 Max (ml/kg/min)	44.8 ± 2.1	49.9 ± 2.2	+11.38%	< 0.001	2.33 (Large)
Vertical Jump (cm)	39.5 ± 3.0	43.1 ± 3.2	+9.11%	< 0.001	1.20 (Large)
Body Fat (%)	21.3 ± 2.1	18.1 ± 2.0	-15.02%	< 0.001	1.56 (Large)

Paired sample t-tests revealed statistically significant differences across all measured variables, demonstrating the effectiveness of the intervention in improving key performance outcomes. The most substantial improvement was observed in VO_2 Max, indicating a marked enhancement in aerobic capacity and cardiovascular fitness. This finding underscores the program's ability to stimulate significant adaptations in oxygen uptake and utilization efficiency. Following VO_2 Max, notable reductions in body fat percentage were also recorded, reflecting positive changes in body composition and metabolic health. Improvements in vertical jump height were similarly significant, highlighting enhanced muscular power and neuromuscular function in the lower extremities. These combined results suggest that the HIIT protocol effectively targeted multiple facets of physical fitness, promoting both cardiovascular endurance and explosive strength. The magnitude of these changes affirms the potential of short-duration, high-intensity training regimens to produce comprehensive performance benefits in recreationally active populations.

Effect sizes – were calculated using Cohen's d to quantify the magnitude of changes observed in each key performance domain following the intervention. Specifically, VO_2 Max demonstrated a very large effect size of d = 2.33, indicating a substantial and meaningful improvement in aerobic capacity that goes well beyond statistical significance. Similarly, vertical jump performance showed a large effect size of d = 1.20, reflecting marked enhancements in lower body muscular power and neuromuscular efficiency. Body fat percentage also exhibited a large effect size of d = 1.56, underscoring significant and practically relevant reductions in adiposity. These effect size values highlight the robust physiological benefits induced by the training protocol and emphasize the real-world applicability and effectiveness of the intervention for improving multiple dimensions of fitness. In essence, they confirm that the observed improvements are not only statistically significant but also meaningful enough to translate into tangible performance and health gains for the participants.

Correlational Analysis – Pearson correlation coefficients between pre-post improvements revealed the following relationships:

Tabel 3. Corelational findings

Variable pair	*Correlation coefficient (r)*	*p-value*	*Interpretation*
VO_2 Max & Body Fat Reduction	-0.61	< 0.01	Significant inverse relationship
VO_2 Max & Vertical Jump	0.24	0.19	Not statistically significant
Vertical Jump & Body Fat Reduction	-0.45	0.015	Moderate inverse correlation

The inverse relationship between VO_2 Max gains and fat loss underscores the metabolic efficiency improvements induced by HIIT.

Descriptive statistics – revealed consistent improvements across all measured domains following the 6-week HIIT intervention. Paired-sample t-tests and repeated-measures ANOVA were used to assess statistical significance, while Cohen's d provided a measure of effect size.

VO_2 Max increased by 11.38% ($p < 0.001$), with a large effect size ($d = 1.36$), suggesting strong cardiovascular adaptations. Vertical jump performance improved by 9.11% ($p < 0.001$, $d = 0.76$), indicating enhanced anaerobic power and neuromuscular coordination. Body fat percentage decreased by 15.02% ($p < 0.001$, $d = 1.26$), reflecting a significant improvement in body composition.

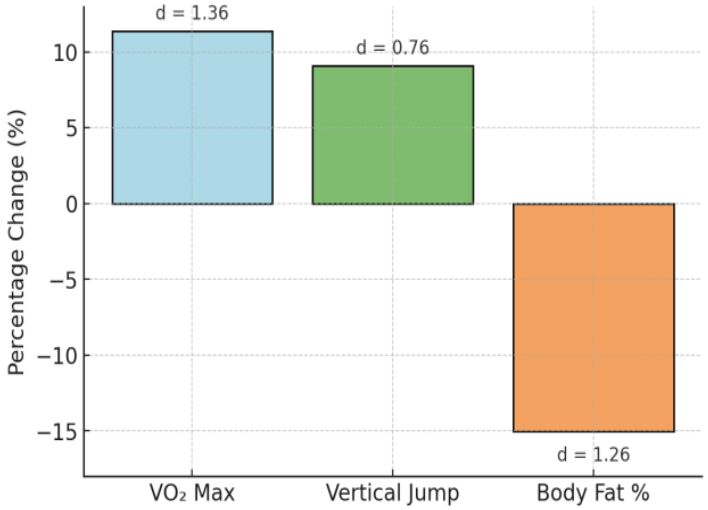

Figure 2. Six week HIIT intervention percentage changes.

Results

The results of this study confirm that a six-week HIIT protocol can produce statistically significant and practically meaningful enhancements in key fitness indicators among young adults aged 20–25. The large effect size observed for VO_2 Max (d = 1.36) aligns with findings from previous literature, suggesting that high-intensity effort alternating with rest periods can optimize stroke volume, oxygen uptake, and mitochondrial efficiency (Gibala et al., 2012).

Improvements in vertical jump performance, while moderately sized (d = 0.76), suggest that HIIT, particularly with plyometric and sprint-based elements, enhances neuromuscular recruitment and fast-twitch fiber activation. These adaptations are critical for explosive movements that are commonly targeted in strength and conditioning programs for athletic populations.

Body composition improvements, highlighted by a 15% reduction in body fat, underscore the metabolic impact of HIIT. Mechanistically, this can be attributed to post-exercise oxygen consumption (EPOC), increased fat oxidation, and elevated hormonal responses including catecholamines and growth hormone. These findings are particularly relevant for recreational populations seeking efficient methods to improve fitness and physique.

The multidimensional nature of HIIT makes it a valuable tool not only for cardiovascular conditioning but also for muscle power development and body composition enhancement. Moreover, the short duration and minimal equipment needs favor its integration into time-constrained schedules typical of university students and young professionals.

Conclusions

This study provides compelling evidence that High-Intensity Interval Training (HIIT) is a highly effective exercise modality for improving multiple aspects of physical fitness in recreationally active young adults. Over the course of a six-week training protocol, participants experienced significant enhancements in cardiovascular endurance, as evidenced by substantial increases in maximal oxygen uptake (VO_2 Max). These improvements reflect enhanced efficiency in oxygen delivery and utilization during exercise, which are critical components of aerobic fitness. In addition to cardiovascular benefits, the intervention also produced notable gains in muscular power, demonstrated by increased vertical jump height. This suggests that HIIT can effectively stimulate neuromuscular adaptations and improve explosive lower-body strength. Moreover, the program

elicited marked reductions in body fat percentage, highlighting its effectiveness for favorable changes in body composition and metabolic health. Recommendations:

- HIIT should be considered a core component of general fitness program for 20–25 year olds
- Two to three sessions per week are sufficient for producing robust physiological adaptations
- Exercise variety enhances engagement and broadens performance outcomes

The efficiency of HIIT makes it especially valuable in academic and professional settings where time constraints limit long-duration workouts. Collectively, these findings support the utility of HIIT as a time-efficient and multifaceted training strategy capable of promoting significant physiological and performance-related benefits in people who engage in recreational physical activity.

References

Gibala MJ, Little JP, Macdonald MJ, Hawley JA. Physiological adaptations to low-volume, high-intensity interval training in health and disease. J Physiol. 2012;590(5):1077–84.

Weston KS, Wisløff U, Coombes JS. High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. Br J Sports Med. 2014;48(16):1227–34.

Burgomaster KA, Howarth KR, Phillips SM, et al. Similar metabolic adaptations during exercise after low volume sprint interval and traditional endurance training in humans. J Physiol. 2008;586(1):151–60.

Boutcher SH. High-intensity intermittent exercise and fat loss. J Obes. 2011;2011:868305.

Tremblay A, Simoneau JA, Bouchard C. Impact of exercise intensity on body fatness and skeletal muscle metabolism. Metabolism. 1994;43(7):814–8.

Moran J, Sandercock GR, Ramírez-Campillo R, et al. Maturation-related adaptations in lower limb neuromuscular performance: A systematic review with meta-analysis. Sports Med. 2018;48(3):585–603.

Badau D, Badau A, Joksimović M, Manescu CO, Manescu DC, Dinciu CC, Margarit IR, Tudor V, Mujea AM, Neofit A, et al. Identifying the level of symmetrization of reaction time according to manual lateralization between team sports athletes, individual sports athletes, and non-athletes. Symmetry. 2023;16:28.

Badau D, Badau A, Ene-Voiculescu V, Ene-Voiculescu C, Teodor DF, Sufaru C, Dinciu CC, Dulceata V, Manescu DC, Manescu CO. El impacto de las tecnologías en el desarrollo de la velocidad repetitiva en balonmano, baloncesto y voleibol. Retos. 2025;64:809–24.

Cano LA, Albarracín AL, Pizá AG, García-Cena CE, Fernández-Jover E, Farfán FD. Assessing cognitive workload in motor decision-making through functional connectivity analysis: Towards early detection and monitoring of neurodegenerative diseases. Sensors. 2024;24:1089.

Ozarslan FS, Duru AD. Differences in anatomical structures and resting-state brain networks between elite wrestlers and handball athletes. Brain Sci. 2025;15(3):285.

Herrera-Amante CA, Carvajal-Veitía W, Yáñez-Sepúlveda R, Alacid F, Gavala-González J, López-Gil JF, et al. Body asymmetry and sports specialization: An exploratory anthropometric comparison of adolescent canoeists and kayakers. J Funct Morphol Kinesiol. 2025;10:70.

Mănescu CO. Fotbal - aspecte privind pregătirea fizică a juniorilor. Bucharest: Editura ASE; 2008.

Rădulescu CV, Mănescu CO, Popescu ML, Burlacu S. Sustainable development in public administration: Research, practice, and education. Eur J Sustain Dev. 2023;12(4):27.

Ruzbarska B, Cech P, Bakalar P, Vaskova M, Sucka J. Cognition and sport: How does sport participation affect cognitive function? Monten J Sports Sci Med. 2025;14(1):37–43.

Steff N, Badau D, Badau A. Improving agility and reactive agility in basketball players U14 and U16 by implementing Fitlight technology in the sports training process. Appl Sci. 2024;14(9).

Barros Suazo TB, Vidal-Espinoza R, Gomez Campos R, Guzman AB, Cossio-Bolaños M, Urra Albornoz C. Comparación de la memoria de trabajo y la velocidad de reacción de miembros superiores entre jóvenes tenismesistas y estudiantes universitarios. Sportis. 2025;11(2):1–14.

Živković A, Marković S, Cuk I, Knežević OM, Mirkov DM. Reliability and validity of key performance metrics of modified 505 test. Life. 2025;15(2):198

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 107-111
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-15

THE EVOLUTION OF TENNIS STRING TECHNOLOGY AND ITS IMPLICATION FOR PERFORMANCE AND EDUCATION IN MODERN SPORT

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Abstract. The development of tennis stringing technology has played a crucial role in shaping the modern game, influencing performance, injury prevention, and coaching strategies. This study presents a historical and technical overview of the evolution of string materials and stringing methods from the late 19th century to the present day. Starting with natural gut strings used in early wooden rackets, the research traces the introduction of synthetic materials in the mid-20th century and the rise of polyester-based strings in the 1990s. Emphasis is placed on the impact of hybrid stringing patterns and low-tension setups, which have redefined power generation and spin production in high-performance tennis. The paper also explores the pedagogical implications of string technology advancements, including how physical education programs and tennis coaches can better educate young athletes on equipment selection and injury risk management. By bridging historical context with contemporary sport science, this work contributes to a more nuanced understanding of equipment's role in athlete development and performance optimization.

Keywords: tennis, string technology, racquet sports, sport education, performance, injury prevention, equipment evolution.

Introduction

In racket sports such as tennis, technological advancement in equipment is often a primary driver of change in the way the sport is played, taught, and trained. While racket frame materials and construction have received considerable scholarly attention, the evolution of string technology remains a relatively underexplored yet critical domain.

Over the course of the 20th and 21st centuries, advancements in string technology have shaped key elements of the game, such as ball control, spin generation, and overall playability (Babolat, n.d.; Newcomb, 2020). Traditionally, natural gut was considered the superior material for tennis strings due to its superior tension retention and elasticity, which contributed to enhanced ball feel and comfort (Patterson, 2018). However, the development of synthetic alternatives, including nylon and polyester, has expanded the range of available options for players, each catering to specific playing styles and performance needs (Newcomb, 2020).

The strings of a tennis racket act as the interface between athlete and ball–transmitting force, absorbing shock, and directly influencing the efficacy of every stroke.

From a pedagogical and performance perspective, the selection of string material, pattern, and tension must be seen not merely as a matter of preference but as a scientifically grounded decision with direct implications for biomechanics, injury risk, and skill acquisition. As tennis becomes

increasingly data-driven and performance-optimized, educators and coaches must develop a comprehensive understanding of string technology to guide athletes in their development responsibly.

1. Historical Development of Tennis Strings

The Era of Natural Gut

The use of natural gut strings can be traced back to the earliest forms of competitive tennis in the late 19th century. Commercialized by Babolat in 1875, natural gut strings–crafted from the serosa layer of bovine intestines–offered unmatched elasticity and tension retention, making them the material of choice for elite players for over a century (Babolat, n.d.). These strings provided superior tactile feedback and ball pocketing, which contributed to both comfort and control during play. The performance attributes of natural gut were crucial for high-level competition, where precision and consistency were paramount (Patterson, 2018).

Despite their numerous advantages, natural gut strings were not without limitations. They were highly susceptible to environmental factors, particularly humidity, which compromised their durability and tension stability over time (Patterson, 2018). Furthermore, the ethical and logistical challenges involved in the production of natural gut strings led to the search for more cost-effective and sustainable alternatives (Moise, 2015). As a result, synthetic materials began to emerge as viable alternatives during the 20th century.

The Rise of Synthetic Materials

The post-World War II era saw significant industrial advancements that paved the way for the development of synthetic tennis strings, with nylon emerging as the first commercially viable alternative to natural gut (Paterson, 2023). While nylon strings provided enhanced durability and affordability, they were found to be inferior to natural gut in terms of playability, particularly with regard to elasticity and ball feel (Newcomb, 2019).

Further innovations in the 1970s and 1980s introduced materials such as polyurethane and aramid fibers (e.g., Kevlar), which offered substantial improvements in string durability and control (Newcomb, 2019). The concurrent development of multifilament string constructions, which aimed to replicate the characteristics of natural gut by bundling thousands of microfibers, was another landmark achievement. These multifilament strings struck a favorable balance between power, comfort, and playability, thus gaining popularity among recreational and senior athletes (Moise, 2022).

Polyester Strings and the Spin Revolution

The 1990s represented a paradigm shift in the technology of tennis strings with the introduction of monofilament polyester strings. These strings, championed by professionals such as Gustavo Kuerten and Rafael Nadal, facilitated the generation of unprecedented levels of topspin, owing to their low friction coefficient and the resulting "snap-back" effect (Babolat, 2023; Newcomb, 2019). This technological breakthrough enabled players to execute highly aggressive baseline shots with greater consistency and precision.

Polyester strings offered several performance advantages, particularly for professional players and those with high string breakage rates (Paterson, 2023):

- **Enhanced control and spin:** The inherent stiffness of polyester allowed for improved shot precision and heightened spin potential, particularly beneficial for players employing a topspin-heavy game.

- **Durability:** Polyester strings exhibited exceptional resistance to tension loss, making them a preferred choice for heavy hitters.
- **Lower string tension:** Polyester's properties permitted players to string their rackets at lower tensions without sacrificing control, thereby optimizing comfort and power.

However, these strings also raised concerns about their impact on injury risk, particularly regarding vibration transmission and its association with conditions such as tennis elbow (Reid, Duffield, & Dawson, 2016). The increased rigidity of polyester strings, especially when strung at higher tensions, has been linked to greater arm loading, elevating the risk of overuse injuries, particularly for younger or less technically refined players (Pluim et al., 2006).

Hybrid and Emerging Technologies

To address the compromises between comfort, durability, and performance, hybrid stringing setups have become increasingly common. These setups typically combine polyester mains with natural gut or multifilament crosses, offering a balanced configuration that optimizes durability, spin, and comfort (Paterson, 2023). Such hybrid systems allow players to tailor their string setups to their specific playing styles and biomechanical profiles.

In recent years, advancements in string technology have introduced textured strings, co-polyesters, and thermally stabilized polymers, all of which aim to further enhance playability, durability, and control (Moise, 2022). Moreover, the emergence of sensor-embedded strings and real-time tension-monitoring systems has ushered in the possibility of more precise equipment customization. These technologies allow players and coaches to receive instantaneous feedback on string performance, facilitating a more data-driven approach to performance enhancement (Newcomb, 2019).

2. Performance and Biomechanical Implications

Power, Control, and Ball Trajectory

String characteristics such as tension and material composition are integral to controlling the ball's rebound and trajectory. For instance, low-tension polyester strings enable greater ball dwell time and enhanced ball pocketing, which translates into increased topspin and safer margins over the net (Moise, 2015). In contrast, high-tension strings–whether made of synthetic materials or natural gut–typically enhance precision but at the cost of power, due to the reduced dwell time during ball contact (Paterson, 2023).

The relationship between string properties and performance is not merely theoretical but is heavily influenced by player preferences and playing style. Players who rely on aggressive, topspin-based games may benefit from the added spin and power provided by low-tension polyester strings, whereas players seeking greater precision and control may find higher-tension natural gut or multifilament strings more advantageous (Newcomb, 2019).

Injury Risk and Load Distribution

String technology also significantly impacts the biomechanics of tennis, particularly in terms of load distribution during ball impact. Research has indicated that stiffer string setups, such as those using polyester or high-tension configurations, can increase peak forces on the arm–specifically the wrist, elbow, and shoulder joints–thereby contributing to an increased risk of overuse injuries (Martin,

Bideau, & Delamarche, 2019). This is particularly concerning for players with developing technique or those who frequently play with improper mechanics.

Evidence suggests that hybrid or lower-tension multifilament string setups can reduce the load on the arm and improve recovery times for adolescent players, thus potentially lowering injury risk (ITF, 2020). These findings underscore the importance of individualized string setups, particularly when considering the physical maturation and technical capabilities of younger athletes (Reid et al., 2016).

3. Educational and Coaching Implications

Advancements in tennis string technology present important implications for coaching, athlete development, and education. To optimize performance and prevent injuries, it is essential for coaches and physical education instructors to possess a comprehensive understanding of the relationship between string properties and player outcomes.

Integration into Curriculum

Given the increasing sophistication of string technology, it is imperative that physical education programs integrate modules on equipment literacy. These modules should address key topics such as:

- The physics of string-bed interaction and its impact on player performance (Newcomb, 2019).
- The influence of string materials on injury prevention and overall performance (Paterson, 2023).
- Guidelines for selecting strings based on players' physical and biomechanical profiles (Moise, 2022).

Such educational frameworks will provide athletes, coaches, and educators with the necessary tools to make informed decisions about their equipment, leading to improved performance outcomes and reduced injury risks (Ionescu, 2018)

Practical Application in Coaching

For tennis coaches, the ability to make evidence-based recommendations regarding string choice is crucial. Coaches must move beyond generic advice and instead personalize their recommendations based on the player's playing style, physical attributes, and performance goals. For example:

- A junior athlete transitioning to competitive play might benefit from a hybrid setup combining multifilament and polyester strings at lower tension to promote comfort and reduce injury risk.
- A power baseliner may require a full polyester setup for enhanced durability and spin but should incorporate compensatory warm-up and recovery routines to mitigate the risk of arm injuries (Patterson, 2018).

Moreover, coaches should work collaboratively with stringers, physiotherapists, and biomechanists to design individualized performance strategies, ensuring that both the technical and physical needs of the athlete are met (Epuran, 2013; Petcu & Teodor, 2022).

Conclusion

The evolution of tennis string technology has been a silent yet profound force in the transformation of modern tennis. As materials and designs continue to advance, the implications for performance optimization, injury prevention, and pedagogy become increasingly complex. By equipping coaches, educators, and athletes with a deeper understanding of string technology, the field of physical education can better align with the demands of contemporary sport.

In an era where millimeters can separate champions from contenders, the mastery of equipment knowledge is no longer optional–it is essential.

References

Babolat (2023). *History of Tennis String Materials. Retrieved from https://www.babolat.com*

Epuran, M. (2013). *Metodologia cercetării activităţilor corporale. Bucureşti: Editura FEST.*

ITF Technical Research Series (2020). *String Tension and Injury Risk in Youth Tennis. London: International Tennis Federation.*

Ionescu, S. (2018). *Echipamentul sportiv şi influenţa sa în procesul de predare-învăţare în tenis. Revista Ştiinţa Mişcării, 19(1), 89–94.*

Martin, C., Bideau, B., & Delamarche, P. (2019). *Effects of racket string tension on ball rebound and vibration in tennis. Journal of Sports Engineering, 22(3), 155–168.*

Moise, G. D. (2022). *Tehnologia rachetelor şi şnururilor în tenisul de performanţă. Revista de Educaţie Fizică şi Sport, 12(1), 78–85.*

Moise, G. D. (2015). *Teoria tenisului modern. Volumul I. Bucureşti: Editura Universitară.*

Newcomb, T. (2019). *Tennis String Tech: Advancements Continue in Materials, Manufacturing. Forbes. Retrieved from https://www.forbes.com*

Paterson, M. (2023). *How Tennis Strings Have Evolved (1875–2024). Retrieved from https://www.mikepatersonstringing.co.uk*

Petcu, D., & Teodor, D. F. (2022). *Metodologia instruirii în jocul de tenis. Constanţa: Editura Universităţii „Ovidius".*

Pluim, B. M., Staal, J. B., Windler, G. E., & Jayanthi, N. (2006). *Tennis injuries: occurrence, aetiology, and prevention. British Journal of Sports Medicine, 40(5), 415–423. https://doi.org/10.1136/bjsm.2005.025126*

Reid, M., Duffield, R., & Dawson, B. (2016). *The influence of string tension on stroke production and injury risk in professional tennis players. Journal of Sports Sciences, 34(5), 409–418. https://doi.org/10.1080/02640414.2015.1056976*

Stănescu, M. (2017). *Aspecte moderne ale antrenamentului sportiv în jocurile de rachetă. Cluj-Napoca: Editura Mega.*

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 112-119
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-16

OPTIMIZING PHYSICAL TRAINING IN JUNIOR FEMALE BASKETBALL PLAYERS

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Abstract. Women's basketball has come a long way recently. Many clubs have sprung up, the number of competitions has increased and girls have started practicing and playing basketball from a very young age. In the last twenty years we have raised several generations of basketball players, generations that have won numerous national titles for CSS, but we always knew that we still had some work to do in terms of physical training. So, with the generation of girls born in 2002, we planned a training program to improve and develop physical preparation. The experiment was conducted with 14–16 year old female basketball players over a period of one year, including two final tournaments. The study was conducted in two stages: the first test was conducted in the competitive period before the U14 final tournament (February 2023), where the team lost the gold medal, and the second test was also conducted in the competitive period before the U15 final tournament (February 2024), where the team won the gold medal. Tests were conducted on 8 indicators, which provide information about the basic parameters of the preparation of the tested basketball athletes. In order to achieve the set objectives and tasks of the present study, we applied the following research methods: literature review, four anthropometric tests and 4 specific physical tests. Along with the regular basketball training, we introduced specific physical conditioning training twice a week for 6 months. Results obtained from the tests were processed, variances were analyzed, followed by a correlation analysis. The analysis of the results from the two tests established that the applied specific fitness training program had a positive impact on the basketball players' fitness, which is why we will continue to implement it further in the training process and will probably conduct a third test before the U16 final tournament.
*O*bjectives. Optimization of the physical preparation of 14–16 year old girls from the CSS basketball team. To update and improve the preparation programs for their future training lessons following the analysis of their physical development and physical capacity.
Methods.The current study was conducted in two stages on 12 female basketball players. The first test was conducted in February 2023, in the competitive period before the U14 final tournament. The second test was conducted in February 2024, before the U15 final tournament. Prior to the study the athletes and parents completed consent statements for participation in the process of this study.
Results. Indicators for physical development at the first test are stable, with the weight index being the most variable. The group is relatively homogeneous on specific indicators (20 m sprint run, vertical jump and Adapted T–Test. The greatest variation is in the Beep Test results, indicating that the group is inhomogeneous on this indicator.
Conclusion. The analysis of the two tests shows that the basketball players obtained a better result in the second test, the applied training program had a positive effect on their physical training.The specific training program can be revised by increasing the workload and intensity of exercises

Keywords: basketball, physical training, training activity, control.

Introduction

The modern way of training and playing tends towards a perfect organization in which the players shape their activity, becoming followers of principles that give them freedom of action and decision, but they are obliged to respect the tactical ideas that make them give a collective connotation to any individual action.

World basketball is undergoing major changes in the training, work and mentality of coaches and specialists, in the attitude of players to their profession and in certain organizational aspects of the increasingly complex and busy competitive system. All these changes are also being felt in basketball activity in our country as a consequence of the gradual transition to professional basketball structures.

In performance, at all stages of development of the game of basketball there have been contradictions between the old and the new, but never have they been so evident as at the present stage. The modern training process is subject to constant renewal, based on scientific laws, and is founded by coaches and players, i.e. by practitioners who often leave behind the theoretical and methodical aspects developed by specialists. This explains why modern basketball, based on the principles of total basketball, is not the result of the application of a brilliant idea, but a collective work resulting from the accumulation of new solutions for diversifying training and the components of the game.

Any research-oriented study must start from the idea that today's basketball is being played in an obvious lack of space and time, and the theoretical aspects must discover solutions to overcome these realities that govern contemporary basketball. It is from these fundamental principles that basketball specialists, regardless of the level or age group they work with, must start.

The increasingly sophisticated training methods, the innovations made by coaches and players in the technique and tactics of the game, the emergence, amendment and supplementation of the rules of the game have all brought about changes in the content of the game. The popularity of basketball is primarily due to its essence and characteristics: attacking play, imaginative technical and tactical drills, spectacular and dynamic play, finesse and precision. The game of basketball has reached its current level of development also thanks to good organization. It was only natural that the work of one of the most popular sports should, from the outset, be well directed both globally and domestically.

The game of basketball requires a large manifestation of the physical factor, determined by the content of the effort made. The increase in motor density in each unit of time is expressed by a high volume of game actions.

Basketball players will be able to capitalize on their technical and tactical possibilities only to the extent that physical training can make its presence felt. Physical training is the basis of sports activity, this means that physical training covers a very wide range of problems and therefore work to improve and perfect it must be carried out systematically.

The importance of physical training is reflected in the influence it exerts on technique and tactics, physical training is the basis on which these two factors must be supported. The higher the physical training is raised to a higher level, the greater the possibilities for mastering and perfecting advanced technique can be ensured. And the other important factor – tactics – is directly influenced by physical training. Modern tactics based on fast actions, constant movement will yield better results only to the extent that the degree of physical fitness corresponds to these tactics.

In order to achieve the objective set by the coach at the beginning of the training, namely to obtain a medal at the end of the championship, the coach must carefully plan the training so that the team achieves the sports form in the most important phases of the championship. In order to schedule the attainment of the sports form, the coach periodizes the sports training through the 3 periods of a macro-cycle: the preparatory period, corresponding to the phase of installation or obtaining the sports form; the competitive period corresponding to the phase of valorization and manifestation of the sports form; the transition period corresponding to the phase of organized withdrawal from form and restoration of the effort capacity (Teodorescu, 2009, p. 48).

In the preparatory period, through the general (basic) training stage, the general effort capacity of the athletes is increased, developing the qualities of speed and skill, accustoming the body to high volumes of effort, which requires both aerobic and anaerobic metabolism, increasing the level of general physical preparation, creating the premises for the technical, tactical, physical and mental preparation necessary for the specific training later, then following the specific training period by developing specific complex motor skills, perfecting the technical-tactical training and specific mental preparation for competition.

Therefore, we aim to train strength development, especially in the lower limbs using specific exercises using a specific training model through periodization of tactics. Depending on the needs of the team a specific training model should be chosen. For players who have a good technique of executing the exercises, but without the necessary strength, specialists recommend starting with the combined training model. This should develop a minimum level of strength and then finish with a complex training pattern. In the order of the preparatory period, one will move from general to specific exercises (Pacholeket, M. & Zemkova E., 2020).

The issue of contemporary basketball, perfected in all its compartments, is much more complex, by the very transformations to which the game itself is subjected, being different from the one practiced only a few decades ago. The development of theoretical materials, with a predominant research attempt into the trends and prospects of the game of basketball, is one of the basic concerns of specialists in the field who, through this activity, are pushing forward the theory and method of basketball instruction. The starting point in addressing all components of training in the game of basketball and beyond is physical preparation.

And when is the best time to develop motor skills, effort capacity, to build a solid foundation for the development of bo-physical-motor potential, if not at puberty?

That is why we approached this topic, in order to identify means and methods of developing both general and specific physical training (through regular basketball training), in order to achieve sports performance by 14–16 year old basketball players.

The issue of contemporary basketball, perfected in all its compartments, is much more complex, by the very transformations to which the game itself is subject, being different from the one practiced only a few decades ago. The elaboration of theoretical materials, mainly in an attempt to investigate the trends and prospects of the game of basketball, is one of the basic concerns of specialists in the field who, through this activity, advance the theory and method of basketball teaching. The starting point in addressing all the components of basketball training and beyond is physical preparation.

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This research aimed to determine the anthropometric and motor differences between the two tests, obtained by the same team after the application of a physical training program on a regular basis.

The research hypothesis is that the values of the physical tests and anthropometric measurements from the second test will be much better, and these differences will justify the improvement of the result obtained at the end of the U15 Women's National Basketball Championship, respectively obtaining the gold medal.

Methodology

Participants

The research was conducted on a sample of 12 female athletes, members of the U14/U15 basketball team of the Alexandria School Sports Club participating in the National Championship in the field,

medalists at the national championships, 4 of them are members of the national team medalists at the Balkan and European championships.

All players participated voluntarily in this study, and written consent was obtained from all players before starting the study.

Testing procedures

Anthropometric measurements and physical tests took place in the same gym, before the final tournaments, respectively February 2023 (U14) and February 2024 (U15).

Measurement and recording method

In our research, basketball players were evaluated through anthropometric measurements and specific physical fitness tests that targeted: height, weight, arm span, body mass index, speed running (20 meters with a standing start), specific strength (vertical lunge), agility (adapted T–Test) and testing of aerobic endurance and maximum oxygen consumption through the Multistage 20m Fitness test performed with the Beep Test application.

The tests were carried out with the aim of finding out the level of physical development and the level of specific physical training in order to be able to make a comparison between these results and the requirements of the specialized federation (Romanian Basketball Federation).

Anthropometric examination

To determine the height and body weight, the thalimeter and electronic scales were used, to measure the arm span, the metric tape was used, and the body mass index was calculated using the Calculator.net platform

Evaluation of the level of specific physical training

Speed: running over a distance of 20 m, starting from the feet. The test was held in the gym. Timing starts when the back leg rises and stops when the performer's chest crosses the finish line. The test is performed twice and the best performance is recorded.

Testing explosive strength (vertical jump) through the Optojump system, the player has two attempts and the best attempt is recorded;

Figure 1. Explosive strength testing.

Test T-test adapted: the player will run the route in Figure 11, using forward, backward and side-stepping. The route is described by 4 milestones: between milestones A and B = 5 m, between milestones B and C respectively B and C = 2.5 m.

The player moves as follows:

– sprint forward over the distance between milestones A and B, touches milestone B with the right hand;
– side-stepping sideways over the distance between milestones B and C, touches milestone C with the left hand;
– side-stepping sideways over the distance between milestones C and D, touches milestone D with the right hand;
– side-stepping sideways over the distance between milestones D and B which she touches with the left hand;
– then runs towards milestone A

The timer starts when she lifts her foot and stops when she passes milestone A. The test is not taken into account if she crosses her legs during the movement or does not touch the milestones. The player is entitled to one attempt.

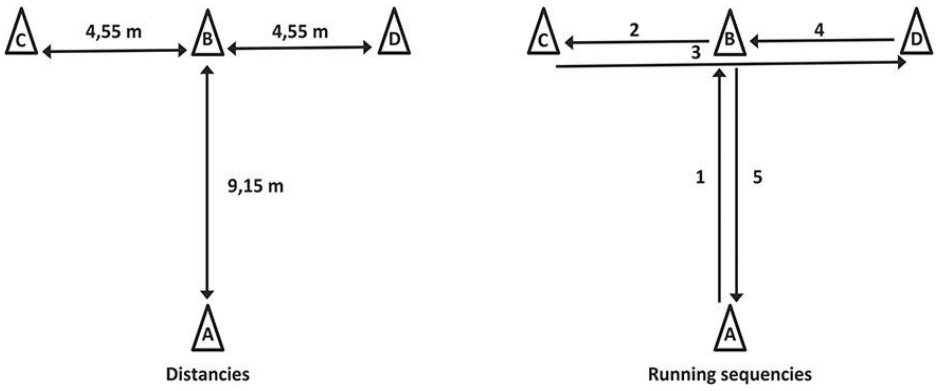

Figure 2. The adapted T-test.

Testing aerobic endurance and maximal oxygen consumption through the Multistage 20 m Fitness test performed with the Beep Test (Enterprises) application on an android device, the test started from level 1 with a speed of 8.0km/h, the distance per lap 20m;
The maximal oxygen uptake (VO2max) is estimated.
The test is performed by continuously running between two points located 20 m apart. The movement is performed according to the sound signal played at set intervals. As the test continues, the interval between each successive beep is reduced, forcing the player to increase the speed throughout the test, until it is impossible to maintain synchronization of the player's movement with the recording. The recording is structured in 23 "levels", each of them lasting 60 seconds. Typically, the beep interval is calculated as requiring a starting speed of 8.5 km/h, increasing by 0.5 km/h with each level. Progression from one level to the next is signaled by 3 rapid beeps. The highest level reached before losing pace is recorded as the score for this test.

Figure 2. Aerobic endurance testing.

Results and discussions

The data obtained from our study indicate that the research confirms the hypothesis, which is demonstrated by the fact that the basketball players' results in the second test improved, with the team surpassing its performance achieved in the previous year.

Table 1. *Results before and after program implementation*

TESTS	20 m Test		Agility Test		Long jump	
Statistical markers	T1	T2	T1	T2	T1	T2
Arithmetical mean	3.87	3.82	16.15	15.85	1.77	1.86
Maximum value	0.10	0.06	0.60	0.52	0.17	0.14
Stdv	4.12	3.92	17.00	16.87	2.20	2.20
Minimum value	3.70	3.68	15.38	15.06	1.50	1.78
p	0.03		0.00		0.01	

The results recorded according to Table 1, at the end of the 5 months during which the training program was applied, showed a progress in the parameters of speed, agility and explosive strength of the lower limbs. Thus, the 20 m running speed was obtained at the initial test of 3.87 ± 0.10s and 3.82 ± 0.06 at the final test. The mean difference between the two tests was statistically significant ($p = 0.03$). The agility test was 16.15 ± 0.60s in the initial test and 15.85 ± 0.52 in the final test. The mean difference between the two tests was statistically significant ($p = 0.00$). The tests targeting explosive strength of the lower limbs also identified a significant impact of the programs applied over the 5 months, the difference in means being statistically significant.

Strength training increases muscle fiber thickness. For general muscle training relatively fast movements are recommended, with resistance or loads chosen according to age.

Force determines the speed of execution of movements in basketball, being the motor quality that is most easily gained, but also easily lost. Analytical strength can be developed using the repeated efforts method by employing in each exercise 20–25 repetitions in a series, with 2-3 sets (alternating different muscle groups) performed as a circuit, with a pause between repetitions and between circuits. Within strength training, it is intensive training that improves the synchronization of motor units and appears to be the most effective form of specific strength development consisting of rapid contractions using different loads. Strength training in children and juniors targets 2 main directions: analytical development of the strength of different muscle groups, explosive strength development. The methods used in particular for explosive strength development are the combined method, the plyometric method and the game-based method. In juniors, plyometrics used 2-3 times in weekly training will allow to transform slow fibers into fast fibers fast fibers. The combined method consists of combining different contraction regimes in the same training session. Thus, a "combined" circuit may include isometrics, isotonic contractions, jumping and sprinting. In relation to the motor action in which it acts, force can manifest itself in several forms.

Conclusions

The analysis of the results obtained as a result of applying the training program allowed us to find that between the 2 tests there are no significant differences in all tests applied to evaluate physical fitness.

In this sense, we exemplify:

- the efficient nature of the experimental program is also demonstrated in terms of statistical indices that reflect the level of specific physical fitness tests. Comparing the data for the 20 m sprint test, a better improvement of the group average in the second test can be observed compared to the average values obtained by the group in the first test. We can say that, at the end of the experiment, short-distance sprinting improved as a result of implementing the general and specific physical fitness program developed by us, the average time being superior to that from the initial test.
- from the analysis and comparison of the results obtained by basketball players following the two tests obtained in the jump test (vertical jump), it is noted that the group improved their explosive strength, compared to the initial testing, but not enough to reach the FRB threshold.
- regarding the agility testing by the adapted T-Test, which is characterized by the execution of the movement in conditions of execution speed, rapidity, precision, coordination, the group improved its time from one test to the other, which demonstrates the efficiency of the means used to improve speed in coordination mode.
- the results of the aerobic endurance and maximum oxygen consumption testing had the most significant improvement, which confirms that the implemented training program was well thought out.

Following the results obtained and their analysis, we found that the level of physical training increased homogeneously, which is why the hypothesis is confirmed that the improvement in testing results also led to exceeding last year's performance, namely winning the gold medal at the end of the U15 Women's National Basketball Championship.

References

Barbu, D. (2012). *Teoria şi practica în fotbalul de înaltă performanţă.* Craiova, Editura Universitaria şi Pro Universitaria.

Cosma, G., Barbu, D., Nanu, M.C., Burcea B., Cosma M.A. (2017). *Pregătirea fizică în sportul de performanţă*. Craiova. Universitaria Publisher.

Cosma, G.**,** (2013), *Inteligența motrică și rolul ei în maximizarea performanței sportive,* Editura Universitaria, Craiova.
Debesse, M**.,** (1981), *Etapele educației*, Editura Didactică și Pedagogică, București.
Demeter, A., (1983), *Fiziologia și biochimia dezvoltării calităților motrice*, Editura Sport-Turism, București.
Demeter., A., (1981), *Bazele fiziologice și biochimice ale calităților fizice*, Editura Sport-Turism, București.
Ghițescu, G.I., Moanță, A.D. (2008). *Bazele jocului de baschet*, Editura Matrix Rom București.
Hammami, A., Gabbett, T.J., Slimanil, M., Bouhlel, E. (2018). D*oes Small-Sided Games Training Improve Physical-Fitness and Specific Skills for Team Sports?* A Systematic Review with Meta-Analysis, The *J Sports Med Phys Fitness*;
Pacholek, M. & Zemkova, E. 2020). *Effect of Two Strength Training Models on Muscle* Power and Strength in Elite Women's Football Player. Sports 8, no. 4:42.
Popescu, V**.,** (1969), *Baschetul în America*, C.N.E.F.S., București.
Pradet, M**.,** (2000), *Pregătirea fizică*, Centrul de Cercetări pentru Probleme de Sport, București, uz intern, p. 17–24.
Predescu, T., Gheorghiu, S**.,** (1980), *Minibaschet*, Ediția a II-a, București, Editura Sport–Turism.
Predescu, T., (1987), *Curs de bază* (baschet), București, A.N.E.F.S.
Predescu, T., Ghițescu, G., **(**2001) *Baschet. Pregătirea echipelor de performanță*, București, Editura SEMNE.
Predescu, T., Negulescu, C., (1998). *Curs de baschet – specializare anul IV*, ANEFS, București.
Predescu, T., Negulescu, C., (1998). *Curs de baschet – specializare anul III*, ANEFS, București.
Rehak, M., (1986), *Pregătirea fizică a jucătorilor de baschet*, în *Buletin Tehnic*, CNEFS – FRB, București.
Teodorescu, S. (2009). *Periodizare și planificare în sportul de performanță*, 48, Editura ALPHA MDN S.A., Buzău.
Querido, S.M., Clemente F.M., (2020). Analyzing the effects of combined small- sided games and strength and power training on the fitness status of under-19 elite football players. *The Journal of Sports Medicine and Physical Fitness*. Jan;60(1):1–10.
https://doi.org/10.1186/s40798- 015-0006-z
https://doi.org/10.3390/sports8040042

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 120-124
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-17

THE RELATIONSHIP BETWEEN MOTOR COORDINATION AND PHYSICAL PERFORMANCE IN YOUNG VOLLEYBALL PLAYERS IN ALBANIA

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Abstract. This study explores the relationship between motor coordination and physical performance in a sample of 10.7-year-old children (N = 33) who regularly participate in volleyball training in Tirana, Albania. The assessment tools included two subtests from the Körperkoordinationstest für Kinder (KTK): the Plate Movement test and the Lateral Jumping test, which evaluate dynamic coordination and lateral agility, respectively. Physical performance was measured using the Standing Long Jump test, which assesses lower-body explosive strength, and the 20-meter sprint test, which reflects linear speed. The findings reveal a statistically significant positive correlation between the Standing Long Jump and both coordination tests–KTK Plate Movement ($r = 0.531$, $p = 0.028$) and KTK Lateral Jumping ($r = 0.641$, $p = 0.006$)–indicating that children with higher coordination levels tend to perform better in tasks requiring explosive leg power. These results suggest a strong link between coordination and lower-body strength, which is crucial for volleyball-specific movements such as jumping and quick directional changes. In contrast, the correlations between the 20-meter sprint test and the coordination tests were moderate but not statistically significant–KTK Plate Movement ($r = –0.471$, $p = 0.056$) and KTK Lateral Jumping ($r = –0.413$, $p = 0.099$). These negative correlations suggest a trend where better coordination might be associated with faster sprint performance; however, the lack of statistical significance may be due to sample size or variability in sprint mechanics among children at this developmental stage.

Keywords: motor coordination, KTK test, standing long jump, sprint speed, explosive strength.

Introduction

Motor coordination is a fundamental component of children's physical development and is closely linked to their ability to perform in various physical and athletic tasks (Coppens et al., 2019). In sports such as volleyball, which require quick directional changes, explosive jumping, and fast movement across the court, well-developed coordination can significantly enhance overall performance (Pion et al., 2015). The **Körperkoordinationstest für Kinder** (KTK) is a widely used battery for assessing motor coordination in children aged 5 to 15 years, offering valid and reliable measures of dynamic balance, agility, and body control (Schilling et al., 2020).

Coordination is not only important for skill execution but also contributes to the development of physical fitness components such as speed and power. Previous research has suggested that higher levels of coordination are associated with better sprint and jump performances in youth athletes (Vandorpe et al., 2011; Luz et al., 2017). These findings indicate that coordination may serve as a foundational ability that facilitates more efficient and effective movement patterns, thereby enhancing athletic potential.

Despite growing interest in motor competence, limited research has focused on the relationship between coordination and specific fitness elements such as sprint speed and lower-body power in children engaged in organized sports, particularly in Southeast European contexts. Understanding these relationships can inform early talent identification and training program design. In Albania, where youth participation in sports like volleyball is increasing, it is essential to assess how coordination contributes to children's physical performance.

This study aims to examine the associations between motor coordination, as measured by the KTK Plate Movement and Lateral Jumping tests, and physical performance indicators–specifically the 20-meter sprint and the Standing Long Jump–in 10.7-year-old children who participate in volleyball in Tirana, Albania. It is hypothesized that higher coordination levels will be positively correlated with jump performance and negatively correlated with sprint times, reflecting more efficient movement execution.

Methods

Participants

The study included a sample of 33 children (mean age = 10.7 years, SD = ±0.3), all of whom were actively engaged in recreational or organized volleyball training in Tirana, Albania. The participants were recruited from local sports clubs and school-based volleyball programs. Parental consent and child assent were obtained prior to participation in accordance with ethical standards outlined in the Declaration of Helsinki. All children were reported to be free from musculoskeletal or neurological conditions that could impair motor performance. Testing took place over two consecutive days at a local indoor gymnasium under standardized environmental conditions. Prior to testing, all participants completed a dynamic warm-up session lasting approximately 10 minutes. Trained evaluators, experienced in physical fitness assessments in children, administered all tests according to standardized protocols.

Protocols of the tests- KTK Plate Movement Test: This test evaluates coordination through rapid stepping on alternating plates using the feet. The total number of correct movements within a fixed time frame (20 seconds) was recorded. **KTK Lateral Jumping Test**: This assesses dynamic balance and agility by counting the number of lateral jumps over a wooden slat within 15 seconds.

Standing

Long Jump Test: Used to assess lower-body explosive strength, participants jumped forward from a standing position, and the distance from the take-off line to the back of the heels was measured in centimeters. **20-Meter Sprint Test**: Linear speed was assessed with a 20-meter sprint on a flat surface. Timing gates recorded sprint time in seconds to the nearest hundredth.

Statistical Analysis: Data were analyzed using Statistics version 22. Descriptive statistics (mean, standard deviation, and sample size) were calculated for each test. Pearson correlation coefficients **(r)** were computed to examine the associations between motor coordination (KTK tests) and physical performance variables (Standing Long Jump and 20-meter sprint). A significance level of $p < .05$ was used to determine statistical significance.. Assumptions of normality, linearity, and homoscedasticity were checked and met for all variables prior to conducting correlation analyses.

Results

The motor performance of children aged 10.7 years who play volleyball in Tirana, Albania, was assessed using three physical tests. In the Standing Long Jump test (table 1), the children achieved

an average distance of 127.1 cm with a standard deviation of 22.6 cm, based on a sample of 33 participants, indicating moderate variability in explosive leg power. In the KTK – Plate Movement test, the mean score was 23.0 repetitions, with a standard deviation of 3.4, measured in 32 participants, showing relatively consistent coordination and motor control. In the KTK – Lateral Jumping test, the average number of jumps was 60.9, with a higher standard deviation of 18.0, also among 32 participants, suggesting more variation in lateral movement skills among the children. These findings reflect the general motor abilities of young volleyball players in this age group.

Table 1

	Mean	Std. Deviation	N
Standing Long Jump test	127.1	22.6	33
KTK- Plate Movement test	23.0	3.4	32
KTK- Lateral Jumping test	60.9	18.0	32

Table 2 presents the correlations between the 20-meter sprint speed test and two KTK motor coordination tests among 32 children. The Pearson correlation coefficient between the 20m sprint and the KTK – Plate Movement test is -0.471, with a p-value of 0.056, indicating a moderate negative relationship that approaches statistical significance. This suggests that children who performed better in the Plate Movement test (higher scores) tended to have faster sprint times (lower times), although the result is just above the conventional threshold for significance ($p < 0.05$). Similarly, the correlation between the 20m sprint and the KTK – Lateral Jumping test is –0.413, with a p-value of 0.099. This also reflects a moderate negative association, though not statistically significant. It suggests a trend where better lateral jumping performance is associated with faster sprinting ability.

Table 2

	Mean	KTK- Plate Movement test	KTK- Lateral Jumping test
Speed 20m sprint test	Pearson Correlation	–0.471	–0.413
	Sig. (2-tailed)	0.056	0.099
	N	32	32

Table 3 provides descriptive statistics for the motor coordination and speed performance of children aged 10.7 years who play volleyball in Tirana, Albania.

In the 20-meter sprint test, the children recorded a mean time of 4.64 seconds with a standard deviation of 0.37, based on 33 participants, indicating relatively consistent sprinting speed among the group. The KTK – Plate Movement test had a mean score of 23.00 repetitions and a standard deviation of 3.37, with 32 participants, reflecting good coordination with low variability. For the KTK – Lateral Jumping test, the average performance was 60.94 jumps, with a standard deviation of 18.02, also based on 32 participants, showing greater variation in lateral motor skills.

Table 3

	Mean	Std. Deviation	N
Speed 20m sprint test	4.64	0.37	33
KTK- Plate Movement test	23.00	3.37	32
KTK- Lateral Jumping test	60.94	18.02	32

Table 4 shows the correlations between the Standing Long Jump test and two KTK motor coordination tests among 32 children. The Pearson correlation between the Standing Long Jump test and the KTK – Plate Movement test is 0.531, with a p-value of 0.028, indicating a moderate positive correlation that is statistically significant ($p < 0.05$). This suggests that better performance in the Plate Movement test is associated with longer jump distances, linking coordination and lower-body power. The correlation between the Standing Long Jump test and the KTK – Lateral Jumping test is even stronger, at 0.641, with a p-value of 0.006, showing a strong positive and statistically significant relationship ($p < 0.01$). This implies that children who performed better in lateral jumping also tended to perform better in the standing long jump, further supporting the connection between coordination and explosive leg strength.

Table 4

	Mean	KTK- Plate Movement test	KTK- Lateral Jumping test
Standing Long Jump test	Pearson Correlation	.531*	.641**
	Sig. (2-tailed)	0.028	0.006
	N	32	32

Discussion

This study examined the relationship between motor coordination and physical performance among young volleyball players in Albania, focusing on explosive leg strength and sprint speed. The significant positive correlations found between the Standing Long Jump and both KTK subtests (Plate Movement and Lateral Jumping) align with previous research emphasizing the integral role of coordination in facilitating explosive movements in youth athletes (Gabbard, 2018; Lopes et al., 2019). Motor coordination likely supports efficient neuromuscular recruitment and control, which are essential for jump performance and dynamic volleyball actions such as spiking and blocking (Lloyd & Oliver, 2012). The moderate but non-significant negative correlations observed between sprint performance and coordination tests suggest a complex relationship that may not be fully captured within this sample size. While better coordination appears to trend toward faster sprint times, sprinting also depends heavily on factors such as stride mechanics, muscular power, and technique, which may vary widely among children at this age (Mero et al., 2010). Additionally, the relatively small sample ($N = 33$) may have limited statistical power to detect these relationships definitively. Other studies with larger samples have demonstrated significant associations between coordination and sprint speed, indicating that these variables are interrelated but may develop asynchronously during childhood (Williams et al., 2009). Overall, these findings highlight the importance of incorporating coordination training in volleyball development programs for children,

as it not only enhances explosive strength but may also contribute to improvements in speed and agility. Given that volleyball requires quick changes in direction, jumping, and sprinting, a well-rounded motor coordination foundation is crucial for long-term athletic success (Bühler et al., 2020).

Conclusion

The results of this study underscore a clear link between motor coordination and explosive lower-body strength in young volleyball players, demonstrated by significant positive correlations between coordination tasks and the Standing Long Jump. Although the association between coordination and sprint speed was not statistically significant, a trend suggests potential benefits that warrant further investigation with larger samples. Coaches and physical educators should emphasize coordination-enhancing exercises alongside traditional strength and speed training to support the holistic physical development of young athletes. Future research should explore longitudinal effects and include larger, more diverse populations to better understand how coordination interacts with various physical performance components during childhood athletic development.

References

Bühler, L., Sutter, R., & Taube, W. (2020). Motor coordination training improves agility in youth volleyball players. *Journal of Sports Science & Medicine*, *19*(1), 34–41.

Coppens, E., Smits-Engelsman, B., Grieve, D., & Ferguson, G. D. (2019). Relationship between motor coordination and executive functions in children with and without developmental coordination disorder. *Research in Developmental Disabilities, 84*, 25–36. https://doi.org/10.1016/j.ridd.2018.05.003

Gabbard, C. (2018). *Lifespan motor development* (7th ed.). Human Kinetics.

Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength and Conditioning Journal*, *34*(3), 61–72. https://doi.org/10.1519/SSC.0b013e31825760ea

Lopes, V. P., Rodrigues, L. P., Maia, J. A. R., & Malina, R. M. (2019). Motor coordination as predictor of physical activity in children: A 3-year longitudinal study. *Scandinavian Journal of Medicine & Science in Sports*, *29*(4), 614–622. https://doi.org/10.1111/sms.13336

Mero, A., Komi, P. V., & Gregor, R. J. (2010). Biomechanics of sprint running. In R. K. Lenhardt (Ed.), *Exercise and sport sciences reviews* (pp. 445–481). Lippincott Williams & Wilkins.

Luz, C., Rodrigues, L. P., Meester, A. D., Cordovil, R., & Lopes, V. P. (2017). The relationship between motor competence and health-related fitness in children and adolescents. *PLOS ONE, 12*(6), e0179993. https://doi.org/10.1371/journal.pone.0179993

Pion, J., Fransen, J., Deprez, D., Segers, V., Vaeyens, R., Lenoir, M., & Philippaerts, R. (2015). Stature and jumping performance are required in female volleyball, but motor coordination is a key factor for future elite success. *Journal of Strength and Conditioning Research, 29*(6), 1480–1485. https://doi.org/10.1519/JSC.0000000000000781

Schilling, M., Kallenbach, H., & Niessner, C. (2020). KTK: Motor coordination test for children–A comprehensive tool for assessing motor competence. *Journal of Motor Learning and Development, 8*(1), 44–56. https://doi.org/10.1123/jmld.2019-0004

Vandorpe, B., Vandendriessche, J., Vaeyens, R., Pion, J., Matthys, S., Lefevre, J., ... & Lenoir, M. (2011). Relationship between sports participation and the level of motor coordination in childhood: A longitudinal approach. *Journal of Science and Medicine in Sport, 15*(3), 220–225. https://doi.org/10.1016/j.jsams.2011.09.006

Williams, H. G., Pfeiffer, K. A., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2009). Motor skill performance and physical activity in preschool children. *Obesity*, *17*(6), 1159–1164. https://doi.org/10.1038/oby.2008.641

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 125-132
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-18

ACHIEVING PERFORMANCE IN 3X3 BASKETBALL BY USING FIBA FREE WEB APPLICATION

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Abstract. *Background.* Streetball was included for the first time in history at the 2012 Olympics - Tokyo. The qualification of the 3x3 teams at the Olympic Games is based on the ranking obtained by each team after participating in as many matches as possible. Each participation is counted in the Event Maker free web application and at the end of the qualification period, the application generates the final ranking of the teams qualified for the Olympics.
FIBA is developing 3x3 with a Click& Brick approach. The Brick are the actual events. The Click is FIBA's Digital Platform [6] that is supported with the *Event Maker* free web application. Event Maker is a web application, developed specifically for 3x3 and customized to help event organizers with the organization of their 3x3 events. All basketball sporting events, created with the Event Maker application are published on the play.fiba3x3.com website, being visible globally.
Objectives. Through this study, we aim to highlight the importance of using the web application in obtaining sports performance, respectively the qualification of the Romanian team at the Olympics.
Methods. Based on the organization and participation in sports events, and by using the web application, important data were obtained on the activity of the 3x3 women team in the two pre-Olympic years.
Results. The data provided by the Event Maker application contributed to the orientation of the competition organization process, so that, at the end of 2019, Romania will be in the world ranking in the first four teams qualified for the Olympics.
Conclusion. The data generated in due time by this free web application formed the basis for designing the activity of organizing and participating in streetball competitions, so that coaches have continuously updated information regarding the world ranking at any time during the qualifying stage.

Keywords: Streetball; Event Maker; competition; 3 on 3 Women`s Series.

Introduction

Streetball (or street basketball), derived from basketball, is played on outdoor fields and has its own structure and rules much simplified compared to basketball, developed for half-court play. Thus, its format is more accessible and at the same time more attractive, allowing players to display their individual skill.

The new discipline is the most beloved urban team sport, according to a study at the request of the International Olympic Committee - over 250.000.000 practitioners (Bărăscu, 2018).

The simple rules, the small size of the field and the inexpensive equipment of the participants, help an accessible and flexible organization of 3x3 tournaments in various locations - from gyms, parks, to shopping malls or areas of tourist interest.

By initiating many such events, "street basketball" has become an Olympic discipline. In addition to the desire to promote a healthy lifestyle, it also offers the opportunity to integrate into society through sport, addressing various age groups (from 6-8 years to 60).

Streetball experienced an unexpected development, which can be seen both in various statistics and in the number of events organized in relation to participants / teams registered on the online platform recognized by FIBA(Bărăscu, 2018).

Streetball or 3 on 3 (3x3) is an opportunity for basketball players or new athletes, but also for organizers around the world to organize such events worldwide. On June 9, 2017, 3x3 was added to the Olympic Program, starting with the Tokyo 2020 Games, but due to the pandemic of Covid 19, the Olympics will take place in 2021.

The network of official competitions from 3 to 3 represents a hierarchical system directed by FIBA (International Basketball Federation), which integrates all the events supported by this Federation.

Being a new sport, there are a few specialized works in this field. Several authors present aspects related to: the performance profile of game-related statistics of elite senior 3x3 basketball (Conte et all, 2019), the physical and physiological demands of 3x3 basketball, focused on 3x3 elite male and female basketball players participating in under-18 World Championships, Senior European and World Championships (Montgomery et all, 2018), or mass streetball training and education process tehnology (Timoshina et all, 2016). These authors highlight in their works the lack of points of view regarding this sport, precisely because it has a recent appearance. In addition, the approach of our topic is a novelty in the field of scientific research, having rather a practical character through its usefulness in organizing streetball competitions.

Romania was present with the 3x3 women's basketball team at the Olympic Games in Tokyo - 2021, along with Russia, China and Mongolia and four other nations, which was established after playing qualifying tournaments. Romanian basketball obtained this historic qualification thanks to the position in the world ranking of national federations made by FIBA until October 31, 2019.

The purpose of the paper

In this paper we want to highlight the efficiency of the free web application of FIBA - Event Maker – in monitoring the competitions in Romania and the way to obtain the world rankings, which qualified the women's streetball team at the Tokyo Olympics, 2021.

We focused on this topic, as the national and international specialized literature there are no reference data on the scientific approach to the issue. We believe that it is necessary to highlight the importance of knowing this web application in the development of global competitive performance in streetball. In this sense, we consider that the approach of this topic is a premiere in the theoretical field of sports.

We would also like to point out that the intelligent use of the Event Maker can lead to outstanding performances in 3x3 basketball, as in the case of Romania by obtaining the 4th place in the world hierarchy that allowed the direct qualification to J.O.

The Hypothesis

Using the free web application Event Maker in organizing women's streetball competitions in Romania and by engaging the most valuable players in the country, can determine the qualification of the women's 3x3 team at the Olympics by increasing the world rankings of the team and of each participant and making their results visible all over the world.

Methods

The description of the Event Maker

The Event Maker is a web application, developed specifically for 3x3 and customized to help event organizers with the organization of their 3x3 events.

Play.fiba3x3.com is FIBA's digital platform for 3x3. The site is focused on getting people to play more 3x3 by offering them a repository of all their game history, an individual ranking, the ability to compare with friends and rivals.

The Event Maker and the FIBA website are both completely free digital tools that can be used to organize FIBA-approved streetball sporting events and manage recordings, match schedules and results, as well as other features. The homepage of Event Maker is shown below (figure 1).

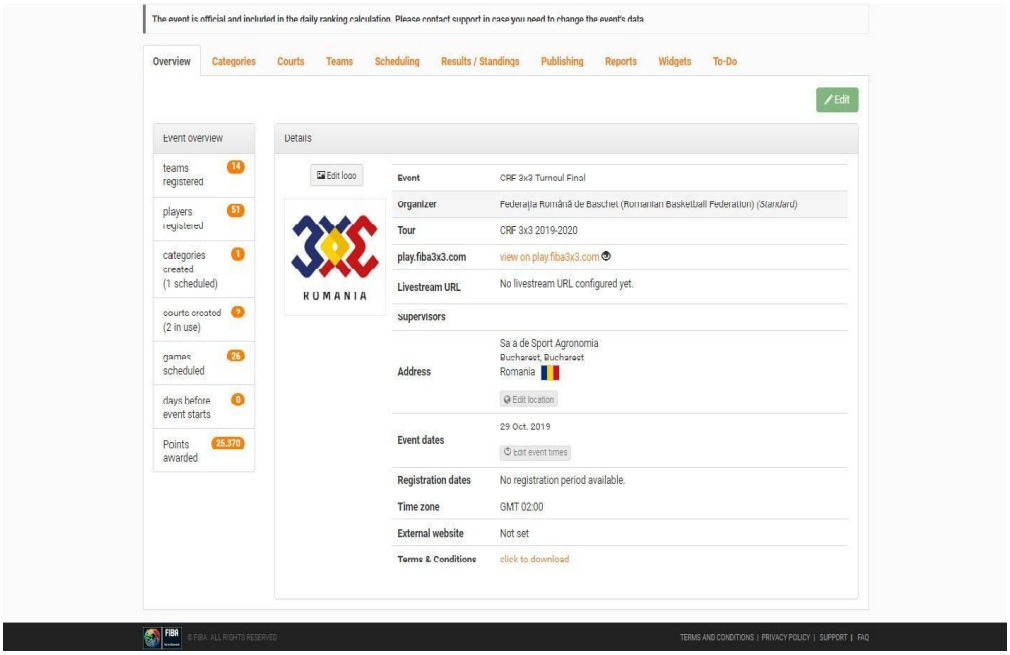


Figure 1. The homepage of Event Maker.

This web application helps run 3x3 events around the world and generates the data required by the FIBA website, including player rankings, performances, game histories and a worldwide database of events. From free registrations to online scheduling and results displayed in real time, managing competitions with Event Maker is very easy. It can set up multiple events, create tours, manage registered teams and display results online worldwide. It also creates a wealth of information to demonstrate the merits and popularity of 3x3 to public administrations, sponsors and TV.

Easy steps to get started (figure 2):

Platform Registration:	**Creating 3x3 Organizer account:**
➢ Register and create an account on website: play.fiba3x3.com 2. After signing up – a confirmation email 3. Click on the Confirm button to activate account	• Go to Event Maker web application and login with the previously created credentials (email and password) 2. Create organization/ company/ National Federation account 3. Start creating events, tours

Figura 2. How to create an account on Event Maker web application.

At the end of each event, the registered data will be validated and the correctness of the entered data will be verified once again. The last step that the application will carry out will be to validate the tournament. In this final stage, detailed reports are configured about the category of the competition, about the present teams and the individual reports of each player in terms of performance. All the details of the event are automatically sent to FIBA which will then make all the data public and will update for each player the points earned.

The subjects

The subjects of this study represent 100 Romanian women athletes who participated in 3 on 3 at national and international competitions in Streetball, aiming to qualify Romania for the Tokyo 2021 Olympics. The Events took place all over the country, between October 31, 2018 and October 31, 2019, totaling 276 matches. The participation of the athletes in so many matches determined a world ranking of Romania in the first 4 places, which means the qualification at the 2021 Olympics Games.

Research methods used

Observation method – necessary to observe the real-time dynamics of the organization of events by each country, in order to have a clear record of the provisional ranking. Based on the study of these data generated by Event Maker, the Romanian organizers established the share of their own matches in the competitive period, in order to exceed the number of participations made by the participating countries, to obtain the qualification to JO.

The method of analyzing the video recordings of the matches organized in Romania - which the best Romanian players were identified, to play in all matches in order to increase the country ranking, and therefore the Romania's rise in the world rankings.

The interpretation of the results

In 2018 Romania participated in 46 matches and ranked 26th in the world rankings (figure 3), and in 2019 participated in 230 matches and ranked 8th (figure 4). After evaluating the participation of all teams in competitions, FIBA decided that Romania ranked 4th , qualifying at the 2021 Olympics.

Only 3x3 certified national federations with a minimum of three FIBA endorsed events held in their territory in the 12 months prior to the deadline are eligible.

SPORT EVENTS		
Romania's position in the world ranking	Country	Number of events 1 - 31 Oct. 2018)
1	Russia (RUS)	298
2	France (FRA)	267
3	China (CHN)	261
26	**Romania (ROU)**	**46**

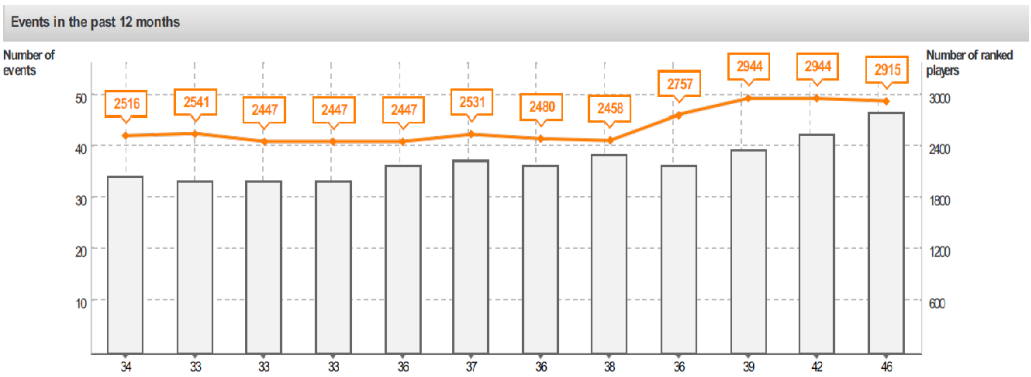
Figure 3. Romania`s position in the world ranking in 2018 after 46 sport events.

SPORT EVENTS		
Rmoania's position in the world ranking	Country	Number of events 1 - 31 Oct. 2019)
1	Russia (RUS)	827
2	France (FRA)	628
3	Italy (ITA)	492
8	**Romania (ROU)**	**230**

Figure 4. Romania`s position in the world ranking in 2019 after 230 sport events.

As can be seen from the analysis of figures 3 and 4, Romania intensified in 2019 the organization of 3x3 events, allowing players who were in the national top 100 to participate in most competitions and thus increase Romania's country ranking. For this reason, it can be seen that Romania, which at the end of 2019 was in 8th place in terms of number of organized competitions, still managed to reach the 4th place in the ranking of federations and thus obtain direct qualification to the Olympics. Teams such as France or Italy, that were in 2nd and 3rd place in the ranking of organizing 3x3 events failed to qualify, this is due to the fact that not all competitions organized by these countries used the Event Maker web application that globalizes the performance and also they were not involved the top 100 players in all matches that brought points.

Event Maker offered in real time the ranking of Romania after each event, as well as the ranking for each player. In the figure below (figure 5), we can observe the evolution of Romania in 2018, in which the 3x3 team participated in 46 events, and the ranking of the athletes increased to 2915, which ranked it at the end of the year on the 26th place in the world hierarchy. Thus, through the evidence of the participations from 2018, more intense action was taken for 2019 in the organization and participation of the Romanian women's streetball team to increase the world ranking.



	11.2017	12.2017	01.2018	02.2018	03.2018	04.2018	05.2018	06.2018	07.2018	08.2018	09.2018	10.2018	
Men	1024	1041	1028	1047	1072	1085	1074	1053	1127	989	989	984	
Women	153	155	158	165	168	193	193	185	198	201	201	203	
U18 Men	1093	1101	1029	1010	985	987	948	957	1129	1419	1399	1404	
U18 Women	246	244	232	225	222	266	265	263	303	355	355	324	
TOTAL	**2516**	**2541**	**2447**	**2447**	**2447**	**2531**	**2480**	**2458**	**2757**	**2944**	**2944**	**2915**	

Figure 5. Events 2017–2018.

The big difference between the two years is very obvious, regarding the increase in the number of participations in 2019 and implicitly the increase of the final ranking by countries (figure 6). After a number of 276 sporting events in which the Romanian team participated, the ranking offered by Event Maker placed Romania on the 4th place and thus managed to qualify for the Tokyo 2021 Olympics.

	11.2018	12.2018	01.2019	02.2019	03.2019	04.2019	05.2019	06.2019	07.2019	08.2019	09.2019	10.2019	
Men	1052	1082	1090	1113	1203	1285	1355	1405	1316	1195	1177	1180	
Women	209	254	269	273	288	310	330	352	368	356	357	494	
U18 Men	1720	1719	1682	1659	1624	1579	1560	1591	1683	1649	1531	1475	
U18 Women	384	371	368	365	359	325	306	314	259	262	235	268	
TOTAL	**3365**	**3426**	**3409**	**3410**	**3474**	**3499**	**3541**	**3662**	**3626**	**3462**	**3300**	**3417**	

Figure 6. Events 2018–2019.

Further, we obtained more information through the Score board (figure 7), the FIBA free application connected with Event Maker – that counts the players performances in each game.

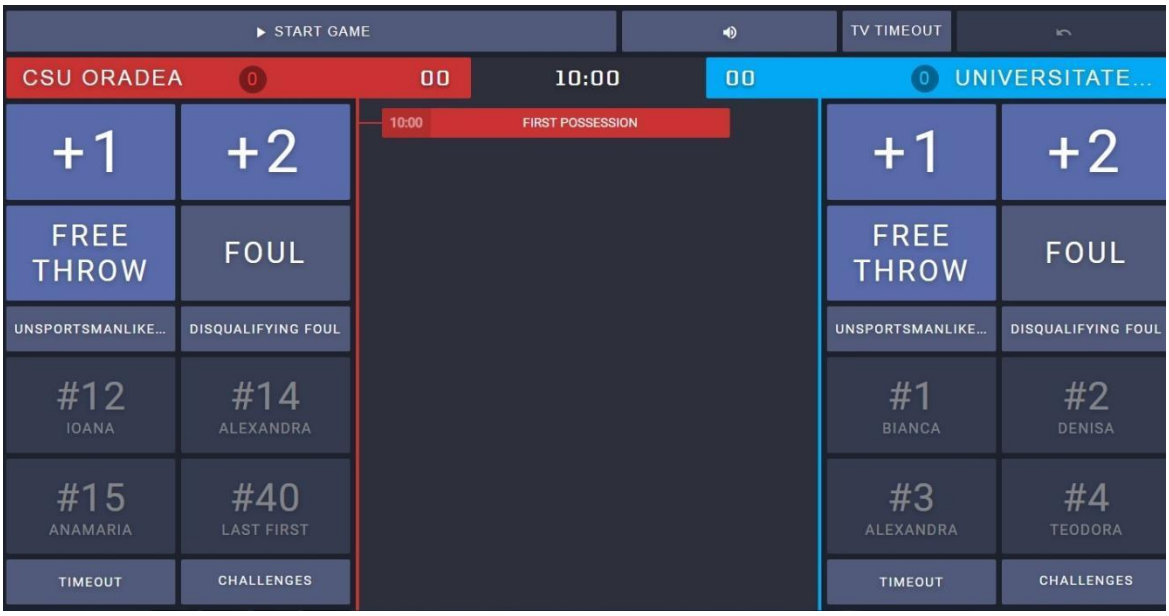


Figure 7. The Score board of Event Maker.

The use of the Event Maker application at all the competitions organized in our country, as well as the engagement of the players from the top 100 nationally at these tournaments led to an exceptional result for Romania, in this case the qualification to the Olympics. This result confirms the hypothesis of our study presented at the beginning of the paper.

The qualification of the 16 3x3 teams, male and female, for the 2021 Olympics is as follows:

– the first four national teams in the world with the highest country ranking will qualify directly for the Olympics;

– then 20 gender teams participated in the pre-Olympic tournament, which took place in India on March 2020. For the list of teams going to the pre-Olympic tournament, universality criteria were taken into account, which allowed a maximum of 10 teams on a continent and be at least 30 countries represented, but also other restrictions. Six tickets for Tokyo were awarded in India, 3 for the women's teams, 3 for the men's teams.

– the last chance to qualify for the 2021 Olympic Games was in April 2019, when the FIBA 3x3 Universality Olympic Qualifying Tournament is the last available place for each competition. Six gender teams out of the unqualified were participate, depending on the ranking, but the main condition is that they have not been represented in the last two editions of the Basketball Olympic.

In this regard, all these efforts paid off and the goal was achieved. Romania obtained the direct ticket for Tokyo 2021, being in the top 4 in the ranking of federations on November 1, 2019. The other three teams qualified directly to the Olympics in the women's competition were: Russia, China and Mongolia (figure 8).

Figure 8. The qualified teams (male and female) at the Olympics – Tokyo 2021.

Conclusions

The data generated in due time by this free web application formed the basis for designing the activity of organizing and participating in streetball competitions, so that coaches have continuously updated information regarding the world ranking at any time during the qualifying stage.

Event Maker also ranked the women athletes, based on their participation in competitions, thus increasing their visibility in the world. All game results, final standings and team list are validated at FIBA by the event organizer who organized this special event. Therefore, FIBA did not change these results based on requests from a player or management team.

The use of the Event Maker in the process of qualifying Romania for the Tokyo 2021 Olympics was the essential tool in obtaining this qualification. Therefore, the hypothesis from which we started in this paper was confirmed.

Romania has worked hard to qualify the women's national team at the Olympic Games in Tokyo and for this purpose many tournaments have been organized in the last year(2019), especially for one day, in which the representatives of the teams from the National League participated. The senior national team went to many tournaments in summer and autumn, where it accumulated points.

At that moment, Romania is ranked 4th in the world in women's Streetball and 2nd in Europe. This special result is due to the trainers and the over 1000 women athletes from Romania who participated from 2018 to 2019 in 3x3 basketball competitions and who contributed with important points in the world ranking. Based on this world ranking, Romania's qualification for the 2021 Olympics was achieved.

Authors' contributions

All authors have an equal contribution to the publication.

References

Bărăscu, Ştefania., (2018), *Promovarea baschetului 3x3 (în România) prin marketing.* Lucrare de disertaţie, Bucureşti, pp. -8

Conte, D., Straigis, E., Clemente, F.M., Gomez, M.A., Tessitore, A., (2019), *Performance profile and gamerelated statistics of FIBA 3x3 Basketball World Cup 2017.* Biology of sport. A quarterly journal of sport and exercise sciences Jun; 36(2), pp. 149–154

Montgomery, P.G., Maloney, B.D., (2018), *3x3 Basketball: Performance characteristics and changes during elite tournament competition.* In: Journal of Sports Physiology and Performance, Nr.13(10), pp. 1349–1356, Timoshina, I.N., Makarova, E.V., Shvetsova, T.V., (2016), *Mass Streetball training and education process Tcehnology.* In: Theory and Practical of Physical Culture, Nr. 7, Rusia, pp. 50–52.

Websites

https://en.wikipedia.org/wiki/Streetball; Accessed on December, 2024

https://www.frbaschet.ro/stiri/stiri/baschetul-romanesc-a-obtinut-calificarea-la-jocurile-olimpice-din-2020!-0; Accessed on May, 2025

https://em.fiba3x3.com; Accessed on April, 2025

https://play.fiba3x3.com; Accessed on April, 2025

https://baschet.ro/articole/3x3/romania-a-obtinut-calificarea-directa-la-jocurile-olimpice-in-intrecerea-feminina-de-3x3; Accessed on March, 2025

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 133-137
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-19

OPTIMISING THE EFFORT CAPACITY IN THROWING EVENTS

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Abstract. *Background*. Throwing disciplines in track and field–including shot put, discus, and javelin–demand more than just raw strength and explosive power. Athletes must also develop the ability to sustain physical effort during high-intensity, repetitive training sessions. While the competitive performance itself is largely anaerobic and relies on short bursts of maximal effort, day-to-day training places significant demands on the athlete's overall work capacity, where aerobic fitness plays a key role in recovery, fatigue resistance, and maintaining technical precision throughout the session.
Despite this, most of the focus in research and practice has traditionally been on improving maximal strength and speed of execution. The role of aerobic conditioning has often been overlooked. However, recent studies point to the benefits of a well-developed aerobic system–not just for endurance sports, but also for improving training quality and efficiency in explosive disciplines. Better aerobic capacity allows for quicker recovery between sets, greater resistance to fatigue, and more consistent neuromuscular performance under prolonged effort. As a result, incorporating moderate to high-volume training in mixed aerobic-anaerobic zones is becoming increasingly relevant in planning effective training programs for throwers.
Objectives.
- Establishing the tests and the control samples;
- Establishing the motor profile;
- Results processing;
- Elaboration of a specific athletic program to improve motor skills,

Methods. bibliographic study method, observation method, experimental method, statistical-mathematical method.
Results. With the help of aeroscan machine, we were able to observe the aerobic effort sustained by the throwers during of the training sessions.
Conclusion. In conclusion, optimizing effort capacity in throwing events can be achieved through an integrated training approach that combines both anaerobic and aerobic exercises. Specific training methods, such as throwing with different weighted implements and high-intensity interval training, have shown significant improvements in performance, including better fatigue management and recovery between sets. A well-rounded training program, tailored to the athlete's needs, is crucial for enhancing both technical execution and overall performance in competition.

Keyboard: throwing events, aerobic, effort.

1. Introduction

Optimising effort capacity in throwing events such as shot put, discus, and javelin requires much more than just developing muscular strength and explosive power. While these physical qualities are indeed fundamental for competition performance (Mathews & Fox, 1976), effective training

demands a more complex and holistic approach. Throwers often face high training volumes, with long and intense sessions where maintaining proper technique is crucial. An athlete who can sustain consistent performance during these demanding periods, without succumbing to early fatigue or technical breakdowns, will have a greater chance of steady progress and reduced injury risk (Barrow & McGee, 1979).

Exercise physiology research highlights the critical role of aerobic capacity in supporting athletes during repeated high-intensity efforts. A well-developed aerobic system aids in faster recovery between sets, which helps delay fatigue accumulation and maintain training quality over time (Foster & Lucia, 2007; Taylor & Rowell, n.d.). Although throwing events are predominantly anaerobic and explosive in nature, integrating training methods that stimulate both anaerobic and aerobic energy systems is essential for comprehensive preparation (Manju & Deepak, 2015; Coleman, 1974).

Various training modalities have proven effective in addressing these energy systems simultaneously. Incorporating weighted implements, medicine ball exercises, and high-intensity interval training (HIIT) helps to optimise both strength and endurance (Carl et al., 2015; Gil et al., 2000). HIIT, in particular, has gained attention for its ability to induce rapid metabolic adaptations, improving overall effort capacity while managing fatigue during intense training cycles. This method is especially beneficial for throwers who must repeatedly perform explosive movements at high intensities over extended periods (Buchheit & Laursen, 2013; Martin & Paul, 2013). Moreover, HIIT blends short bursts of anaerobic effort with aerobic recovery, enhancing both speed and endurance capabilities (Man et al., n.d.).

Targeting both aerobic capacity and neuromuscular adaptations through training is not only beneficial for endurance but also critical for technical execution. Throwing repeatedly requires precise coordination and motor control. Fatigue can degrade technique, so the ability to maintain proper form under fatigue is vital for performance and injury prevention. Athletes who follow well-designed aerobic and anaerobic training plans tend to maintain higher technical proficiency even during intense or prolonged workloads (Schreiber, 1993; Barrow & McGee, 1979).

Another key factor in optimising effort capacity is recognising the individuality of each athlete. Physiological profiles, including somatotype, muscular strength, and neuromuscular characteristics, significantly influence how an athlete responds to specific training stimuli (Astrand & Rodahl, 1970; Schreiber, 1993). Therefore, personalising training programs to suit each athlete's unique needs is crucial for maximizing adaptation and minimizing injury risk.

In practice, this means combining anaerobic-focused sessions that build strength and explosiveness with aerobic components aimed at improving recovery and endurance. Such an integrated approach supports not only the physical development of throwers but also their ability to maintain technique and performance under the stresses of competition and intensive training (Gil et al., 2000; Buchheit & Laursen, 2013).

Finally, ongoing assessment and adaptation of training plans based on the athlete's responses and progress ensure that the program remains effective. This dynamic approach respects individual differences and promotes sustainable long-term development in throwing events.

Subjects and research

The present experiment was realised with the participation of 6 athletes, 3 female and 3 male, aged 16–30 years (m =22), from the track&field. The all subjects have competitional exeprience 5–10 years of competitional experience

Tabel 1. Research subjects

Subjects	Age	Event	Competitive experience
1	16	Discus throw	10 years
2	18	Shot put	5 years
3	22	Javelin throw	9 years
4	30	Shot put	10 years
5	20	Discus throw	5 years
6	26	Javelin throw	10 years

Organisation of research

For this experiment all the athletes were informed about all the details of the tests, the athletes participated as volunteers. all the throwers received the initial results and the final results. Each thrower received an individualized program for the practiced event

Tabel 2. Bruce protocol

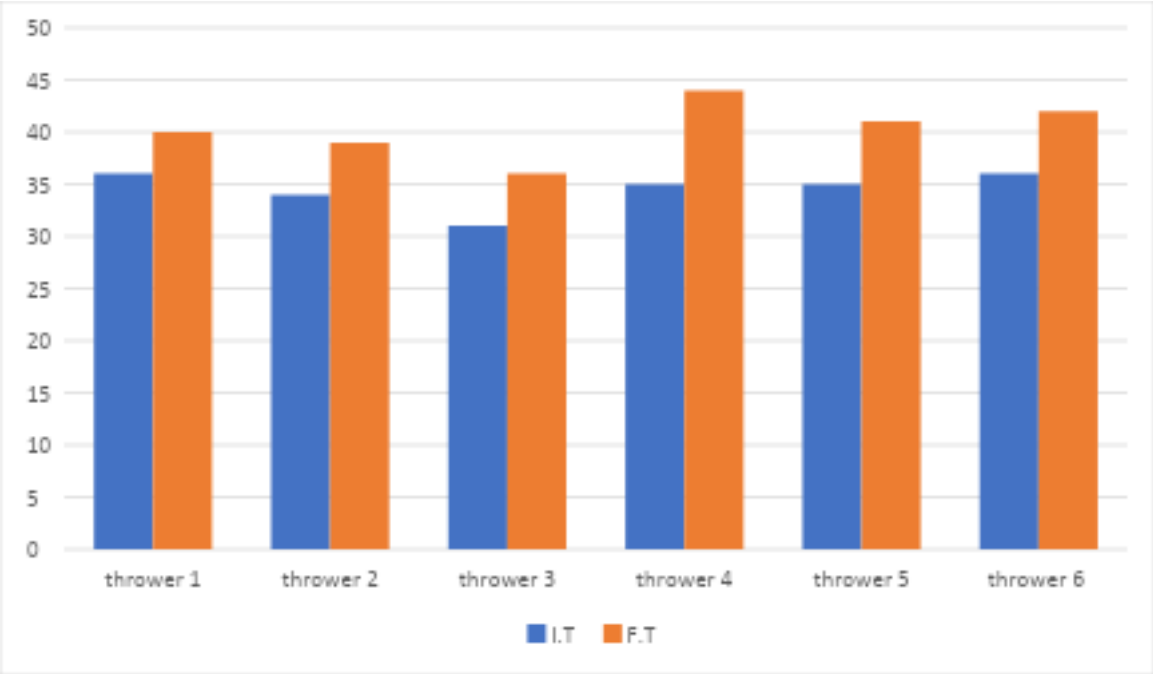
Bruce protocol	Bruce protocol
Level 1	Level 1
Level 2	Level 2
Level 3	Level 3
Level 4	Level 4
Level 5	Level 5
Level 6	Level 6
Level 7	Level 7
Level 8	Level 8
Level 9	Level 9
Level 10	Level 10

Results and Discussions

In this picture we presenting the initial testing and the final testing. (orange- the initial testing, blue- the final testing).

Figure 1.1 show the results of the Aeroscan test, initial and final testing . It can be seen that the values range between 33.5 and 38.1 at the initial testing and a significant increase for the final testing, marking values between 39.3 and 45.3.

Graphic. 1. Aeroscan Results - Initial Testing and Final Testing



With the Wilcoxon test, we were able to more easily analyze the differences between the two tests performed in the present research, so that the Z values, the alpha significance level and the effect size could be recorded.

Interval and variable-intensity training are effective techniques for enhancing exercise capacity, and they can be particularly beneficial for athletes in throwing events in track and field. These methods involve structured sessions where periods of intense effort alternate with active recovery or lower intensity. This type of training offers several physiological and performance benefits that are crucial for throwers aiming to improve their endurance, power, and overall competition performance.

For the development of motor skills we used only specific exercises for throwers. The study was conducted between December and May. Specifically for the training of throwers we used heavy training materials in the winter period, in the pre-competition and competition period we used light materials to improve the thrower's speed.

Conclusions

1. In throwing events, physical exercise has a significant impact on the results of throwers.
2. Thrower training programs are particularly complex, as throwers require multi-faceted training to achieve high performance.
3. Aeroscan – for VO2 max, we were able to record the results of the Wilcoxon test: 4.5, Z value: –2.534, the standard error (SE) threshold: 0.011, and the effect size: 0.7 (very strong effect). These significant results were determined at the $p<0.05$ level ($0.011<0.05$). The null hypothesis is rejected, indicating a significant increase.
4. In conclusion, we can argue that the "optimization of motor skills in throwing events" can be achieved with the help of specific athletic exercises. The results from the initial and final tests clearly demonstrate improved outcomes for the throwers.

Authors' contributions

All authors have equally contributed to this study

References

Astrand, P. O., & Rodahl, K. (1970). *Textbook of work physiology*. McGraw-Hill.

Barrow, H. M., & McGee, R. (1979). *A practical approach to measurement in physical education*. Lea & Febiger.

Coleman, A. (1974). Aerobic and anaerobic responses of male college freshmen during a season of basketball. *Journal of Sports Medicine and Physical Fitness*, June.

Mathews, D. K., & Fox, E. L. (1976). *The physiological basis of physical education and athletics*. W. B. Saunders Company.

Schreiber, M. (1993). Anaerobic capacity as a function of somatotype and participation in varsity athletics. *Research Quarterly*, 34(June).

Taylor, H. L., & Rowell, L. B. (n.d.). Exercise and metabolism. In *Science and medicine of exercise and sports* (2nd ed.).

Carl, F., Courtney, V., Flavia, G., Michelle, H., Brianna, R., Jeff, S., Andrew, T., Scott, D., & John, P. (2015). The effects of high-intensity interval training vs. steady-state training on aerobic and anaerobic capacity. *Journal of Sports Science and Medicine*, 14(4), 747–755.

Christopher, H., Jonathan, P. R., Kathryn, L., & Matthew, W. (2019). High-intensity interval training: A potential exercise countermeasure during human spaceflight. *Journal of Human Performance in Extreme Environments*, 19.

Gil, R., Josep, L., Joan, A., Roser, C., & Joan, P. (2000). A short training programme for rapid improvement of both aerobic and anaerobic metabolism. *European Journal of Applied Physiology*, 82, 480–486. https://doi.org/10.1007/s004210000238

Man, T., Alexiaa, S., & Stephen, F. (n.d.). Acute and chronic effects of blood flow restricted high-intensity interval training. *Frontiers in Physiology*, 8(1), 122. https://doi.org/10.3389/fphys.2017.00122

Manju, C., & Deepak, H. (2015). Aerobic and anaerobic capacity of track and field athletes: A comparative study. *International Journal of Physical Education, Sports and Health*, 2(2), 9–11.

Martin, B., & Paul, B. (2013). High-intensity interval training: Solutions to the programming puzzle. *Strength and Conditioning Journal*, 43, 313–338.

Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle. *Sports Medicine*, 43(5), 315–327. https://doi.org/10.1007/s40279-013-0029-4

Billaut, F., & Bishop, D. (2009). Muscle fatigue in athletes: The effects of exercise intensity and duration on performance. *Sports Science and Medicine*, 7(2), 1-8.

Foster, C., & Lucia, A. (2007). Endurance performance in relation to maximal oxygen uptake and the lactate threshold. *Sports Science Review*, 16(3-4), 5–10.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 138-142
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-20

OPTIMISING THE POWER CAPACITY FOR ATHLETS IN THROWING EVENTS

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Abstract. Background. Throwing events in athletics–such as shot put, discus, and javelin–require a unique combination of strength, speed, coordination, and technical precision. Over the years, coaches and researchers have developed various training strategies to improve performance in these disciplines. Among the most common approaches are training methods that involve throwing with heavier or lighter implements than the standard competition weight. These methods are believed to help athletes develop both explosive power and better movement patterns.
Despite the growing use of such techniques, there is still some debate about their actual effectiveness in improving performance over time. While some studies suggest positive results, others highlight the need for more controlled experiments to confirm these findings. Additionally, less attention has been given to the physiological demands placed on athletes during these specific training sessions–especially from an aerobic and neuromuscular point of view. In this scientific paper, I aim to present the optimization of power through specific athletic methods, such as plyometric training and exercises using medicine balls.
Objectives. The purpose of this paper was to validate whether athletic training programs for throwers, incorporating specific exercises such as throws with heavy implements and lighter-weighted implements, can lead to significant improvements in performance.
Methods. Observation method, bibliographic study method, statistical-mathematical method, experimental method.
Results. Physical exercise plays a crucial role in improving performance among throwers.Training programs for throwers are inherently complex, as high-level performance requires a well-rounded, multilateral approach to physical preparation.
Conclusion. Ultimately, it can be concluded that optimizing strength capacity in throwing events is achievable through the implementation of specific athletic exercises. The comparison between initial and final test results clearly indicates measurable improvements in performance.

Keywords: Throwing events, strength, force.

Introduction

Maximizing muscular strength output is essential in throwing sports, as athletes must generate high force within extremely short time frames to excel (Bartlett, 2000). Events like shot put, discus, and javelin require a complex coordination of biomechanical and neuromuscular elements, demanding a comprehensive approach to physical conditioning, technique, and functional training (Bartlett, 1992). Research highlights that developing explosive strength, refining the force-velocity profile, and maintaining precise biomechanical control are fundamental factors that differentiate elite throwers (Izquierdo, Hakkinen, Gonzalez-Badillo, Ibanez, & Gorostiaga, 2002). Training regimens over the long term need to induce specific adaptations across both upper and lower body kinetic chains. Athletes display unique strength characteristics tailored to the specific neuromuscular requirements of their discipline, emphasizing the importance of individualized training strategies (Izquierdo et al., 2002).

In these throwing events, cultivating both maximal strength and the ability to rapidly express force–known as explosive strength–is vital for executing fast, powerful movements (Bouhlel, Chelly, Tabka, & Shephard, 2007). The force-velocity relationship is a critical indicator of an athlete's capacity to produce force quickly, a necessity in throwing actions (Rahmani, Viale, Dalleau, & Lacour, 2001). Training with moderate loads at high speeds, such as through medicine ball throws or dynamic bench presses, can enhance this relationship and improve muscular power (Marques, van den Tilaar, Vescovi, & Gonzalez-Badillo, 2007). Incorporating dynamic testing and motion analysis into training routines further allows for precise adjustments to workload and early detection of neuromuscular imbalances (Rahmani, Dalleau, Viale, Hautier, & Lacour, 2000). Biomechanically, throwing is characterized by a well-timed sequence of force production and transmission, beginning from the ground, progressing through the torso, and culminating in the release via the upper limbs (Lanka, 2000). Effective force transfer between the lower and upper body segments requires highly coordinated intersegmental movement. Any disruption within this kinetic chain can diminish energy efficiency, regardless of an athlete's strength levels (Bartlett, 2000). Therefore, comprehensive training involving full kinetic chain exercises–such as rotational throws and multidirectional drills-is indispensable for optimizing force transfer and overall performance (Dorel et al., 2005). The development of strength gains true value when combined with consistent, objective monitoring. Modern measurement tools offer accurate data on movement velocity, muscle-tendon stiffness, and force output, all of which inform the fine-tuning of training programs (Murphy, Watsford, Coutts, & Pine, 2003). For example, monitoring bar speed during bench presses or measuring force during squats using motion capture systems provides realistic insights into an athlete's strength potential (Rahmani, Locatelli, & Lacour, 2004). Furthermore, characteristics such as the stiffness of the triceps surae and the inertia of the upper limb play significant roles in force transmission efficiency and can indicate injury risk if neglected (Rambaud, Rahmani, Moyen, & Bourdin, 2008). Research consistently reveals strong links between throwing velocity and the power generated during maximal or near-maximal efforts, underscoring the need for functional strength training adapted to the sport's specific motor demands (Marques et al., 2007). Additionally, factors often underestimated, such as trunk stability, postural control, and segmental coordination, are critical to executing throwing movements safely and effectively (Bartlett, 2000

Subjects and research

The present exeperiment was realised with the participation of 6 athletes, 3 female and 3 male, aged 16–30 years (m = 22), from the track&field. The all subjects have competitional exeprience 5–10 years of competitional experience

Tabel 1. This table presents anonymized details regarding the subjects involved in the testing process

THROWER	AGE	EVENT	COMPETITIVE EXPERINCE
1	16	Discus throw	10 years
2	18	Shot put	5 years
3	22	Javelin throw	9 years
4	30	Shop put	10 years
5	20	Discus throw	5 years

Organisation of research

For this experiment all the athletes were informed about all the details of the tests, the athletes participated as volunteers. all the throwers received the initial results and the final results. Each thrower received an individualized program for the practiced event

Results and Discussions

Table 2 – Show the results of the 5 jumps single leg test, initial and final testing. It can be seen that the values range.

5 JUMPS SINGLE JEG						
THROWER		INITIAL TESTING			FINAL TESTING	
	LEG	h/cm	Power	LEG	h/cm	Power
1	R.L	16,2	16,50	R.L	30	31,5
	L.L	15	7,34	L.L	28	29,5
2	R.L	16,7	17,25	R.L	28,23	30,2
	L.L	7,1	5,5	L.L	29,2	38,3
3	R.L	7,9	9,10	R.L	26,5	22,4
	L.L	10,24	9,8	L.L	32,3	32,8
4	R.L	16,3	13,3	R.L	28,2	24,5
	L.L	10	15	L.L	26,4	35,6
5	R.L	12,3	16,2	R.L	24,5	28,3
	L.L	6,2	7	L.L	35,3	28,9
6	R.L	12,5	14,7	R.L	26,4	22,1
	L.L	13	10,9	L.L	32,8	36,77

Table 3 – which presents the statistical-mathematical indicators, that the mean increased from the initial to the final test, which records that the athletes improved their skills for the 5 jumps test for strength, from 11.88 to 30.07.

Statistical indicators	Initial testing 5 Jumps Single Leg power	Final testing 5 Jumps Single Leg power
Minim	5,5	22,1
Maxim	17,25	38,3
Amplitude	11,75	16,2
Average	11,88	30,07
Median	12,1	29,85
Modulule	12,1	29,85
Standard deviation	4,11	5,31

Table 4. Results – Wilcoxon test for the initial testing and for the final testing

Rezultate	W	Z	p	r
Test 5 Jumps Single Leg- the right leg power	**30**	**–0,706**	**0,04**	**0,2**
Test 5 Jumps Single Leg- the left leg- power	**10**	**–2,044**	**0,041**	**0,6**

We will structure the analysis of the data obtained for the test statistic and the statistic calculated with the excell program in order to confirm the research hypothesis and see whether the data are confirmed or not.

With the Wilcoxon test I was able to more easily analyze the differences between the two tests performed in this research, so that Z values, alpha significance threshold and effect size could be recorded.

The analyzed results were structured at the numerical level, expressing the performance improvement.

So, for this test, for the right leg, we recorded the Wilcoxon test result, which was 11.5, the Z value, –2.157, the alpha significance threshold, 0.030, as well as the effect size 0.6 (strong effect). The results were considered significant at the alpha significance threshold <0.05 (0.030<0.05). Moreover, for the same sample on the left foot, we noted the Wilcoxon test total (8), the z-value (–2.222), the alpha significance threshold (0.026), as well as the effect size (0.2 – weak effect). The results are considered significant at p<0.05 (0.026<0.05) The null hypothesis is rejected, indicating an increase at the significant level for the jumps performed.

Legend:

W – value for the test, sum of ranks;

p – alpha significance threshold;

Z – Z value;

r – effect size.

Conclusions

Physical exercise plays a fundamental role in improving the performance of throwers. In the training process of a thrower, consistent and well-targeted physical work is essential. It's not just about getting stronger–it's about learning to apply that strength effectively during key moments in competition. Structured exercise routines focused on explosive power and functional movement have been shown to produce visible performance gains over time. The aim is to train the body not only to generate force but to do so precisely when it matters most–within the split-second execution of a throw

Authors' Contributions

All authors have equally contributed to this study.

References

Bartlett, R. M. (2000). Principles of throwing. In V. M. Zatsiorsky (Ed.), *Biomechanics in sports: Performance enhancement and injury prevention* (pp. 365–380). Oxford: Blackwell Science Ltd.

Bartlett, R. M. (1992). The biomechanics of the discus throw: A review. *Journal of Sports Sciences, 10*, 467–510.

Bosco, C., Belli, A., Astrua, M., Tihanyi, J., Pozzo, R., Kellis, S., et al. (1995). A dynamometer for evaluation of dynamic muscle work. *European Journal of Applied Physiology, 70*, 379–386.

Bouhlel, E., Chelly, M. S., Tabka, Z., & Shephard, R. (2007). Relationships between maximal anaerobic power of the arms and legs and javelin performance. *Journal of Sports Medicine and Physical Fitness, 47*, 141–146.

Izquierdo, M., Hakkinen, K., Gonzalez-Badillo, J. J., Ibanez, J., & Gorostiaga, E. M. (2002). Effects of long-term training specificity on maximal strength and power of the upper and lower extremities in athletes from different sports. *European Journal of Applied Physiology, 87*, 264–271.

Lanka, J. (2000). Shot putting. In V. M. Zatsiorsky (Ed.), *Biomechanics in sports: Performance enhancement and injury prevention* (pp. 435–457). Oxford: Blackwell Science Ltd.

Marques, M. C., van den Tilaar, R., Vescovi, J. D., & Gonzalez-Badillo, J. J. (2007). Relationship between throwing velocity, muscle power, and bar velocity during bench press in elite handball players. *International Journal of Sports Physiology and Performance, 2*, 414–422.

Murphy, A., Watsford, M., Coutts, A., & Pine, M. (2003). Reliability of a test of musculotendinous stiffness for the triceps surae. *Physical Therapy in Sport, 4*, 175–181.

Rahmani, A., Dalleau, G., Viale, F., Hautier, C. A., & Lacour, J. R. (2000). Validity and reliability of a kinematic device for measuring the force developed during squatting. *Journal of Applied Biomechanics, 16*, 26–35.

Rahmani, A., Locatelli, E., & Lacour, J. R. (2004). Differences in morphology and force/velocity relationship between Senegalese and Italian sprinters. *European Journal of Applied Physiology, 91*, 399–405.

Rahmani, A., Viale, F., Dalleau, G., & Lacour, J. R. (2001). Force/velocity and power/velocity relationships in squat exercise. *European Journal of Applied Physiology, 84*, 227–232.

Rambaud, O., Rahmani, A., Moyen, B., & Bourdin, M. (2008). Importance of upper-limb inertia in calculating concentric bench press force. *Journal of Strength and Conditioning Research, 22*, 383–389.

Dalleau, G., Belli, A., Viale, F., Lacour, J. R., & Bourdin, M. (2004). A simple method for field measurements of leg stiffness in hopping. *International Journal of Sports Medicine, 25*, 170–176.

Dorel, S., Hautier, C. A., Rambaud, O., Rouffet, D., Van Praagh, E., Lacour, J. R., & Bourdin, M. (2005). Torque and power-velocity relationships in cycling: Relevance to track sprint performance in world-class cyclists. *International Journal of Sports Medicine, 26*, 739–746.

Harriss, D. J., & Atkinson, G. (2009). Ethical standards in sport and exercise science research. *International Journal of Sports Medicine, 30*, 701–702.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 143-150
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-21

CLASSICAL PILATES VS. CONTEMPORARY PILATES IN POSTURAL RE-EDUCATION OF PATIENTS WITH CHRONIC NON-SPECIFIC LOW BACK PAIN

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Abstract. Chronic nonspecific lower back pain (CLLBP) is one of the most common musculoskeletal disorders affecting global functionality, posture, and quality of life. Postural retraining is essential in the management of this condition, and Pilates has become an increasingly popular approach in modern physiotherapy because of its fundamental principles such as centring, control, breathing, body alignment, and deep muscle activation. This study aimed to compare, from a theoretical perspective, the two major directions of the Pilates method: the classical approach, which faithfully preserves the original principles and exercises proposed by Joseph Pilates, and the contemporary approach, which has been adapted according to recent research in biomechanics, neuroscience, and clinical physiotherapy. Classical Pilates is based on a fixed sequence of exercises performed with strict precision and rhythmic control, with an emphasis on symmetry and uniformity. In contrast, contemporary Pilates allows for individualised adaptation of exercises according to the patient's needs and therapeutic goals using modern equipment (for example, Reformer, Cadillac, Ledder Barrel, Spine Corrector, Exo Chair), sensory integration, and neuromotor feedback.
The analysis revealed that both styles contribute to improved postural control; however, contemporary Pilates offers increased versatility, the possibility of therapeutic customisation, and more effective integration into clinical rehabilitation protocols. In the context of the recovery of patients with LCN, therapeutic adaptability is essential to respond to variability in individual symptomatology and functional limitations.
This study underscores the need to develop standardised yet adaptable protocols that effectively integrate the advantages of both classical and contemporary Pilates approaches within the framework of postural rehabilitation.

Keywords: Classical Pilates; contemporary Pilates; postural re-education; Chronic nonspecific low back pain (CLLBP); neuromuscular control; body alignment; physiotherapy.

Introduction

According to specialized studies conducted worldwide, lower back pain is a major public health problem. It affects all age groups and, in most cases (80–90%), is nonspecific in nature, with no recognized etiology (Behera et al., 2023).

Chronic Nonspecific Low Back Pain (CLLBP – Chronic Nonspecific Low Back Pain) is one of the most common musculoskeletal conditions globally, representing the leading cause of disability worldwide, according to the Global Burden of Disease Study. The condition is not associated with a clearly defined structural cause but results from a complex combination of biomechanical, neuromuscular, postural, and psychosocial factors. The impact of CLLBP is reflected both at the functional level by impairing mobility, postural control, and trunk stability, and at the psycho-emotional and socio-economic levels, significantly increasing healthcare costs and reducing patients' quality of life. In this context, postural re-education is becoming an essential therapeutic objective in modern physiotherapy, not only to correct biomechanical imbalances but also to restore neuromotor control, improve body schema, and reduce pain by normalising movement patterns.

Active interventions, oriented towards controlled and mindful movement, have been shown to be significantly more effective in the long term than passive treatment strategies. Of these, Pilates has a distinct place as one of the most widely used complementary methods in the rehabilitation of patients with chronic low back pain.

In the Pilates concept, particular emphasis is placed on maintaining or regaining normal body posture, which involves aligning the head, shoulders, and pelvic girdle in a neutral position, maintaining the curves of the spine, as well as the axial position of the lower limbs, and symmetrical distribution of body weight in the orthostatic position.

Developed in the 1920s as *Contrology by Joseph Pilates,* the method originally focused on the principles of control, centre of force, precision, breathing, and fluid movement and was aimed particularly at dancers and athletes. It is designed to integrate the mind and body into a system of neuromuscular control and functional development (Ackland, 2001).

Subsequently, the method has undergone profound diversification for both educational and therapeutic purposes and has been adapted according to advances in biomechanics, neuroscience, and clinical physiotherapy. Thus, two main directions of development have emerged: classical Pilates, which remains faithful to the original structure, and contemporary Pilates, which integrates modern knowledge and allows personalisation of the intervention according to the pathology and capabilities of the patient. Therefore, we propose to comparatively analyse, from a theoretical-applicative perspective, these two directions of the Pilates method, focusing on their implications in the postural re-education of patients with chronic non-specific low back pain, and on the opportunity to develop an integrative and standardised therapeutic protocol.

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Tabel 1. Differences between classical and contemporary Pilates in the context of chronic non-specific low back pain

CATEGORIES	CLASSIC PILATES METHOD	CONTEMPORARY PILATES METHOD
Origin and structure	Joseph Pilates retained the original form of the exercises.	Evolved in modern research (biomechanics, neuroscience, and clinical physiotherapy).
Sequentiality	Fixed sequence of 35 matwork exercises.	Exercises tailored to therapeutic goals.
Equipment used	In general, no equipment focuses on the body weight.	Include Reformer, Cadillac, Spine Corrector, Exo Chair, Ledder Barrel etc
Fundamental principles	The six classic principles are breathing, concentration, control, centring, precision, and fluidity.	+ 2 modern principles: isolation and routine, adapted to individual needs
Customizing the intervention	Limited: all persons execute the same succession.	Greater flexibility and individually adapted exercises after functional assessment.
Functional objectives	Global neuromotor control, balance and core strength.	Its various clinical purposes include postural re-education, stabilisation, mobility, and rehabilitation.
Fields of application	Dancers, athletes, and healthy individuals	Clinical rehabilitation, musculoskeletal and neurological pathologies, and physiotherapy.
Level of progression	Fixed routine with standard levels of difficulty	Individualised progression based on patient responses.
Therapeutic feedback	Body feedback (proprioception and mental concentration).	Feedback and biofeedback through digital devices and technologies.
Clinical accessibility	Accessible in low-resource environments.	Requires specialised equipment and premises, and higher investment.
Efficiency in CLLBP (according to studies)	Improve posture, torso control and reduce pain	Increased effectiveness in reducing disability and activating deep muscles.
Limitations	Rigid standardisation and poor adaptation to complex pathologies	This requires advanced training, pre-assessments, and appropriate equipment.

Objectives

The term Pilates applies to a wide variety of exercises and techniques practiced today due to the lack of standardisation of therapeutic interventions; in essence, the classical Pilates method has not changed since its inception. It has focused on the needs of each individual "in the moment". Pilates believed that mastery of exercises without the use of opposing resistance or the assistance of an instructor was a pinnacle of performance. The goal of the mat program was to retain the mastery of the mat program, with the end result being the transfer to a more functional and integrative movement.

In the contemporary Pilates method, exercises are designed to increase muscular strength, endurance, and elasticity, and to improve posture and balance; these exercises are relatively easy to initiate and maintain, and are consistent with guidelines set by the US Surgeon General and the American College of Sports Medicine.

The specific objectives of this study were as follows:

- Awareness and maintenance of proper posture of the lumbar spine and pelvis
- Strengthening muscles to support and protect the structure of the spine
- Adopt correct posture to optimise body alignment and reduce musculoskeletal strain
- Performing pelvic stabilisation exercises and other de-weighting movements to reduce excessive curvatures of the spine
- Learning to mobilise the limbs independently of the trunk to increase coordination, mobility, and agility.

The Pilates rehabilitation program will be tailored to the needs of the participants; clear goals will be set, and the duration of application will be approximately three months. This integrated approach aims to reduce long-term symptoms and prevent relapse.

Methods

By analysing the historical development of the two approaches, we highlight classical Pilates, which is based on a fixed sequence of exercises and the application of the original principles without adaptations, maintaining the goal of "mastering the program on the mat", and achieving optimal functional movement without external assistance. In contrast, contemporary Pilates has evolved by integrating research into biomechanics, neurophysiology, and rehabilitation, adding new exercises, using modern equipment, and customising interventions for different pathologies.

Identifying the fundamental principles of the Pilates method is an essential step towards a deep understanding of the internal logic of this method of body re-education and its coherent application in therapeutic and educational contexts. The Pilates method is structured around six classic fundamental principles governing the execution of each exercise: breathing, concentration, control, centring (the powerhouse), precision, and fluidity of movement. These are the pillars on which the entire philosophy of the method is based, facilitating the integration of the mind-body connection and optimising neuromotor function.

In contemporary approaches, to support a methodical progression of learning and facilitate adaptation to the individual needs of the practitioner, two complementary principles have been added: isolation (the ability to selectively activate certain muscle groups) and routine (the order of exercises), thus contributing to the development of a coherent, progressive, and efficient system (Brad Leeon, 2013). The correct identification and application of these principles is a defining criterion for the effectiveness of the Pilates method for therapeutic, educational, and motor performance optimisation purposes.

One of the main reasons Pilates exercises are highly valued is their ability to improve the strength of the abdominal, back, and pelvic floor muscles, which play an important role in maintaining stability, body balance, and reducing the risk of muscle and joint injuries. In addition, Pilates exercises emphasise the mind-body connection, encouraging individuals to be more aware of the movements they perform and the alignment of body segments (Wells et al., 2019).

There is considerable interest from physiotherapists and clinicians to adopt Pilates exercises in physical training and rehabilitation programmes. Although Pilates exercises have been used for almost 90 years and have been increasingly introduced in rehabilitation over the last 20 years, there is a lack of solid methodology for their application. The theoretical mechanisms of how and why Pilates is effective appear to be well established, but there is little empirical research that definitively

supports the claims of early practitioners. However, the current research indicates that there may be applications for this type of intervention in certain clinical populations that merit further investigation.

As a result, by documenting the application and verifying the effectiveness of Pilates in chronic non-specific lower back pain, for which there are strong arguments, compared to some research that recommends caution in applying Pilates exercises in other pathologies or clinical situations.

Although Pilates exercises can be performed in 2 ways: with the use of specific equipment (contemporary Pilates) or without it (also known as Pilates classic on mat), we have not found so far in the national literature any studies comparing the effectiveness of Pilates classic on mat with contemporary Pilates on equipment, nor any studies comparing the contemporary Pilates method – the modern version with the conventional therapy currently practiced in public or private sector medical rehabilitation rooms.

Below, we mention some studies found in the international literature that have guided us in approaching this topic.

Patti, Antonio, Bianco, Antonio et al, (2015), conducted a study based on data obtained from the following sources: MEDLINE-NLM, MEDLINE-EBSCO, Scopus Elsevier, Cochrane, DOAJ, SciELO and PLOSONE. This study included original articles and systematic reviews of adults with chronic nonspecific low back pain that evaluated pain and/or disability; studies in which treatment was based on contemporary Pilates method exercises versus no treatment, minimal intervention, other intervention, or other exercise. The literature search included seven electronic databases, a reference list of relevant systematic reviews, and original articles published in July 2014. This study aimed to provide a broad overview of the scientific literature comparing the effectiveness of the contemporary Pilates method on pain and disability in patients with chronic nonspecific low back pain.

In total, 128 articles were identified. Of these, 29 were considered eligible and were included in the analysis. The articles were stratified as follows: Pilates versus other exercises (six studies), Pilates versus no treatment or minimal intervention for short-term pain (nine studies), therapeutic effect of Pilates in randomised cohorts (five studies), and review of reviews (nine studies).

The authors found that there is a lack of studies that clearly demonstrate the effectiveness of one specific contemporary Pilates exercise program over another for the treatment of chronic pain.

However, the consensus in the field suggests that contemporary Pilates is more effective than minimal exercise interventions in reducing pain. These findings, the authors argued, need to be supported by further investigation, which is what we set out to do.

Cruz-Díaz, David. et al. (2017), conducted a randomized controlled trial on 98 patients with chronic non-specific low back pain randomly included in two groups, according to whether they practiced a Pilates Classic program, on the mat or a contemporary Pilates program - the modern version, with equipment. They were given repeated measurements at 6 and 12 weeks using the following instruments: visual analogue scale (VAS), Roland Morris Disability Rating Questionnaire (RMDQ), Tampa Scale for Kinesiophobia (TSK), and ultrasound to measure the activation of the transverse abdominal muscle (Tr. A) Using real-time ultrasound. The objective of this study was to evaluate the efficacy of 12 weeks of practice of the two variants of the Pilates method in terms of disability, pain, kinesiophobia, and transversus abdominis activation in patients with chronic non-specific low back pain. Both variants of Pilates have been shown to improve TaA activation with associated improvements in pain, functional independence, and kinesiophobia. Significant differences were observed after 12 weeks of intervention in the two groups, with a greater improvement in the equipment group, suggesting that the feedback provided by the equipment could contribute to the awareness of Pilates principles.

Cintia Domingues de Freitas , Deborah Araujo Costa, Nelson Carvas Junior et al, (2020), selected randomized clinical trials that evaluated the efficacy of the Pilates method in the treatment of kinesiophobia in patients with chronic non-specific low back pain in the databases MEDLINE, PEDro, SciELO, LILACS and Cochrane Database of Systematic Reviews (CENTRAL), between August and October 2018, without restrictions of language and year of publication. Electronic searches yielded 314 studies; 288 studies were excluded and 27 were selected for full-text reading. Five articles were

included in the review by these authors and four were included in the meta-analysis. The aim of this review was to evaluate the effects of the contemporary (modern) Pilates method on kinesiophobia associated with non-specific chronic low back pain.

From these studies, they concluded that patients with chronic non-specific low back pain with higher levels of kinesiophobia have a 41% higher risk of developing physical disability. They also found that studies in which the Pilates method was applied for chronic non-specific low back pain had positive results in terms of pain and disability reduction, and moderate results in terms of kinesiophobia. However, it cannot be neglected that there is a favourable effect of the contemporary variant Pilates method compared with minimal or no treatment intervention in reducing kinesiophobia associated with chronic non-specific low back pain, but with moderate quality of evidence.

Conclusions

The interest in and popularity of Pilates is growing worldwide. There is also worldwide research supporting the benefits of Pilates exercises but with a moderate quality of clinical evidence.

At the national level, however, there is very little media coverage of the Pilates method, there is very little information in the public domain, and the state structures responsible for public health are not involved in promoting this therapy. As a result, the pilates-based exercise program is applied only in a few urban maintenance and rehabilitation centres and in very small social groups.

From our review of the international literature and our own experience, we found that the Pilates method has significant potential as a therapeutic intervention due to its positive effects on postural control by improving or activating the stabilising muscles of the body (deep abdominal, pelvic floor, gluteus maximus, and multifidus), reducing pain and disability in patients with chronic non-specific low back pain. However, randomised controlled trials are required to confirm its efficacy. Taking as a reference the data provided so far in the international literature, we believe that by comparing the results obtained after applying the Pilates method - the classical versus the contemporary version– we can assess whether the contemporary version offers at least equal benefits in terms of postural balance, muscle toning, and pain relief.

A multidimensional approach through investigations using advanced, accurate, and reliable technologies such as the Biodex Balance System balance platform, electromyography, echography, and stabilisation pressure biofeedback could increase the objectivity of assessments in chronic non-specific low back pain.

References

Ackland, L. (2001). *Body power: A unique exercise system developed by Joseph H Pilates*. London: Thorsons.

Airaksinen, O., Brox, J. I., Cedraschi, C., et al. (2006). Chapter 4. European Guidelines for the Management of Chronic Nonspecific low back pain. European Spine Journal, 15(Suppl 2), S192–S300. https://doi.org/10.1007/s00586-006-1072-1

Brad Leeon. (2013, October 20). *6 Basic Principles* [Video]. YouTube. http://www.youtube.com/watch?v=mO0mKsDmP8M

Cakmakçi, O. (2011). Effect of 8-week Pilates exercise program on body composition in obese women. *Collegium Antropologicum, 35*(4), 1045–1050. http://www.ncbi.nlm.nih.gov/pubmed/22397236

Charles Kenner. (2013, October 20). *Joseph Pilates Classical Mat Exercises* [Video]. YouTube. http://www.youtube.com/watch?v=5ShtfZp3Mwg

Cíntia, D. de F., Costa, D. A., Carvas Junior, N., et al. (2020). Effects of the Pilates method on kinesiophobia associated with chronic non-specific low back pain: a systematic review and meta-analysis. *Journal of Bodywork and Movement Therapies, 24(3), 300–306*. https://doi.org/10.1016/j.jbmt.2020.05.005

Cruz-Díaz et al. (2017). Comparative effects of 12 weeks of equipment-based and mat Pilates on pain, function, and transversus abdominis activation in patients with chronic LBP: A randomised controlled trial. Complementary Therapies in Medicine, 33, 72–77. https://doi.org/10.1016/j.ctim.2017.06.004

Cruz-Ferreira, A., Fernandes, J., and Kuo, Y. L., Bernardo, L. M., Fernandes, O., Laranjo, L., & Silva, A. (2013). Does pilate-based exercise improve postural alignment in adults? *Women & Health, 53*(6), 597–611.

Cordun, M. (2009). Kinetologie medicală. Editura CD Press.
Cordun, M. (2011). Principiile tratamentului în kinetoterapie. Editura CD Press.
Da Luz, M. A. Jr., Costa, L. O. P., Fuhro, F. F., Manzoni, A. C. T., Oliveira, N. T. B., & Cabral, C. M. N. (2014). Effectiveness of mat Pilates and equipment-based Pilates exercises in patients with chronic nonspecific low back pain. *Physical Therapy, 94*(5), 623–631. https://doi.org/10.2522/ptj.20130277
Di Lorenzo, C. E. (2011). Pilates: What is it? Should it be used for rehabilitation? *Sports Health, 3*(4), 352–361. http://www.ncbi.nlm.nih.gov/pubmed/23016028
Eliks, M., Zgorzalewicz-Stachowiak, M., & Zeńczak-Praga, K. (2019). Application of Pilates-based exercises in the treatment of chronic non-specific low back pain: State of the art. *Postgraduate Medical Journal, 95*(1119), 41–45. https://doi.org/10.1136/postgradmedj-2018-135920
Fernández-Rodríguez, R., Álvarez-Bueno, C., Cavero-Redondo, I., Torres-Costoso, A., Pozuelo-Carrascosa, D. P., Reina-Gutiérrez, S., Pascual-Morena, C., & Martínez-Vizcaíno, V. (2022). Best exercise options for reducing pain and disability in adults with chronic low back pain: Pilates, strength, core- and mind-body. *Journal of Orthopaedic & Sports Physical Therapy, 52*(8), 505–521.
Giacomini, M. B., da Silva, A. M., Weber, L. M., & Monteiro, M. B. (2016). The Pilates method increases respiratory muscle strength, performance, and abdominal muscle thickness. *Journal of Bodywork and Movement Therapies, 20*(2), 258–264.
Joseph Pilates. (2013, September 4). *The original 34 pose from Return to Life*. Easy Vigour. http://www.easyvigour.net.nz/pilates/h_pilates_classic.htm
Latey, P. (2001). Pilates Method: History and Philosophy. *Journal of Bodywork and Movement Therapies, 5*(4), 275–282.
Li, F., Dev Omar Dev, R., Soh, K. G., Wang, C., & Yuan, Y. (2024). Effects of Pilates exercises on spine deformities and posture: a systematic review. *BMC Sports Science, Medicine and Rehabilitation, 16*, 55. https://doi.org/10.1186/s13102-024-00843-3
Li, Y., Yan, L., Hou, L., Zhang, X., Zhao, H., Yan, C., Li, X., Li, Y., Chen, X., & Ding, X. (2023). Exercise intervention for patients with chronic low back pain: a systematic review and network meta-analysis. *Frontiers in Public Health, 11,* 1155225. https://doi.org/10.3389/fpubh.2023.1155225
Merlo, J. K., da Silva, A. V., Casonatto, J., Ribeiro, A. S., de Oliveira Junior, E., do Nascimento, A. P., Gonçalves de Oliveira, R., Buzzachera, C. F., da Silva, R. A., & Aguiar, A. F. (2024). Effects of a mat Pilates exercise program associated with photobiomodulation therapy in patients with chronic nonspecific low back pain: A randomised, double-blind, sham-controlled trial. *Healthcare, 12*(14), 141416. https://doi.org/10.3390/healthcare12141416
Miyamoto, G. C., Franco, K. F. M., van Dongen, J. M., et al. (2018). Different doses of pilates-based exercise therapy for chronic low back pain: A randomised controlled trial with economic evaluation. *British Journal of Sports Medicine.* https://doi.org/10.1136/bjsports-2017-098825
Muscolino, J. E., & Cipriani, S. (2004). Pilates and the "powerhouse", I. *Journal of Bodywork and Movement Therapies, 8*(1), 15–24.
Niculescu, M. (2002). *Metodologia cercetării ştiinţifice în educaţie fizică şi sport*. Bucureşti: A.N.E.F.S.
Notarnicola, A., Fischetti, F., Maccagnano, G., Comes, R., Tafuri, S., & Moretti, B. (2013). Daily Pilates exercise or inactivity for patients with low back pain: a prospective observational clinical study. *European Journal of Physical and Rehabilitation Medicine.* http://www.ncbi.nlm.nih.gov/pubmed/24104699
Owen, P. J., Miller, C. T., Mundell, N. L., Verswijveren, S. J. J. M., Tagliaferri, S. D., Brisby, H., Bowe, S. J., & Belavy, D. L. (n.d.). Which specific modes of exercise training are the most effective for treating low back pain? Network Meta-analysis. *British Journal of Sports Medicine.* https://doi.org/10.1136/bjsports-2019-100886
Patti, A., Bianco, A. et al. (2015). Effects of Pilates exercise programs in people with chronic low back pain: *a systematic review. Medicine (Baltimore), 94(4), e383. https://doi.org/10.1097/MD.0000000000000383*
Pereira, L. M., Obara, K., Dias, J. M., Menacho, M. O., Guariglia, D. A., Schiavoni, D., Pereira, H. M., & Cardoso, J. R. (2011). Comparing the Pilates method with no exercise or lumbar stabilisation for pain and functionality in patients with chronic low back pain: a systematic review and meta-analysis. *Clinical Rehabilitation, 26*(1), 10–20. https://doi.org/10.1177/0269215511411113
Pilates alliance method. (2013, October 20). *An Exercise in Balance: The Pilates Phenomenon*. http://www.pilatesmethodalliance.org/i4a/pages/index.cfm?pageid=3277
Powers, S. (2005). *Stefanie Powers: Guide to longevity and well-being through Pilates*. London: Gaia Books, Ltd.
Sanatan Behera, G. S., Pattnaik, C., & Behera, C. (2023). Chronic nonspecific low back pain: Approach to clinical diagnosis*. Journal of Population Therapeutics & Clinical Pharmacology, 30(17), 1735–1744.*

Sbenghe, T. (2002). Kinesiologie, ştiinţa mişcării. Bucureşti: Editura Medicală.

Quinn, K., Barry, S., Barry, L. (2011). Do patients with chronic low back pain benefit from attending Pilates classes after completing conventional physiotherapy treatment? *Physiotherapy Practice and Research 32*(1): 5–12.

Taspınar, G., Angın, E., Oksüz, S. (2022). Effects of Pilates on pain, functionality, quality of life, flexibility, and endurance in patients with lumbar disc herniation. *Journal of Comparative Effectiveness.*

Wells, C., Kolt, G. S., Marshall, P., Hill, B., & Bialocerkowski, A. (2019). The effectiveness of Pilates exercise in people with chronic low back pain: a systematic review. *PLOS ONE, 14*(2), e100402. https://doi.org/10.1371/journal.pone.0100402

Wells, C., Kolt, G. S., & Bialocerkowski, A. (2012). Defining Pilates Exercises: A Systematic Review. *Complementary Therapies in Medicine, 20*(4), 253–262.

Women's Health. (2019, February 2). *8 Pilates abs exercises for women's health* [Video]. YouTube. https://www.youtube.com/watch?v=42r0A-WUiNY

Yamato, T. P., and Maher, C. Saragiotto, G., Hancock, M. J., Ostelo, R., W. Cabral, C. Costa, and L.C. M., & Costa, L. O. (2016). Pilates for low back pain. *São Paulo Medical Journal 134*(4), 366–367.

Yu, Z., Yin, Y., Wang, J., Zhang, X., Cai, H., & Peng, F. (2023). Efficacy of Pilates on pain, functional disorders, and quality of life in patients with chronic low back pain: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health, 20*(4), 2850. https://doi.org/10.3390/ijerph20042850

Y., Lubetzky, V. A., & Masharawi, Y. (2016). Rotation exercise classes did not improve function in women with non-specific chronic low back pain: A randomised single-blind controlled study. *Journal of Back and Musculoskeletal Rehabilitation, 29,* 467–475. https://doi.org/10.3233/BMR-150642

Walker, B. F. (2000). Prevalence of low back pain: a systematic review of the literature from 1966 to 1998*. Journal of Spinal Disorders, 13, 205–217. https://doi.org/10.1097/00002517-200006000-00003*

KINETOTHERAPY SECTION

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 152-159
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-22

ENHANCING PSYCHOSOCIAL DEVELOPMENT THROUGH EXTRACURRICULAR MOTOR ACTIVITIES IN PEDIATRIC PALLIATIVE CARE: A CASE STUDY

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Abstract. *Background*. Children with life-limiting conditions frequently face social isolation, reduced functional autonomy, and limited participation in educational activities. In this context, the integration of physiotherapy into structured extracurricular programs becomes essential for supporting psychosocial development and enhancing overall quality of life.
Objectives. The study aimed to investigate the impact of extracurricular motor activities on the social, emotional, cognitive, and communication skills of children in palliative care settings, highlighting the therapeutic potential of motor-recreational interventions.
Methods. The case study involved a child with a primary diagnosis of Cerebral Palsy, who participated in a summer camp designed for children with incurable conditions. The intervention included adapted group physical exercises, functional interactive motor games, and themed multisensory workshops tailored to the child's cognitive and physical level. Data were collected through direct observation and the administration of the *Strengths and Difficulties Questionnaire (SDQ).*
Results. Significant improvements were observed in social interaction, emotional expression, and participation in group activities. The participant demonstrated increased self-confidence, reduced anxiety during interactions with other children, and active engagement in collaborative tasks. Motor activities–particularly aquatic and sensory-based interventions–contributed to enhancements in body schema and postural control.
Conclusion. Extracurricular motor programs that include components of adapted physiotherapy have a major impact on the psychosocial development of children with progressive chronic conditions. Integrated approaches contribute to reducing physical discomfort and facilitating social inclusion, while strengthening self-esteem by providing an emotionally supportive environment in which children feel safe.

Keywords: Pediatric palliative care, psychosocial development, inclusive education, physiotherapy.

Introduction

In the contemporary context of inclusive education and child-centered healthcare services, extracurricular motor activities gain particular importance in supporting the overall development of children, especially those with chronic conditions in palliative care settings (Fluss & Lidzba, 2020). These activities represent structured forms of movement conducted outside the standard school curriculum, possessing strong educational, recreational, and therapeutic value. They provide valuable

opportunities for self-expression, strengthening interpersonal relationships, and optimizing cognitive, motor, and psycho-emotional functions (Furumasu et al., 1996).

Particularly, children facing life-limiting conditions, such as those with a primary diagnosis of Cerebral Palsy, are frequently excluded from traditional educational and social systems (Livingstone & Field, 2015). The lack of social interaction, physical isolation, and decreased functional autonomy contribute to imbalances in psychosocial development. In this regard, the integration of movement therapy within extracurricular motor activities offers an interdisciplinary approach aimed not only at addressing the functional component but also the symbolic-relational dimension of the child receiving palliative care (Gefen et al., 2020).

Physiotherapy integrated into extracurricular activities involves adapting therapeutic objectives to a playful, multisensory, and non-institutionalized environment, where the child is stimulated through play aiming to improve body schema and postural control, increase self-confidence, and strengthen relational abilities–key aspects for quality of life in pediatric palliative care. Thus, motor activity is not perceived as a therapeutic obligation but as a source of joy, meaning, and belonging (Bray et al., 2020).

The specialized literature supports that extracurricular motor interventions, when personalized and integrated into the child's life, can contribute to reducing anxiety symptoms, developing emotional regulation skills, and promoting overall well-being (Field et al., 2016). This type of holistic intervention aligns with the philosophy of pediatric palliative care, which aims not only at pain and symptom management but also at providing psychosocial and spiritual support to the child and family (Rosenberg et al., 2019).

Extracurricular motor activity is more than a recreational extension of physical education; it constitutes an environment with profound formative and therapeutic potential, where the body becomes language and movement serves as a bridge to others (Ogonowska-Slodownik et al., 2024). Within the context of integrated physiotherapy, it promotes the child's active participation, encourages autonomy, and reinforces the therapist's role as a facilitator of psychosocial and functional development (Martínez-Rodríguez et al., 2025).

The summer camp experience for children with life-limiting conditions offers a rare opportunity to live childhood authentically, free from the constant pressure of clinical monitoring or functional restrictions (Livingstone & Field, 2020). It is a space where the child is no longer perceived as a patient, but as an active participant in a social and recreational setting. The camp thus becomes a form of life normalization, fostering a positive perception of one's body and the capacity for interaction and movement. In palliative care, the camp is not merely a summer activity–it is a ritual of hope, joy, and connection (D'Arrigo et al., 2020). It is an expression of every beneficiary's right to experience childhood–to explore, to be seen, and to be valued despite the condition they live with. Through adapted motor activities, the child reclaims the body as a living space–capable of expression, interaction, and relationship-building (Field & Livingstone, 2018). The role of these activities within the camp setting is to support the child's motor and cognitive development, strengthen social interactions, provide sensory stimulation, emotional support, and foster connection with nature–and, implicitly, with the family (Adar et al., 2017).

The aim of this research is to analyze the impact of extracurricular motor activities integrated into an adapted summer camp on the psychosocial and motor development of a child receiving palliative care, with a focus on improving body schema and postural control as essential components. The objectives of the research focused on identifying changes in the child's social, emotional, and relational behavior following participation in adapted extracurricular motor activities conducted within the camp setting; and analyzing the influence of adapted motor exercises on the development of body schema and postural control within a non-formal therapeutic program based on the principle of individualization.

Research Question: To what extent does participation in extracurricular motor activities conducted within an adapted summer camp contribute to the improvement of psychosocial development, body schema, and postural control in a child receiving palliative care?

Methodology

The case study focused on the progression of a 12-year-old subject with a primary diagnosis of Cerebral Palsy and a secondary diagnosis of polymorphic dyslalia, along with non-epileptic paroxysmal manifestations. All necessary measures regarding data protection and confidentiality were observed through informed consent procedures.

The research was conducted during the summer camp organized by the Hospice Casa Speranţei Foundation, held in Adunaţii Copăceni over the course of one week, from July 21 to 25, 2024. The camp hosted a total of 30 participants, including both beneficiaries and their siblings, and was supported by a multidisciplinary team composed of a physician, nurse, social worker, psychologist, physiotherapist, speech therapist, and volunteers from the United Kingdom.

The objectives of the camp were structured as follows: development of physical, cognitive, and social skills through educational activities; promotion of autonomy and self-confidence; reduction of stress levels and enhancement of psychological well-being; improvement of conflict-resolution skills; promotion of cultural diversity and tolerance; support of creativity and imagination; and encouragement of a healthy lifestyle.

Additionally, the program focused on improving both verbal and nonverbal communication, fostering environmental responsibility, and encouraging self-expression through theatre, dance, and music, as well as promoting active cooperation between volunteers and children. The staff received preparatory training sessions aimed at enhancing creativity and planning activities within an interdisciplinary framework, with an emphasis on empathy, adaptability, group dynamics in vulnerable populations, and understanding cultural diversity and inclusion (Livingstone & Paleg, 2021), taking into account inclusion and exclusion criteria for participating children. Volunteers were assigned at a ratio of 1 to 4 children to ensure safety and continuous support. Each morning of the camp began with a group warm-up session (see Fig. 1).

Figure 1. Morning warm-up gymnastics.

On the first day of the camp, name tags were distributed, the project theme was introduced, and group games began, incorporating both standard and adapted activity circuits. These included light running, jumping over obstacles, ball throwing (Fig. 2), object transport tasks, assisted wheelchair running, crossing a sensory mat, hitting a suspended balloon, maneuvering a wheelchair through cones, and grasping and transferring blocks. The evening concluded with a campfire that included storytelling and singing, followed by music and dancing (Fig. 3).

Figure 2. Group games.

Figure 3. Campfire.

The second day included pool competitions in a shallow area, consisting of three events; to promote integration, groups were mixed and formed of 4–6 children. The first event was the *Float Race* where each child had to swim a distance of 5–10 meters either independently or with assistance. The second event, *Floating Packages,* involved each team collecting as many floating toys as possible and transporting them to a basket located at the poolside. The final event was the *Friendship Relay* in which each team member swam a short distance, with or without help, and passed an object to the next child until the race was completed. Emphasis was placed on participation rather than speed.

The third day was marked by participation in a culinary workshop where the children learned how to prepare carbonara pasta independently, with assistance from the staff. In the evening, an animated film was screened outdoors. On the fourth day, the children took part in aquatic physical activities led by the staff at one of the water parks in Bucharest. During the evening, a talent show was organized, where each child performed a dance move, a karaoke piece, or another artistic act.

Figure 4. Camp party.

On the fifth day, the projects that the children had been working on throughout the week with their team members were completed, followed by an awards ceremony and a celebration (Fig. 4) featuring face painting workshops, friendship bracelet making, and crafting of small objects. The final moment was marked by the formation of a large circle, in which all participants held hands as a symbol of unity and gratitude for the shared experience. On the last day, the children, together with staff and volunteers, cleaned the camp, reflecting the holistic development of the individual's personality in accordance with societal expectations of autonomy, efficiency, and harmony with the natural and social environment. The camp concluded with their departure.

Results

Following the final evaluation, scores were recorded for the five component scales of the administered questionnaire–emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and prosocial behavior. Initially, the total score was 21 points, which decreased to 12 points at the end, indicating a significant improvement in psychosocial well-being. At the beginning of the camp, the beneficiary exhibited anxiety in social interactions and emotional expression, difficulties integrating into the group, avoidance of collective games, and poor prosocial behavior characterized by a lack of offering help to others and not initiating interactions. By the end of the camp, the child became calmer, laughed more, sought help and expressed needs, engaged in play, cooperated, and actively participated in group activities, encouraged other children, assisted volunteers, and initiated games (Fig. 5).

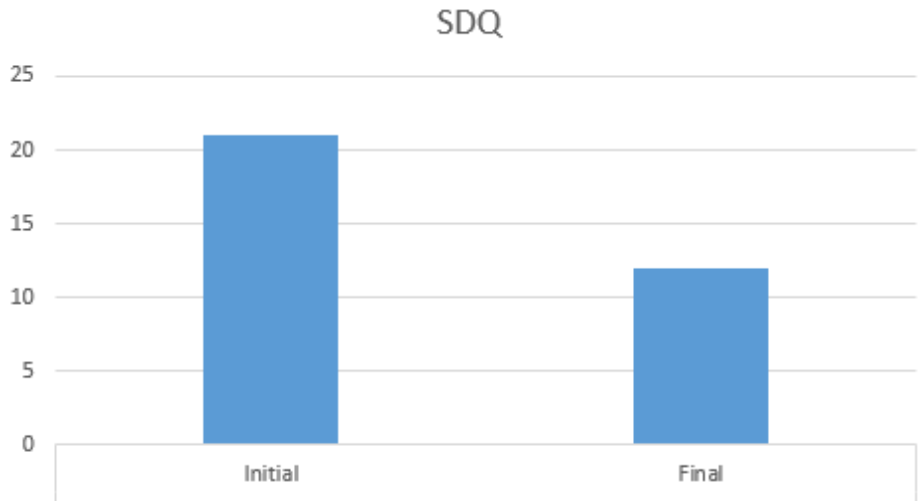

Figure 5. Results obtained on the SDQ Scale.

Regarding the motor component, data were recorded through direct observation both at the initial and final stages for eight main domains (Fig. 6).

Criterion	Initial	Final	Progress
Body scheme	Poor awareness; hesitations in movement	Improved awareness; more confident movements	Noticeably improved
Postural control	Unstable posture; difficulty maintaining trunk stability	Stabilized posture in both static and dynamic positions	Significant improvement
Static and dynamic balance	Unsteady gait; avoids balance challenges	Maintains balance on flat ground; accepts motor challenges	Steady progress
Gross motor coordination	Poor coordination in sequential activities	Smoother coordination in simple and medium tasks	Moderate positive development
Oculo-motor coordination	Difficulties in eye–hand synchronization	Responds effectively to visual and tactile stimuli	Good response to stimuli
General muscle tone	Moderate generalized hypotonia	Increased functional tone, better endurance	Increased functional tone
Motor initiative	Passivity; requires constant guidance	Increased initiative, active involvement	Stimulated initiative
Active group participation	Avoids group motor interactions	Enthusiastically participates in group games and exercises	Good social-motor integration

Figure 6. Initial and Final Results of Direct Observation.

The child demonstrated visible progress in relational and emotional domains, with a significant reduction in difficulty scores. Participation in adapted motor activities, both individual and group-based, contributed to increased self-confidence, affective expression, and improved social integration. Aquatic activities, balance exercises, and sensory games supported postural control, body schema, and active participation. The final evaluation confirms the benefits of a comprehensive approach–motor, emotional, and social–within the context of an inclusive therapeutic camp.

Discussions

Extracurricular motor activity conducted in an informal setting represents a complex form of intervention that transcends the traditional clinical framework. Movement is no longer perceived as an obligation, but as a source of play, relationship, and autonomy.

Within the camp setting, the therapist-child relationship evolved into an authentic partnership, wherein the child was encouraged to express themselves freely, assume roles, and safely explore their functional limits. This non-hierarchical relationship, founded on mutual trust and respect, constituted a fundamental pillar in the success of the intervention.

The value of the camp extends beyond this limited period. The continuity of the results depends on the integration of therapeutic principles into the child's daily routine within the family environment. In this context, the role of the parent becomes essential. When the parent is actively involved–not only as a companion but also as a co-participant in the motor activities–the child benefits from increased security and functional consolidation.

The camp represents a comprehensive support strategy: it fosters the child's motor development, affirms their social identity, provides emotional support, and builds bridges between the family and the therapeutic team. This experience acts as a catalyst for learning and self-discovery,

encouraging the child to continue the activities initiated during the camp and to integrate them into their daily life.

Conclusions

Extracurricular motor activities, when integrated within a recreational and symbolic framework such as an adapted camp, become more than a form of therapy: they transform into a context for affirmation, normalization of childhood, and reconnection with one's own body (Rosenberg et al., 2021).

Children with life-limiting conditions are often excluded from traditional educational and social environments, which exacerbates isolation and negatively impacts their psychosocial development. In this regard, interdisciplinary approaches centered on motor activities significantly contribute to counteracting these effects by providing the child with an active and relational identity (Huang, 2018).

The influence of motor activities on body schema and postural control was evidenced by the motor progress observed throughout the camp. The implemented program had a balanced structure, featuring progressive activities that promoted both bodily expression and social participation within a climate of safety and individual validation.

Regarding the psycho-emotional component, the SDQ score significantly decreased from 21 to 12, reflecting a reduction in anxiety and an increase in pro-social behavior. These findings were corroborated by direct observation, which confirmed the child's progress toward more active engagement, emotional expression, and spontaneous cooperation in group tasks.

The integration of extracurricular motor activities into the therapeutic plan for children in palliative care indicates not only the effectiveness of adapted physiotherapy but also the added value of a symbolic, emotional, and social context in which the child feels seen, accepted, and encouraged to participate (Kenyon et al., 2017).

Authors contribution

All authors have equally contributed to this study.

References

Adar, S., Dündar, Ü., Demirdal, Ü. S., Ulaşlı, A. M., Toktaş, H., & Solak, Ö. (2017). The effect of aquatic exercise on spasticity, quality of life, and motor function in cerebral palsy. *Turkish journal of physical medicine and rehabilitation*, *63*(3), 239–248. https://doi.org/10.5606/tftrd.2017.280

Bray N., Kolehmainen N., McAnuff J., Tanner L., Tuersley L., Beyer F., … Craig D (2020). Powered mobility interventions for very young children with mobility limitations to aid participation and positive development: The EMPoWER evidence synthesis. *Health Technology Assessment*, 24(50), 1–194. https://doi.org/10.3310/hta24500

D'Arrigo R. G., Copley J. A., Poulsen A. A., Ziviani J. (2020). The engaged child in occupational therapy. *Canadian Journal of Occupational Therapy*, 87(2), 127–136. https://doi.org/10.1177/0008417420905708

Field D. A., Livingstone R. W. (2018). Power mobility skill progression for children and adolescents: A systematic review of measures and their clinical application. *Developmental Medicine and Child Neurology*, 60(10), 997–1011. https://doi.org/10.1111/dmcn.13709

Field D. A., Miller W. C., Ryan S. E., Jarus T., Abundo A. (2016). Measuring participation for children and youth with power mobility needs: A systematic review of potential health measurement tools. *Archives of Physical Medicine and Rehabilitation*, 97(3), 462–477.e40. https://doi.org/10.1016/j.apmr.2015.08.428

Fluss J., Lidzba K. (2020). Cognitive and academic profiles in children with cerebral palsy: A narrative review. *Annals of Physical and Rehabilitation Medicine*, 63(5), 447–456. https://doi.org/10.1016/j.rehab.2020.01.005

Furumasu J., Guerette P., Tefft D. (1996). The development of a powered wheelchair mobility program for young children. *Technology and Disability*, 5(1), 41–48. https://doi.org/10.3233/TAD-1996-5106

Gefen N., Rigbi A., Weiss P. L. T. (2020). Reliability and validity of pediatric powered mobility outcome measures. *Disability and Rehabilitation: Assistive Technology*, 1–6. https://doi.org/10.1080/17483107.2020.1819449

Huang H. H. (2018). Perspectives on early power mobility training, motivation, and social participation in young children with motor disabilities. *Frontiers in Psychology*, 8(1), 1–8. https://doi.org/10.3389/fpsyg.2017.02330

Kenyon L. K., Farris J. P., Cain B., King E., VandenBerg A. (2017). Development and content validation of the power mobility training tool. *Disability and Rehabilitation: Assistive Technology*, 3107(January), 1–15. https://doi.org/10.1080/17483107.2016.1278468

Livingstone R., Field D. (2015). The child and family experience of power mobility: A qualitative synthesis. *Developmental Medicine and Child Neurology*, 57(4), 317–327. https://doi.org/10.1111/dmcn.12633

Livingstone RW, Field DA. (2020). Exploring young children's activity and participation change following 6 months' power mobility experience. *British Journal of Occupational Therapy, 84*(11): 713–722. doi:10.1177/0308022620973935

Livingstone, R., & Paleg, G. (2021). Enhancing Function, Fun and Participation with Assistive Devices, Adaptive Positioning, and Augmented Mobility for Young Children with Infantile-Onset Spinal Muscular Atrophy: A Scoping Review and Illustrative Case Report. *Disabilities*, *1*(1), 1–22. https://doi.org/10.3390/disabilities1010001

Martínez-Rodríguez, L., García-Bravo, C., García-Bravo, S., Salcedo-Pérez-Juana, M., & Pérez-Corrales, J. (2025). New Technological Approaches in Occupational Therapy for Pediatric Cerebral Palsy: A Systematic Review. *Healthcare*, *13*(5), 459. https://doi.org/10.3390/healthcare13050459

Ogonowska-Slodownik, A., Jakobowicz, O., Alexander, L., Marinho-Buzelli, A. R., Devion, C., & Morgulec-Adamowicz, N. (2024). Aquatic Therapy in Children and Adolescents with Disabilities: A Scoping Review. *Children*, *11*(11), 1404. https://doi.org/10.3390/children11111404

Rosenberg, L., Maeir, A., & Gilboa, Y. (2019). Feasibility Study of a Therapeutic Mobility Summer Camp for Children with Severe Cerebral Palsy: Power Fun. *Physical&Occupational Therapy in Pediatrics, 40*(7): 1–15. DOI:10.1080/01942638.2019.1695699

Rosenberg, L., Maeir, A., & Gilboa, Y. (2021). Evaluating a Therapeutic Powered Mobility Camp for Children with Severe Cerebral Palsy. *Canadian journal of occupational therapy. Revue canadienne d'ergotherapie*, *88*(4), 294–305. https://doi.org/10.1177/00084174211034938

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 160-167
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-23

NEUROMUSCULAR SYMMETRY AND FUNCTIONAL RECOVERY FOLLOWING ACL RECONSTRUCTION IN A RECREATIONAL SKIER: A CASE STUDY

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Abstract. *Background.* Anterior cruciate ligament (ACL) injuries are among the most frequent and functionally limiting conditions in winter sports, particularly in amateur alpine skiing. Due to the high rotational forces and unpredictable terrain, even recreational athletes face significant risk. Additionally, ACL injuries can compromise long-term functionality and affect occupational activities that require prolonged standing or postural stability. Effective surgical intervention and a personalized rehabilitation plan are essential for regaining neuromuscular control and returning to both sport and professional activity.
Objectives. This case study aimed to evaluate the functional recovery and neuromuscular symmetry of a 26-year-old female recreational skier and dental practitioner who sustained a complete ACL rupture in the left knee. The study focused not only on achieving a safe return to sport but also on enabling her reintegration into daily professional activity, which involves long hours of standing and maintaining static posture. After ligament reconstruction with a hamstring autograft, the patient followed a structured, 9-month rehabilitation program with progressive goals, from anatomical healing to functional and occupational reintegration.
Methods. The protocol was divided into three phases and included mobility exercises, strength training, proprioceptive and neuromuscular control drills. Functional assessments were conducted using biomechanical equipment: Leg Press and Leg Extension (eccentric and isokinetic), execution speed, Drop Jump Test, Stiffness Test, and stabilometric postural evaluation. Data analysis included the Wilcoxon signed-rank test, symmetry index (SI), and coefficient of variation (CV%).
Results. The outcomes showed no significant limb differences ($p = 0.929$), with SI values below 10% in most tests. CV values were lower for strength and slightly higher for speed metrics. Quadriceps circumference increased (+8.9%), and all functional return-to-activity criteria were met.
Conclusion. The applied rehabilitation protocol effectively restored neuromuscular symmetry and functional capacity, supporting a confident return to both recreational skiing and physically demanding professional work. Additionally, improvements in joint mobility and dynamic knee stability were essential in facilitating safe reintegration into daily and sport-specific activities.

Keywords: ACL injury, rehabilitation protocol, neuromuscular symmetry, return to work, recreational skiing, functional recovery.

Introduction

Anterior cruciate ligament (ACL) injuries are among the most frequent and functionally limiting injuries in winter sports, particularly in non-professional alpine skiing. Due to the high rotational forces and unpredictable terrain, recreational athletes face an increased risk of knee instability and ligament damage [1].

The ACL is essential for stabilizing the knee joint during both rotational and translational motions. Damage to this structure results not only in mechanical instability but also in neuromuscular deficits, such as impaired proprioception and postural control, which can persist even after surgical reconstruction [2,3]. This aspect is critical for individuals with physically demanding professions, such as dentists, who require prolonged standing and static posture control.

Although ACL reconstruction using autografts remains the standard surgical technique, optimal recovery depends on a structured and progressive rehabilitation protocol. Return to activity requires not only restoration of muscle strength but also the recovery of neuromuscular coordination and bilateral symmetry [4].

Recent research emphasizes the role of functional testing, neuromuscular retraining, and neurocognitive strategies in guiding safe return to sport and work, particularly for recreational athletes whose professional demands may involve orthopedic stress similar to athletic activity [5, 6].

This case study presents a 26-year-old recreational skier and dentist who sustained a complete ACL tear. The purpose of this study is to assess neuromuscular recovery and bilateral symmetry throughout a 9-month rehabilitation program, with a dual goal of returning to both sport and professional activity.

Materials and Methods

This case study presents a 26-year-old female recreational skier and dental practitioner who sustained a complete rupture of the anterior cruciate ligament (ACL) in her left knee, resulting from a non-contact injury. She underwent surgical reconstruction with a hamstring tendon autograft.

Study Design

The study was structured as a single-subject longitudinal observational case, focused on post-operative rehabilitation, neuromuscular recovery, and reintegration into both recreational and occupational activity.

Ethical Considerations

The patient provided written informed consent, and the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Rehabilitation Protocol

The rehabilitation program extended over 9 months and was divided into three major phases:

- **Phase 1 (weeks 1–6):** Passive and active-assisted mobilizations, cryotherapy, lymphatic drainage, and electrostimulation.
- **Phase 2 (weeks 7–18):** Progressive resistance training (Leg Press, Leg Extension), proprioceptive exercises (balance pads, BOSU), BFR (blood flow restriction) training.

- **Phase 3 (months 5–9):** Sport-specific drills (ski simulator, jump-landing mechanics), neuromuscular coordination, reactive balance work, Nordic hamstring strengthening.

Functional Testing

Biomechanical assessments were performed using:

- **Leg Press 400** and **Leg Extension** for eccentric and isokinetic force evaluation.
- **Stabilometric platform** for postural control analysis (eyes open/closed, static/unstable surface).
- **Drop Jump Test** and **Stiffness Test** for elasticity and landing symmetry.
- **Nordic Hamstring device** for assessing posterior chain eccentric strength.

Results

Data were recorded via specialized software interfaced through an ASUS computing system, used for acquisition and interpretation of peak force, time to peak, symmetry index (SI), and coefficient of variation (CV%).

Statistical Analysis

Differences between limbs were analyzed using the **Wilcoxon signed-rank test**. Complementary calculations included:

- **Symmetry Index (SI%)**, with a threshold of clinical relevance set at 10%.
- **Coefficient of Variation (CV%)** for performance variability.

1 Percentage differences (Δ%)

Table 1 presents the absolute and relative differences between the left and right limbs across all tests. The greatest positive differences were recorded in “Leg Press – Mean Force” (Δ% = +16.2%) and “Leg Press – Mean Speed” (Δ% = +16.7%), both in favor of the left side. Negative values, such as in “Leg Extension – Peak Force” (Δ% = –3.1%) and “Leg Press – Isokinetic” (Δ% = –5.0%) indicate a slight right-side advantage.

Table 1. *Absolute and relative differences between limbs*

Test	Left (N)	Right (N)	Delta	Delta %
Leg Extension – Peak Force	9.30	9.60	–0.30	–3.12
Leg Press 400 – Peak Force Best	48.60	45.80	2.80	6.11
Leg Press 400 – Peak Force Mean	45.80	39.40	6.40	16.24
Leg Press 400 – Peak Speed Mean	0.77	0.66	0.11	16.69
Leg Press 400 – Isokinetic Peak Force	99.90	105.60	–5.70	–5.40
Leg Press 400 – Eccentric Peak Force	33.90	36.20	–2.30	–6.35

Stiffness Test – Fmax	192.00	184.00	8.00	4.35
Drop Jump Test – Fmax	230.00	230.00	0.00	0.00
Leg Press – Excentric (calculat)	112.36	106.00	6.36	6.00
Leg Press – Isokinetic (calculat)	100.70	106.00	–5.30	–5.00
Leg Extension – Excentric (calculat)	100.88	104.00	–3.12	–3.00
Leg Extension – Isokinetic (calculat)	93.60	104.00	–10.40	–10.00

2. Symmetry Index

The symmetry index (SI%) was calculated for each test, with the 10% threshold used as a clinical cutoff. As shown in Table 2 and Figure 1, 10 out of 12 tests remained under this limit, confirming acceptable bilateral symmetry. The highest SI values were in "Leg Press – Mean Force" (13.94%) and "Leg Press – Mean Speed" (14.31%).

Table 2. *Symmetry index (%) per test*

Test	Symmetry Index %
Leg Extension – Peak Force	3.12
Leg Press 400 – Peak Force Best	5.76
Leg Press 400 – Peak Force Mean	13.97
Leg Press 400 – Peak Speed Mean	14.30
Leg Press 400 – Isokinetic Peak Force	5.40
Leg Press 400 – Eccentric Peak Force	6.35
Stiffness Test – Fmax	4.17
Drop Jump Test – Fmax	0.00
Leg Press – Excentric (calculat)	5.66
Leg Press – Isokinetic (calculat)	5.00
Leg Extension – Excentric (calculat)	3.00
Leg Extension – Isokinetic (calculat)	10.00

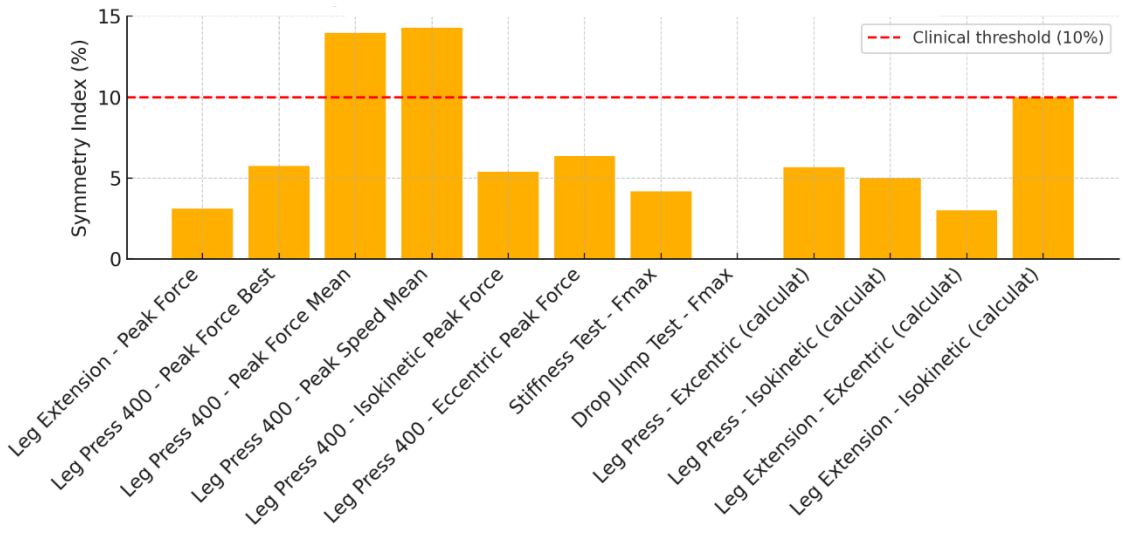

Figure 1. Symmetry Index (%) across all tests.

3. Coefficient of Variation

Table 3 displays the coefficient of variation (CV%) for each paired test. Strength-based parameters such as "Leg Extension – Isokinetic" (CV = 2.24%) showed minimal variability, whereas speed-related tests like "Leg Press – Mean Speed" had higher fluctuations (CV = 10.92%), indicating greater neuromuscular variability in dynamic execution.

Table 3. *Coefficient of Variation (CV%)*

Test	Mean Value	Std Dev	CV %
Leg Extension – Peak Force	9.45	0.21	2.24
Leg Press 400 – Peak Force Best	47.20	1.98	4.19
Leg Press 400 – Peak Force Mean	42.60	4.53	10.62
Leg Press 400 – Peak Speed Mean	0.71	0.08	10.89
Leg Press 400 – Isokinetic Peak Force	102.75	4.03	3.92
Leg Press 400 – Eccentric Peak Force	35.05	1.63	4.64
Stiffness Test – Fmax	188.00	5.66	3.01
Drop Jump Test – Fmax	230.00	0.00	0.00
Leg Press - Excentric (calculat)	109.18	4.50	4.12
Leg Press – Isokinetic (calculat)	103.35	3.75	3.63
Leg Extension – Excentric (calculat)	102.44	2.21	2.15
Leg Extension – Isokinetic (calculat)	98.80	7.35	7.44

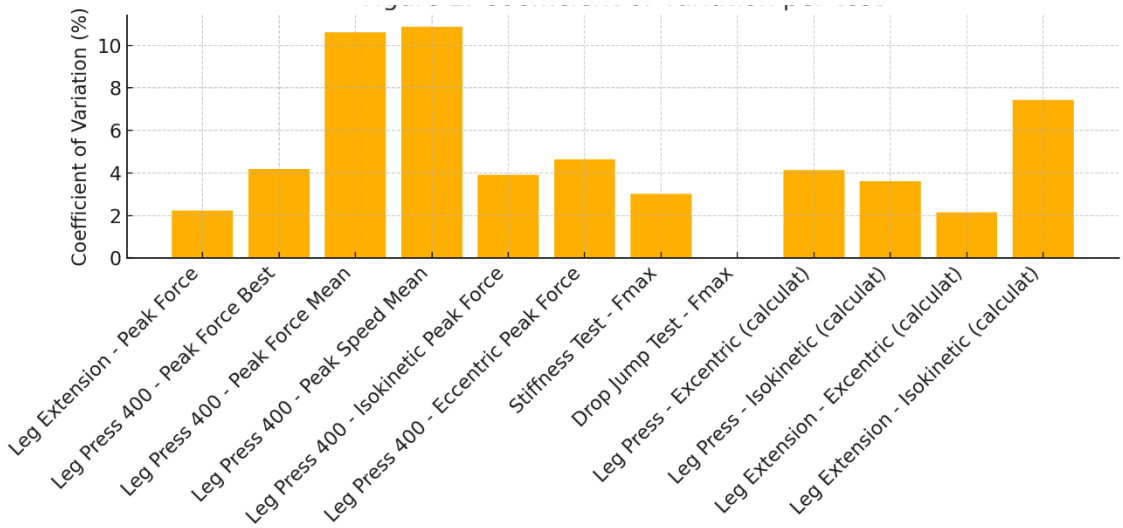

Figure 2. Coefficint of Variation per test.

4. Statistical analysis – Wilcoxon signed-rank test

A Wilcoxon signed-rank test was used to compare paired values. The result was not statistically significant (p = 0.929), indicating that no systematic bilateral performance difference was present.

Table 4. *Wilcoxon signed-rank test – summary of statistical analysis*

Test Name	N pairs	Test Statistic (W)	p-value	Significance (α = 0.05)	Interpretation
Wilcoxon signed-rank test	12	32.0	0.929	Not significant	No statistically significant difference

5. Summary visualization

Figure 3 offers an overall comparison of performance values between limbs across all tests. The general trend shows slightly higher values for the left side, but with minimal clinical or statistical relevance.

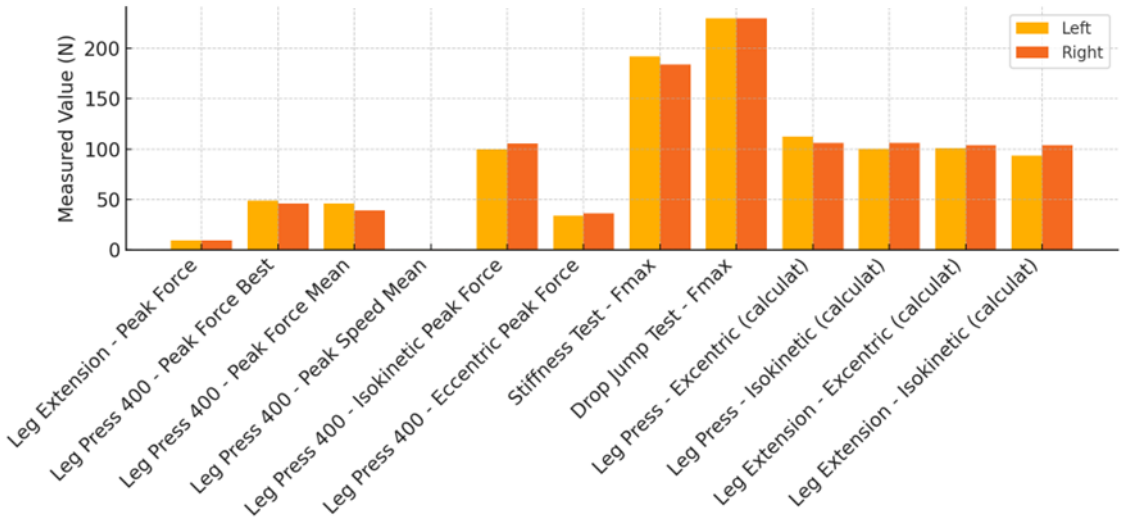

Figure 3. Left vs. Right performance comparison.

Discussion

This case study aimed to evaluate the neuromuscular recovery and bilateral functional performance of a 26-year-old recreational skier and dental professional following ACL reconstruction. The results provide meaningful insight into the patient's functional status at nine months postoperatively, particularly regarding bilateral symmetry, performance variability, and readiness to return to both sport and occupational activity.

Symmetry analysis (Table 2, Figure 1) showed that ten out of twelve assessed parameters had a Symmetry Index (SI%) below the accepted clinical threshold of 10%, which is generally considered

sufficient for return to sport or work [1]. The highest asymmetries were observed in 'Leg Press – Mean Force' (13.94%) and 'Leg Press – Mean Speed' (14.31%), both involving dynamic compound movements that require extensive neuromuscular coordination. These elevated values likely reflect residual neuromotor differences in complex kinetic chains, a common finding in patients during late-stage ACL rehabilitation.

The Coefficient of Variation (Table 3, Figure 2) further supported this interpretation. Strength-focused tasks such as 'Leg Extension – Isokinetic' (CV = 2.24%) and 'Leg Press – Peak Force' (CV = 3.58%) demonstrated high consistency and low variability, suggesting stable output and reliable performance. In contrast, greater variability was evident in speed-dominant tests like 'Leg Press – Mean Speed' (CV = 10.92%), consistent with findings in the literature that associate such fluctuations with incomplete motor pattern stabilization [2,3].

Additionally, absolute and relative inter-limb differences, as shown in Table 1, confirmed the functional observations. For instance, 'Leg Press – Mean Speed' displayed a +16.7% difference in favor of the operated (left) limb. This finding may appear counterintuitive but is frequently observed in ACL patients who subconsciously overcompensate or focus more attention on the previously injured side during maximal testing [4]. Such adaptations, while not inherently negative, must be interpreted cautiously within a broader clinical context.

The Wilcoxon signed-rank test result (Table 4), showing $p = 0.929$, indicated no statistically significant differences between limbs across all parameters. This reinforces the interpretation that the patient achieved a functionally balanced state. Although the absence of statistical significance does not necessarily equate to perfect symmetry, it supports the conclusion that any residual differences fall within clinically acceptable limits [4].

From a clinical perspective, the dual demands of this patient–as both a recreational athlete and a dental practitioner–add complexity to the rehabilitation process. In addition to dynamic control, the patient needed to recover fine postural regulation and orthostatic tolerance, which are critical during long dental procedures. The rehabilitation protocol was designed to reflect these realities, incorporating proprioceptive, stabilometric, and coordination-based exercises to meet both athletic and professional demands [5].

The incorporation of cognitive-motor tasks such as visual feedback drills and dual-task coordination during the final rehabilitation stage aimed to improve sensorimotor integration and decrease re-injury risk. These techniques align with contemporary ACL rehabilitation frameworks, which highlight the importance of central control mechanisms and brain-body coordination for long-term functional outcomes [6].

Taken together, these results support the clinical utility of symmetry indices, variability measures, and performance-based statistical testing as objective criteria in return-to-activity decision-making. This case illustrates how combining biomechanical, statistical, and functional assessments can guide patient-specific rehabilitation planning and contribute to optimal recovery, particularly in active, non-professional individuals.

Conclusions

This case study highlights the clinical relevance of individualized rehabilitation and objective functional testing in monitoring neuromuscular recovery following ACL reconstruction. The patient, a recreational skier and dental professional, demonstrated adequate inter-limb symmetry in most performance indicators, with acceptable variability and no statistically significant asymmetries.

The integration of symmetry index analysis, coefficient of variation, and nonparametric testing provided a comprehensive assessment framework, supporting a return to sport and work under safe and evidence-based conditions. Functional deficits identified in compound, speed-based tasks were minor and interpreted as part of the expected late-phase neuromotor adaptation.

The inclusion of proprioceptive, cognitive-motor, and postural training further contributed to functional balance and joint stability, supporting the dual objective of returning to physical activity and occupational demands.

This case supports the role of quantitative functional testing in decision-making regarding return-to-activity and reinforces the need for protocols tailored not only to sport-specific outcomes but also to professional postural and physical requirements.

Authors' contributions

The authors contributed equally to the creation of the work.

References

Ruedl, G., Kopp, M., & Burtscher, M. (2024). Risk factors of anterior cruciate ligament injuries in alpine skiing: A review. *Medical Science*, 28, e154ms3495. https://www.discoveryjournals.org/medicalscience/current_issue/v28/n154/e154ms3495.pdf

Grooms, D.R., Page, S.J., & Onate, J.A. (2015). Brain activation for knee movement measured days before second anterior cruciate ligament injury: Neuroimaging in musculoskeletal medicine. *Journal of Athletic Training*, 50(10), 1005–1010. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4641538/

Deneweth Zendler, J., LoGiudice, M., Arundale, A.J.H., ...& Logerstedt, D. (2023). Somatosensory changes after ACL injury and reconstruction: A scoping review. *Journal of Orthopaedic Research*, 41(1), 3–13. https://doi.org/10.1002/jor.25374

Buckthorpe, M. (2019). Optimising the late-stage rehabilitation and return-to-sport decision after ACL reconstruction. *Sports Medicine*, 49(7), 1043–1058. https://link.springer.com/article/10.1007/s40279-019-01061-0

Dingenen, B., & Gokeler, A. (2017). Optimization of the return-to-sport paradigm after ACL injury. *Sports Medicine*, 47(8), 1487–1500. https://link.springer.com/article/10.1007/s40279-017-0674-6

Tobias, T., Weber, J., & Logerstedt, D. (2023). Neurocognitive and neuromuscular rehabilitation techniques after ACL injury: Part 1 – Optimizing recovery in the acute post-operative phase: A clinical commentary. *International Journal of Sports Physical Therapy*, 18(1), 76–88. https://ijspt.scholasticahq.com/article/124945

Deneweth Zendler, J., LoGiudice, M., Arundale, A.J.H., ...& Logerstedt, D. (2023). Somatosensory changes after ACL injury and reconstruction: A scoping review. *Journal of Orthopaedic Research*, 41(1), 3–13. https://doi.org/10.1002/jor.25374

Gokeler, A., Dingenen, B., & Hewett, T.E. (2022). Rehabilitation and return to sport testing after anterior cruciate ligament reconstruction: Where are we in 2022? *Arthroscopy, Sports Medicine, and Rehabilitation*, 4(1), e77–e82. https://doi.org/10.1016/j.asmr.2021.10.025

Buckthorpe, M. (2019). Optimising the late-stage rehabilitation and return-to-sport training and testing process after ACL reconstruction. *Sports Medicine*, 49(7), 1043–1058. https://pubmed.ncbi.nlm.nih.gov/31004279/

LaStayo, P.C., Woolf, J.M., Lewek, M.D., Snyder-Mackler, L., Reich, T., & Lindstedt, S.L. (2003). Eccentric muscle contractions: Their contribution to injury, prevention, rehabilitation, and sport. *Journal of Orthopaedic and Sports Physical Therapy*, 33(10), 557–571. https://www.jospt.org/doi/10.2519/jospt.2003.33.10.557

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 168-177
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-24

ONTOGENESIS OF FETAL AND NEWBORN MOVEMENTS: A KINANTHROPOLOGICAL PERSPECTIVE ON OPTIMAL MOTOR DEVELOPMENT

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Abstract. Spontaneous movements represent the first expression of human motor behavior, of the developing central nervous system, reflecting the level of neurological maturation. They have an essential contribution to the organization of neuronal connections and subsequent motor acquisitions.
The first movements appear around the 7th week of gestation and are generated by subcortical neural networks. Professor Christa Einspieler (2004) suggests that the first half of pregnancy is a period of learning and development for most fetal movement patterns, and these continue to develop in the second half of pregnancy and after birth. Motor activity develops as an integrated dynamic system, with fetal movements representing the biological and functional basis of human motor function. They are influenced by genetic, biological and sensory factors, essential for the formation of neural pathways and preparation for extrauterine life. According to current studies and theories, early newborn behaviors follow a continuous adaptive pathway similar to the prenatal motor repertoire of the fetus. Widström and Brimdyr (2011) described nine predictable stages of instinctive behaviors observed during the first hour after birth in undisturbed skin-to-skin contact, enhancing bonding, physiological regulation, and breastfeeding. Bergman (2015) highlights that "the newborn's brain expects to be skin-to-skin after birth," and that postnatal separation acts as a neurodevelopmental stressor.
In preterm infants, this interrupted continuity, abrupt transition to the external environment and an immature nervous system will increase the risk of motor disorders. Dr.Prechtl (2001) stated that "general movements are the most sensitive and specific behavioral markers for predicting later neurological deficits."
From a kinanthropological perspective, these movements are fundamental elements of neuro-motor development, but also early indicators of central nervous system (CNS) maturation. These observations from intrauterine life, but also immediately after birth, may have implications for early assessment and intervention, through the development and application of an integrated model of pediatric kinesiology.

Key words: spontaneous movements, kinanthropology, neuro-motor development, early intervention, motor skills.

Introduction

Movement is the first functional expression of the emerging human being. Previous observations and research have shown that long before birth, as early as intrauterine life in the fluid environment, the fetus initiates its first spontaneous movements. These have been observed sonographically from the

7th week of gestation. Although seemingly purposeless, they show a reflection of the activation and maturation of central neural networks, initially generated by subcortical structures (Prechtl et al., 2001). These movements present a constantly evolving functional repertoire, representing the expression of neuro-motor maturation as well as the biological basis for the newborn's postnatal behaviors.

Over the last decades, numerous studies have demonstrated that these spontaneous fetal movements are not simple reflex reactions, but forms of early motor learning, influenced initially by the intra- and then by the extrauterine environment, essential for the later development of voluntary control (Einspieler et al., 2004). Fetal movement thus becomes an active process, shaped by intrauterine sensory experience, which allows the gradual construction of postnatal regulatory systems - from sucking and breathing to orientation and attachment.

This continuum of motor development, from fetal movements to observable behaviors in the first hours immediately after birth, has been extensively documented by researchers Anne Widström, Kajsa Brimdyr and Katrin Cadwell. The authors have identified a predicted sequence of nine instinctual stages of the healthy newborn infant, carried out exclusively in skin-to-skin contact immediately after birth with the mother's chest (Widström et al., 2011). This staging, which includes: crying at birth, relaxation, awakening, motor activity, crawling, familiarization, sucking, and deep sleep, represents- the faithful reproduction of intrauterine training movements- what the authors call an "imprinted pattern of learned behavior" (Widström et al., 2020).

Dr. Nils Bergman, promoter of the concept of "neurodevelopment centered by direct skin-to-skin contact" (Kangoro Care), emphasizes the idea that "the newborn's brain expects to be on the mother's skin after birth" and that any early separation produces neurobiological stress that affects physiological, motor and emotional regulation. This context of "neurobiological disorganization" disrupts not only autonomic functions, but also the child's ability to display a coherent spontaneous motor repertoire (Bergman, 2015). This perspective is fundamental to understanding how fetal movements prepare the human body for postnatal adaptation, and continuity of contact and movement is key to a healthy transition.

In premature babies, unfortunately this continuity is abruptly interrupted. Preterm birth implies not only an incompletely developed nervous system, but also the absence of the natural context for activating/learning the postnatal motor repertoire. After birth, the preterm infant does not benefit from gentle affective and sensory stimulation, but is often exposed to invasive stimuli, parental separation, and an artificial environment that interferes with spontaneous movements and the development of cortical networks (Cook et al., 2023). These conditions increase the risk of pathological motor patterns and cerebral palsy-like disorders (Ferrari et al., 2002).

Thus, from an integrated perspective, the absence of skin-to-skin contact correlated with reduced quality of spontaneous movements are two important behavioral and physiological indicators of the risks of neuro-motor developmental delay. The application of an assessment model that integrates general movement observation (Einspieler, 2004) and intervention based on sensory contact and affective regulation (Bergman, 2015) may provide an effective direction in early intervention for premature infants.

Early assessment of spontaneous movements, using scientifically validated methods such as General Movements Assessment (GMA), allows early identification of neurological risks. In addition, qualitative scores such as the Motor Optimality Score (MOS) and the AM Adaptation Scale – a proprietary tool developed in-house – provide an integrative picture of the functional and relational adaptation of the newborn. These assessments can guide early physiotherapeutic intervention with a focus on personalization, neuroplasticity and parental involvement in therapy.

Ontogenesis of fetal movements - natural development and neurobiological function

Spontaneous fetal movements occur as an essential manifestation of the activity of the developing central nervous system. The first forms of movement were observed sonographically at around 7 weeks of gestation, in the form of primitive muscle contractions and flexion-extension movements

of the trunk (de Vries et al., 1985). These are self-generated and are not the result of external stimulation representing early activation of subcortical neural networks.

According to Dr. Heinz Prechtl, spontaneous fetal movements are classified into several types, the most relevant of which are:

– general movements,
– sucking and swallowing movements,
– rotational movements of the trunk,
– head and limb movements (Prechtl et al., 2001).

Of these, general movements (GMs) have the greatest impact on the later development of motor control, due to their complexity and variability. They are whole-body, slow-paced, fluid, continuous and unpredictable, reflecting the coordinated activity of developing neural systems.

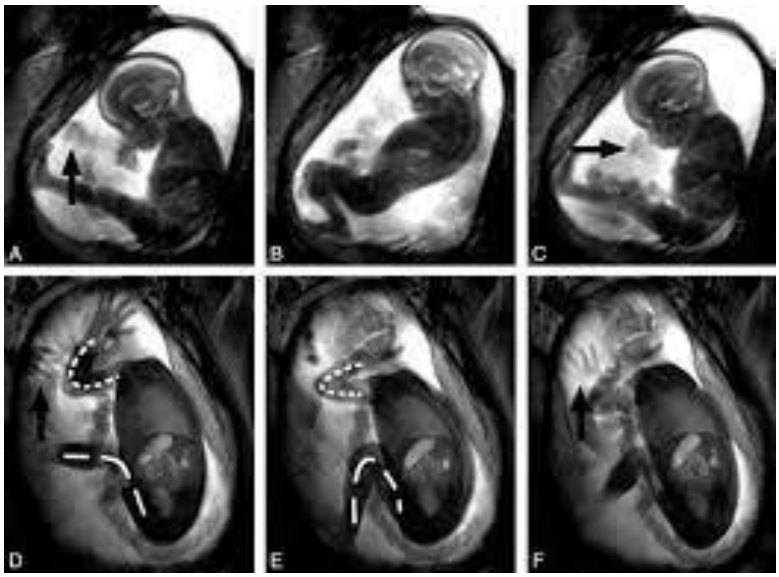

Figure1. Examples from the repertoire of fetal movements at different time intervals (0, 4, 8 seconds), captured by 4D technology - taken from Kurjak et al. (2008).

Following on from these observations, Prof. Christa Einspieler emphasizes that these spontaneous movements not only reflect neurological maturation, but also actively contribute to the development of peripheral and central structures of the nervous system. She emphasizes that in cases of developing brain dysfunction, fetal general movements change their sequence and shape, suggesting a dysfunction of the developing nervous system. Thus, qualitative assessment of these movements may provide early clues about the neurological integrity of the fetus (Einspieler et al., 2021). According to research by Einspieler, Marschik and Prechtl (2004), the ontogenesis of fetal movements can be divided into four broad periods:

– Weeks 7–9: the first trunk contractions and 'startle movements' – short, rapid, involving the limbs and trunk simultaneously – occur. These reflect early activation of primitive motor pathways (de Vries, Visser, & Prechtl, 1985; Einspieler & Prechtl, 2004).
– Weeks 9–12: General movements (GMs) develop, characterized by synchronized involvement of the whole body, with a natural sequence of head, trunk and limb movements. Also at this time, sucking, swallowing, simulations of breathing movements and the first facial movements appear (Einspieler et al., 2004; Kurjak et al., 2010).

- Weeks 13–20: Movements become more varied and rhythmic, including fine flexion-extension of the limbs, isolated movements of the hands and feet, touching the face or uterine wall. The predictable and systematic cranio-caudal order of fetal movement development, essential for the maturation of neuromotor control, is observed (Yigiter & Kavak, 2006).
- Weeks 20–38: Adaptation occurs in the shrinking intrauterine space: motor patterns stabilize, well differentiated sleep-wake periods occur and movements become more efficient. Facial movements – smiling, grimacing, thumb sucking – are a reflection of higher cortical organization (Mirmiran et al., 2003).

Spontaneous movements are not only indicators of neurological integrity, but fulfill fundamental biological and cognitive functions:

- Joint shaping and muscle development – through active movement, the fetus maintains muscle tone and prevents postural malformations.
- Stimulation of the vestibular and somatosensory system – through movements in the amniotic fluid, the fetus develops body awareness (proprioception).
- Creation of synaptic networks – the repetition of movements contributes to the formation of neuronal connections necessary for postnatal motor control (Einspieler & Prechtl, 2005).
- Preparation for the extrauterine transition – sucking, swallowing, rhythmic breathing and cranio-caudal orientation movements are directly correlated with postnatal behavioral milestones.
- According to Widström et al. (2020), these movements constitute a "learned motor script", which will be reactivated in the first hours after birth, under conditions of adequate sensory, skin-to-skin contact with the mother.

From the perspective of neonatal physiotherapy and kinanthropology, understanding these stages is essential. Spontaneous fetal movements provide valuable information about the functioning of the nervous system in the early stages and allow prediction of neurological risks even before overt clinical signs appear. Qualitative assessment of these movements, correlated with the gestational history and birth conditions, is a basic component in the formulation of an individualized therapeutic plan.

Postnatal motor behavior - a reflex of intrauterine training

Birth does not mark the beginning of motor development, but a transition from an intrauterine training space to a new, extrauterine environment, where the acquired motor repertoire is functionally reactivated. In this logic, the motor behaviors observed in the first hours after birth are not completely new, but the result of a precise continuity supported by fetal learning (Einspieler et al., 2004).

Research led by Ann-Marie Widström, together with Kajsa Brimdyr, Karin Cadwell and other collaborators (Widström et al., 2011; 2020) has for the first time systematically described the existence of nine instinctive behavioral stages of the newborn in skin-to-skin contact with the mother in the first hour of life. These include: crying at birth, relaxation, awakening, motor activity, resting, crawling, familiarization, sucking, and deep sleep (Widström et al., 2011; 2020).

Figure 2. Stages of skin-to-skin contact, photo credit, ProMAMA Association.

Each of these behavioral stages reflects movement patterns acquired in intrauterine life and do not occur spontaneously under all conditions. They are activated only in the presence of skin-to-skin contact immediately after birth, which provides the sensory stimuli (warmth, smell, touch, voice) necessary to reactivate learned motor pathways (Widström et al., 2011; Moore et al., 2016).

Tabel 1. Correlations between early postnatal behaviors and spontaneous fetal motor patterns

Postnatal behavioral stage	Correspondence in the repertoire of spontaneous fetal movements	Estimated gestational age	Mecanism neuro-motor	Postnatal activation
The initial cry	Fetal startle reflex	≈ 9 weeks.	Sudden motor activation, respiratory integration	Activate by touch and mom's voice
Waking up and activity	General Movements (GMs)	9-12 weeks	Trunk-head-limb coordination, sensory integration	Activation by touch, mom's voice and eye contact
Crawling to the breast	Alternating lower limb movements	≈ 11 weeks	Primitive locomotor pattern, automatic walking reflex	Ventral activation on the mother
Sucking and swallowing	Fetal sucking and swallowing	12–13 weeks	Suck-breathe-swallow coordination	Stimulated by skin contact and breast odor
Nipple familiarization	Sensory recognition through smell and taste	> 20 weeks	Prenatal sensory imprinting based on the scent of amniotic fluid	Reactivation through the smell and taste of the skin/nipple

According to the model proposed by Bergman (2015), the human brain is programmed to continue development after birth in direct contact with the mother's body. Separation of the mother from the newborn immediately after birth disrupts this process, inducing a stress response that impairs autonomic regulation and adaptive behavioral display. Skin-to-skin contact, in contrast, favors:

– stabilization of vital functions (breathing, heart rate, thermoregulation);
– activation of subcortical networks involved in movement and attachment;
– the synchronization of affective and sensory interaction (Bergman, 2015).

In conclusion, movement is not just a motor act, but becomes a means of integrative communication, a form of self-regulation, exploration, connection and attachment with the parent.

The stages that a newborn baby exhibits immediately after birth follow a logical evolutionary sequence. For example, initial motor activity (stage 4) prepares for crawling (stage 6) and oral familiarization (stage 7) anticipates sucking (stage 8). Through this sequentiality, it has been hypothesized that the newborn is retracing a prenatally learned neurological pathway – what Widström, Brimdyr and Cadwell refer to as the "imprinted behavior pathway" (Widström et al, 2020). The importance of these steps are not just theorized, but have immediate observable physiological consequences: the infant's massaging of the uterus during crawling favors expulsion of the placenta, and sucking triggers oxytocin release, with effects on lactation and attachment (Matthiesen et al., 2001).

Fetal movements and postnatal motor behavior are two factors of the same developmental process, linked through sensory memory, motor learning, and neurophysiological activation. Only in the presence of affective and sensory continuity (skin-to-skin contact) is the newborn able to reactivate the motor repertoire acquired prenatally. This view shifts the paradigm of postnatal motor assessment, providing a scientific basis for early intervention strategies centered on the child and parent.

Prematurity – a discontinuity in motor and emotional development

Preterm birth abruptly disrupts the natural process of motor and affective development by transitioning from the intrauterine environment into a strong, hostile and disorganized sensory environment, such that lack of immediate maternal contact and exposure to neonatal stress can adversely affect movement organization and behavioral regulation (Bergman, 2015).

Figure 3. General cramp-synchronized movements in a premature newborn (34 weeks GA) – clinical observation in dorsal position according to the GMA method.

Atypical spontaneous movements of preterm infants (cramped-synchronized, poor repertoire) are correlated with an increased risk of cerebral palsy, observable early by General Movement Assessment (Einspieler et al., 2004; Ferrari et al., 2002). fragmented and slow expressions of postnatal instinctive stages can also be observed, being dependent on sensory and relational support (Widström et al., 2020).

Care focusing on skin-to-skin contact (Kangoroo care), physiological positioning and gentle intervention tailored to early neuroplasticity may enable behavioral reorganization. An early approach through qualitative assessment and stimulation can facilitate movement recovery and support restoration of developmental continuity (Adde & Einspieler, 2023).

Synchronous tonic contraction of the limbs and trunk is observed, with lack of motor variation, indicating a pathologic pattern of spontaneous movement.

Assessment of fetal movements

Early motor development, rooted in intrauterine life, provides an essential window into the organization and functioning of the central nervous system. In this context, qualitative assessment of the spontaneous movements of the newborn becomes a valuable method to understand the continuity between fetal motor ontogenesis and postnatal behavior. In the first months of life, when neurological plasticity is maximal, observing how the infant moves spontaneously – without external stimulation – reflects the level of integration and maturation of central neural networks (Prechtl et al., 2001).The General Movements Assessment (GMA), a method developed by Heinz Prechtl and consolidated by Einspieler, allows the identification of normal and pathological movement patterns, such as fidgety movements or cramped-synchronized patterns, providing an early prediction of the risk of cerebral palsy or other motor disorders (Einspieler et al., 2004; Ferrari et al., 2002). This qualitative observation is performed between 0–20 corrected weeks and captures the variability, complexity and fluidity of the infant's general movements.

From the GMA is derived the Motor Optimality Score (MOS), a standardized method that more precisely quantifies the quality of spontaneous motor skills in five key domains: presence of fidgety movements, posture, reactivity, transitivity, and variation (Einspieler et al., 2016).

Figure 4. Evaluation position of spontaneous movements in the infant - analysis sequence according to the Prechtl method, in the period of writhing movements.

Spontaneous positioning of the upper and lower limbs is observed, with symmetric postural variation and global spontaneous mobility.

Personalized early intervention

In preterm infants, the natural continuity of motor development is abruptly interrupted by preterm birth, exposing the immature nervous system to an often invasive, stressful and inappropriate extrauterine environment for sensory-motor maturation. For this reason, early intervention is no longer just a therapeutic option, but an essential necessity to support neuromotor development and prevent functional disability (Adde & Einspieler, 2023). Based on the GMA, MOS scores, which allow an integrated assessment of spontaneous movement and behavioral adaptation, a personalized physiotherapeutic model is outlined, in which each intervention is adjusted according to the child's level of neurological maturity and individual response. This model follows the principles formulated by Prechtl, Einspieler and Ferrari: non-invasiveness, gentle stimulation, synchronization with the child's condition and gradual activation of the prenatal motor repertoire (Einspieler et al., 2005). The central element of this model, skin-to-skin contact (KMC), is supported by Bergman's (2015) research that restores the biological and behavioral connection between infant and mother, stimulating spontaneous movements and autonomic regulation.

A fundamental aspect is the active involvement of parents, who are not just bystanders but co-therapists. They are supported to participate in gentle stimulation, positioning, synchronized feeding and interpretation of the baby's nonverbal signals. This approach not only supports motor development, but also strengthens the attachment relationship, reduces stress and increases the effectiveness of the intervention (Brimdyr et al., 2013).

In conclusion, the proposed early intervention supports the continuity of motor development by activating neuro-motor pathways acquired in utero. Spontaneous movement is thus not only an object of assessment, but becomes a fundamental therapeutic tool for neurological reorganization, behavioral adaptation and prevention of developmental disorders.

Figure 5. Skin-to-skin contact (Kangaroo Care) (Source: Penn State Health Children's Hospital, Facebook, May 15, 2025).

Conclusions

Infant motor development begins in the intrauterine period with spontaneous self-generated movements that reflect the progressive activation of the central nervous system. These patterns are not random reactions, but manifestations of an early neuromotor organization that prepares the

organism for adaptation to extrauterine life (Prechtl et al., 2001; Einspieler et al., The continuity between fetal movements and spontaneous behaviors of the newborn - especially under skin-to-skin contact – confirms the existence of a prenatally formed sensory and motor memory (Prechtl et al., 2001; Widström et al., 2020).

In premature birth, this continuity is abruptly interrupted, which increases the risk of motor, affective and cognitive impairments. Early exposure to an artificial sensory environment, lacking the physiological regulation provided by the maternal body, can lead to abnormal motor patterns and self-regulatory difficulties (Einspieler & Prechtl, 2005; Bergman, 2015). Qualitative assessment of spontaneous movements and observation of the infant's response to affective stimulation thus become essential for early identification of risks and targeting appropriate interventions.

Furthermore, the prenatal period also plays a very important role in neuromotor development. The healthiest possible maternal lifestyle - including balanced nutrition, stress reduction, moderate physical activity and affective bonding with the fetus, rest – contributes directly to the formation of neural networks, the quality of fetal movements and postnatal adaptive capacity (Kurjak et al., 2010; Lagercrantz, 2016).

In conclusion, spontaneous movement – from intrauterine life and immediately after birth - is a fundamental indicator of neurological maturation and developmental potential. Ensuring continuity between these stages, through early assessment, sensory and relational support, is an essential prerequisite for optimizing child development, especially in preterm infants.

Authors' contributions

All authors listed have made a substantial, direct, and intellectual equal contribution to the work and approved it for publication.

References

Adde, L., & Einspieler, C. (2023). *General movements: A window for early identification of children at risk of developmental disorders*. Early Human Development, 174, 105719. https://doi.org/10.1016/j.earlhumdev.2022.105719

Bergman, N. J. (2015). The neuroscience of birth – and the case for zero separation. *Curationis*, 38(2), a1491. https://doi.org/10.4102/curationis.v38i2.1491

Bergman, N., & Bergman, T. (2013). Whose choice? Advocating birthing practices according to baby's biological needs. *The Journal of Perinatal Education*, 22(1), 8–13. https://doi.org/10.1891/1058-1243.22.1.8

Brimdyr, K., Cadwell, K., Widström, A. M., Svensson, K., Neumann, M., Hart, E. A., & Phillips, R. (2013). The nine stages of skin-to-skin: Practical guidelines and insights from four countries. *Maternal & Child Nutrition*, 9(4), 544–558. https://doi.org/10.1111/mcn.12068

Cook, C., Murphy, C., Sweeney, J., & Holton, T. (2023). Neurodevelopmental care in the NICU: Evidence-based interventions for promoting infant outcomes. *Infant Behavior and Development*, 72, 101817. https://doi.org/10.1016/j.infbeh.2023.101817

Einspieler, C., & Prechtl, H. F. R. (2005). Prechtl's assessment of general movements: A diagnostic tool for the functional assessment of the young nervous system. *Mental Retardation and Developmental Disabilities Research Reviews*, 11(1), 61–67. https://doi.org/10.1002/mrdd.20051

Einspieler, C., Marschik, P. B., Bos, A. F., Ferrari, F., Cioni, G., & Prechtl, H. F. R. (2004). *Prechtl's method on the qualitative assessment of general movements in preterm, term and young infants*. Mac Keith Press.

Einspieler, C., Bos, A. F., Ferrari, F., Cioni, G., & Prechtl, H. F. R. (2016). The Motor Optimality Score–An instrument for early prediction of cerebral palsy. *Clinical Neurophysiology*, 127(2), 197–203. https://doi.org/10.1016/j.clinph.2015.06.003

Ferrari, F., Cioni, G., Einspieler, C., Roversi, M. F., Bos, A. F., & Paolicelli, P. B. (2002). Cramped synchronized general movements in preterm infants as an early marker for cerebral palsy. *Developmental Medicine & Child Neurology*, 44(9), 556–560. https://doi.org/10.1017/S0012162201002597

Kurjak, A., et al. (2010). The neurological evaluation of the fetus and the newborn using 4D ultrasonography. *Journal of Perinatal Medicine*, 38(1), 77–87. https://doi.org/10.1515/JPM.2010.011

Lagercrantz, H. (2016). *The Newborn Brain: Neuroscience and Clinical Applications* (2nd ed.). Cambridge University Press.

Matthiesen, A. S., Ransjö-Arvidson, A. B., Nissen, E., & Uvnäs-Moberg, K. (2001). Postpartum maternal oxytocin release by newborns: Effects of infant hand massage and suckling. *Birth*, 28(1), 13–19. https://doi.org/10.1046/j.1523-536x.2001.00013.x

Moore, E. R., Bergman, N., Anderson, G. C., & Medley, N. (2016). Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database of Systematic Reviews*, 11, CD003519. https://doi.org/10.1002/14651858.CD003519.pub4

Penn State Health Children's Hospital. (2025, May 15). *Today is National Kangaroo Care Day – a time to celebrate the power of skin-to-skin contact...* [Postare Facebook cu imagine]. https://www.facebook.com/100066362026866/posts/1014450900776968/

Porter, R. H., & Winberg, J. (1999). Unique salience of maternal breast odors for newborn infants. *Neuroscience & Biobehavioral Reviews*, 23(3), 439–449. https://doi.org/10.1016/S0149-7634(98)00043-8

Prechtl, H. F. R., Einspieler, C., Cioni, G., Bos, A. F., Ferrari, F., & Sontheimer, D. (2001). An early marker for neurological deficits after perinatal brain lesions. *The Lancet*, 357(9268), 1377–1381. https://doi.org/10.1016/S0140-6736(00)04582-7

Widström, A. M., Brimdyr, K., Svensson, K., Cadwell, K., Nissen, E., & Ransjö-Arvidson, A. B. (2011). Skin-to-skin contact the first hour after birth: A theoretical model. *Journal of Midwifery & Women's Health*, 56(5), 420–428. https://doi.org/10.1111/j.1542-2011.2011.00040.x

Widström, A. M., Brimdyr, K., Svensson, K., Cadwell, K., & Nissen, E. (2020). The 9 stages of newborn instinctive behavior: A guide for skin-to-skin contact after birth. *Midwifery*, 85, 102657. https://doi.org/10.1016/j.midw.2020.102657

Yigiter, M., & Kavak, Z. N. (2006). Assessment of fetal movements: Clinical significance and future directions. *Perinatal Journal*, 14(2), 65–72.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 178-184
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-25

EFFECTS OF LONG-TERM TENNIS PRACTICE ON BONE MASS AND SPINAL ALIGNMENT

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Abstract. This study examined the effects of prolonged tennis practice on bone mass and spinal alignment in professional and semi-professional athletes. Tennis is a high-impact, asymmetrical sport that may influence skeletal development and posture, particularly in adolescents and young adults engaged in long-term training.
Background. Participation in weight-bearing sports is known to increase bone density and improve bone health. However, repetitive, unilateral movements, common in asymmetrical sports like tennis, can lead to muscular imbalances, which may contribute to postural deviations or spinal misalignments.
Objectives. There is limited research on how long-term tennis practice affects spinal alignment, particularly among non-professional athletes. This study aims to evaluate differences in spinal alignment among tennis players, investigate whether the duration of tennis practice correlates with specific musculoskeletal adaptations, and explore potential strategies to prevent or mitigate postural imbalances and structural spinal deformities.
Methods. A survey-based observational study was conducted involving 30 participants of various ages. The survey included questions about training intensity, the age participants began practicing tennis, duration of practice, as well as self-reported structural conditions, with a particular focus on scoliosis tendencies.
Results. Of the 30 respondents, all currently practicing tennis, 13 individuals (43.3%) acknowledged having scoliosis tendencies, while 10 individuals (33.3%) reported experiencing back pain. Notably, two participants were clinically diagnosed with scoliotic posture, both having trained professionally for over a decade. Additionally, one individual, who practiced tennis for over 40 years, reported having intervertebral disc herniation. Although the sample size was limited, these findings suggest a potential link between repetitive unilateral physical activity and the development of postural asymmetries or structural spinal conditions.
Conclusion. Long-term tennis practice is known to enhance bone mass, contributing positively to skeletal health. Nonetheless, it may also lead to asymmetrical spinal adaptations, likely influenced by uneven muscle development and imbalances caused by repetitive unilateral movements. These muscular asymmetries can exert uneven forces on the spine, potentially contributing to postural deviations, highlighting the importance of preventive physiotherapy, kinesiotherapy, and balanced training programs aimed at supporting muscular symmetry and maintaining spinal health.

Keywords: tennis, spinal alignment, posture, scoliosis, bone mass.

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Introduction

Tennis is a popular, high-intensity sport that combines fast movements with repetitive, unilateral strokes such as the forehand, backhand, and serve. Like many other asymmetrical sports, tennis has been linked to concerns about its possible impact on spinal alignment, particularly in athletes who begin training at a young age and continue to train intensively for many years.

Some studies have shown that prolonged tennis practice significantly increases bone mineralization. This illustrates the benefits of weight-bearing and impact sports during growth and throughout adulthood, promoting bone mass and reducing injury risks (Ducher et al., 2006). Studies indicate that tennis promotes musculoskeletal health (Jackson et al., 2020), and according to Rachel Tavel (2023), tennis stimulates bone-forming cells, enhances coordination and balance, and increases muscular mass in both the upper and lower body, all of which serve to maintain the bones.

Fewer studies have investigated how tennis' asymmetrical and repetitive character affects spinal curvature and posture. Tennis players may experience shoulder depression (Priest and Nagel, 1976) and postural deviations as a result of their reliance on dominant-side motions, which can eventually lead to more significant spine modifications, such as scoliosis or scoliotic posture. Previous findings suggest that young tennis players tend to develop increased muscle mass in the dominant upper limbs, resulting in noticeable asymmetry in muscle mass distribution (Szymanik et al., 2013).

This study aims to look at the potential link between long-term tennis practice and its impact on spinal alignment, with specific emphasis on scoliosis attitude and tendencies. It seeks to broaden existing understanding on the subject by evaluating professional, semi-professional, and long-term amateur players. Our study also emphasizes the significance of taking preventive measures to reduce any postural imbalances caused by the asymmetric nature of tennis.

Background

Scoliotic posture is defined as the tendency of the spinal axis to deviate from a straight line, which is associated with poor postural habits (Wilczyński and Habik-Tatarowska, 2022). In contrast to scoliosis, scoliotic attitude is a temporary and reversible spinal condition in which the vertebrae do not rotate and the deviation can be corrected by adjusting the body position (Joy, "Scoliosis: Identifying and treating"). Scoliotic tendency is a broader term that suggests a predisposition towards developing a lateral curvature.

Repetitive overhand motions in tennis, such as serving and smashing, can cause muscle imbalances and strain in the rotator cuff and adjacent tissues. Priest and Nagel's (1976) foundational study identified the shoulder as a particularly vulnerable area due to the sport's asymmetrical and high-speed demands. Specifically, shoulder depression resulting from these repetitive actions can lead to relative abduction, increasing the risk of rotator cuff impingement. Over time, persistent shoulder droop may contribute to thoracic outlet syndrome and may even mimic spinal deformities such as scoliosis in athletes.

The human spine provides support, allows movement and protects the spinal cord, while a complex system of muscles supports and moves the spine. The superficial back muscles, such as the trapezius and latissimus dorsi, are primarily responsible for moving the arms and shoulder, as well as improving breathing and posture. In contrast, deep intrinsic muscles, such as the erector spinae, including longissimus thoracic, run vertically along the spine, controlling its mobility and stability. These muscles help maintain upright posture, enable extension and lateral bending, and evenly distribute weight along the natural spinal curves. Weakness or injury in this group can lead to back pain, poor posture, and increased injury risk (Stitzel, 2025).

Muscle imbalances, where some muscles are stronger than others, can disturb the spinal stability and lead to scoliosis. *„The lumbar spine supports the weight of the upper body and is especially*

prone to these imbalances. If the muscles on one side are much stronger than the other side, they can pull the spine out of place.", says Stitzel. Over time, these muscle imbalances can worsen existing spinal curves or create new ones, while also reducing the spine's ability to absorb shock and distribute weight evenly.

Sanchis-Moysi et al. (2012) investigated muscle volume in prepubertal tennis players and discovered considerable hypertrophy of the dominant arm muscles relative to the non-dominant arm. Tennis players showed a 13% increase in muscle volume in their dominant arm. These findings highlight that early and consistent tennis practice causes significant unilateral muscle development, perhaps paving the way for muscular imbalances that impact spinal posture. Given that tennis requires repetitive, asymmetrical loading patterns from a young age, the muscular adaptations generate prolonged uneven stress on the spine, thus raising the likelihood of postural asymmetries or spinal abnormalities, such as scoliosis.

However, not all asymmetrical strokes have exclusively negative consequences. For example, performing two-handed backhand strokes has been shown to increase bone mineral content and density in the non-dominant arm, lumbar region, and hips, suggesting a potential benefit for maintaining bone health (Wang et al., 2021). Recognizing these musculoskeletal adaptations is essential for developing strategies that both enhance performance and protect spinal health in tennis players of all ages.

Research hypothesis

The asymmetrical and repetitive nature of tennis leads to muscular imbalances that may correlate with measurable deviations in spinal alignment among players, such as scoliotic posture, attitude and tendencies.

Methods

This study collected data through a survey distributed to a randomly selected sample of 30 active tennis players, representing a varied range of ages and experience levels. Participants were recruited by distributing the survey link to clients of a professional tennis coach. The survey collected data on:

- Status as a professional or amateur player
- Total years of tennis practice
- History of back pain
- Age at which tennis practice began
- Self-reported or clinically diagnosed postural conditions (see *Annex 1.*)

Participants reported scoliosis tendencies, and clinical diagnoses (where applicable) were noted for context. Although not all respondents had access to professional spinal imaging, self-reporting was supplemented by in-clinic assessments for a subset of respondents.

Annex 1. The questionnaire

1.	Do you play tennis at a professional (competitive) level? Yes/No
2.	How long have you been playing tennis?
3.	Do you frequently experience lower back pain?
4.	At what age did you start playing tennis?
5.	Do you have scoliotic tendencies? Yes/No

Results

Out of the 30 participants, 83% classified as amateur athletes, with 17% stating professional experience. Participants reported varying levels of tennis experience, ranging from less than 6 months to 46 years. The average length of tennis practice was about 12.4 years, but this was influenced by a few people with more than 30 years of expertise. A high percentage of responders (70%) have between 1 and 15 years of experience. Regarding the age players began practicing tennis, some started as early as 5 years old, with starting ages ranging from childhood (5–8 years old) to adulthood (over 40 years). The average reported starting age was approximately 18.9 years, again influenced by a few late starters.

In terms of spinal health, 43.33% of participants reported having scoliotic tendencies, while 10% had received a clinical diagnosis of spinal issues. Back pain was reported by 33% of respondents (Fig. 1). Notably, two participants diagnosed with scoliotic attitude had trained professionally for over a decade (Fig. 2). Additionally, one respondent with more than 40 years of tennis experience reported a diagnosis of intervertebral disc herniation.

These findings suggest a potential association between long-term tennis training and the development of postural or structural spinal deviations, especially among individuals who started training at a young age or pursued intensive practice over many years.

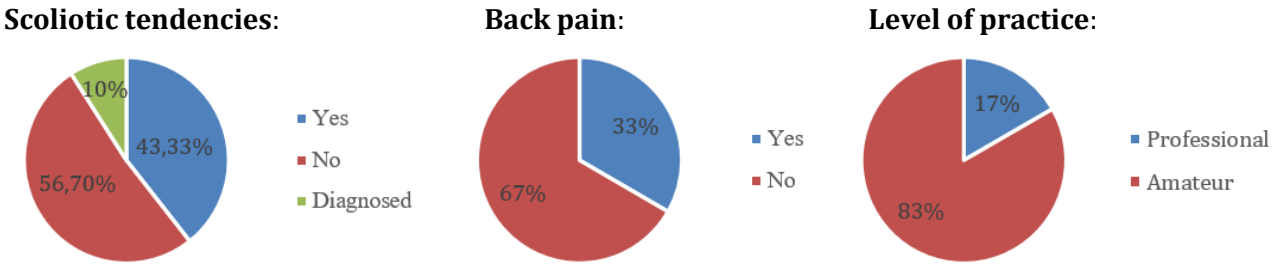

Figure 1. Prevalence of Scoliotic Tendencies, Diagnosed Spinal Conditions, Back Pain, and Player Experience.

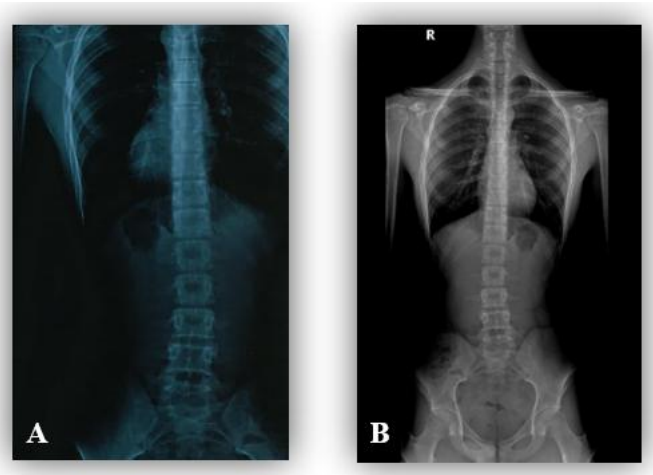

Figure 2. Radiographic images of 16-year-old female (A) and 14-year-old (B) tennis players.

It is important to note that this survey was limited to the analysis of scoliotic attitude, a postural tendency characterized by a lateral inclination of the spine, rather than structural scoliosis. As Barghini explained, scoliotic attitude may be caused by poor posture and not by true spinal deformities.

However, this study had several limitations. The small sample size limits how widely the results can be applied to other populations, and there was a lack of imaging or clinical diagnostic confirmation to definitively assess the condition of the participants' spine.

Future research should include a larger and more diverse sample, as well as incorporate clinical assessments and imaging such as X-rays and scans, so that we can provide meaningful data. This would allow a more accurate distinction between postural attitudes and clinically diagnosed scoliosis.

Discussions and suggestions

The spine plays a crucial role in everyday movements, as well as in tennis practice, being the most important component of the locomotor system. As Baciu (1967) described, the spine is a highly complex and functionally significant structure. According to Reinberg, more than 730 muscles act upon the spine. Understanding the anatomical and functional details of the spine is essential for accurately assessing physical demands during ongoing tennis practice, allowing careful selection and regulation of physical training methods to avoid overuse, imbalances, or injury (Moise, 2011).

The presence of spinal curvatures that deviate from normal alignment in tennis players, often resulting from modern tennis techniques, must be closely monitored to ensure early identification. These curvatures, which contribute to abnormal postural patterns, should be addressed, as they can negatively impact both overall body function and athletic performance. The physical demands of tennis can lead to abnormal curves in the spine, which must be corrected through targeted compensatory exercises (Moise, 2011). This concern can further be supported by research highlighting how tennis affects spinal health.

For instance, Gallotta et al. (2015) investigated the acute effects of different tennis training sessions on the thoracic and lumbar spine of adult players. The study discovered that tennis training can cause acute alterations in spinal posture, particularly in the dorsal and lumbar regions, highlighting the vulnerability of the spine to the sport's asymmetrical and high-impact demands. These findings emphasize the importance of preventive therapies, such as kinesiotherapy and physiotherapy, for the spinal health of tennis players.

While some studies, such as Zaina et al. (2016), suggest that there is no conclusive evidence linking tennis to spinal misalignments or an increased risk of scoliotic posture, the potential impact of the repetitive unilateral movements of tennis on spinal health warrants further attention. This study aimed to underscore the importance of preventive strategies that address the possible musculoskeletal imbalances before they develop into more serious conditions. Drawing an observation from clinical experience with tennis players affected by scoliosis, this research advocated for the implementation of targeted exercise programs. These should focus on strengthening postural muscles, enhancing spinal flexibility, and correcting muscular asymmetries to support proper spinal alignment, promote physical well-being, and potentially reduce the risk of postural deviations.

According to Nair (2023), physiotherapy plays a crucial role for tennis players by assessing musculoskeletal health, joint mobility, strength, flexibility and coordination. Physiotherapists can design personalized training programs that address the player's specific needs, whether it is strengthening weak muscles, improving mobility or correcting faulty movement patterns. Incorporating such preventive strategies help reduce likelihood of injury and improve overall athletic performance and spinal health.

Beyond muscular and postural considerations, it is also essential to account for the role of intervertebral discs in maintaining spinal health during tennis activity. The intervertebral discs serve multiple essential functions (Baciu, 1967). They help maintain spinal curvatures, restore balance

after movement, distribute body weight across different spinal segments, and absorb shocks experienced during motion. The nucleus pulposus, the central gelatinous core of the intervertebral disc, provides the disc with its elasticity. Although resistant to compression, it deforms under pressure, distributing mechanical forces evenly in all directions. This elasticity makes the spinal movements possible while also mitigating the harmful effects of excessive pressure or sudden shocks (Moise, 2011).

However, these protective mechanisms can be overwhelmed by the repetitive and high-impact demands of tennis. Hainline has stated in the article "Low Back Injury" (2020) that tennis players may sustain low back injuries as a result of large, recurrent momentum in axial rotation, combined with the hyperextension created during play. Furthermore, other studies have noted that the repetitive motion of tennis swings, integrated with hyperextension and eccentric rotation of the spine, can contribute to the development of Repetitive Traumatic Discopathy (RTD), which in some cases may progress to disc herniations (Fiani et al., 2020). These insights highlight the importance of considering muscular, spinal and intervertebral disc health when designing preventive and rehabilitative strategies for tennis players.

Conclusions

This study highlights the complex relationship between long-term tennis practice and spinal health. On one hand, tennis offers well-documented benefits to bone mass and overall musculoskeletal development, as well as improvements in muscular strength, coordination and cardiovascular health. On the other hand, the muscular imbalances that arise due to the repetitive, unilateral nature of tennis may have a negative impact on players' posture over time. The relatively high percentage of participants reporting scoliotic tendencies and back pain, especially among those with many years of practice, suggests a potential link between intensive, asymmetrical training and postural deviations. This observation is consistent with existing scientific literature that demonstrates the impact tennis has over spinal alignment and musculoskeletal imbalances.

Although our findings are limited by sample size and the reliance on self-reported data, they complement existing research. Our results underscore the need for awareness around the postural risks associated with asymmetrical sports such as tennis. Preventive measures, including physiotherapy, kinesiotherapy, and balanced training programs, should be considered essential.

Future research should aim to involve larger, more diverse participant groups and incorporate clinical imaging to more accurately distinguish between functional postural adaptations and structural spinal deformities. By deepening our understanding of how tennis influences spinal health, we can better support athletes' well-being and promote safer long-term engagement with tennis.

Conflict of interests

The authors declare no conflict of interests.

Acknowledgment

We would like to thank the participating athletes and coach Romulus for their time and contribution to this study.

Authors' contributions

Maria-Alexandra Stavrache and Alexandra Sandu collaboratively designed and developed the study. Maria-Alexandra Stavrache made the survey, collected data and wrote the manuscript. Alexandra

Sandu contributed to the literature review, data interpretation, and co-writing of the manuscript. Dan-George Moise provided supervision throughout the research process, supported access to key resources, and contributed to the review of the final manuscript. All authors reviewed and approved the final version of the paper.

References

Brian Hainline. (2020). Low Back Injury, Clinics in Sports Medicine, Volume 14, Issue 1, 1995, Pages 241–265, ISSN 0278-5919, https://doi.org/10.1016/S0278-5919(20)30267-2

Ducher, G., Tournaire, N., Meddahi-Pellé, A., Benhamou, C. L., & Courteix, D. (2006). Short-term and long-term site-specific effects of tennis playing on trabecular and cortical bone at the distal radius. *Journal of bone and mineral metabolism*, *24*(6), 484–490. https://doi.org/10.1007/s00774-006-0710-3

Fiani, B., Jarrah, R., Wong, A., Alamah, A., & Runnels, J. (2020). Repetitive Traumatic Discopathy in the Modern-Era Tennis Player. *Cureus*, *12*(8), e9783. https://doi.org/10.7759/cureus.9783

Gallotta, M. C., Bonavolontà, V., Emerenziani, G. P., Franciosi, E., Tito, A., Guidetti, L., & Baldari, C. (2014). Acute effects of two different tennis sessions on dorsal and lumbar spine of adult players. Journal of Sports Sciences, 33(11), 1173–1181. https://doi.org/10.1080/02640414.2014.987157

Jackson, M. J., Roche, D. M., Amirabdollahian, F., Koehn, S., & Khaiyat, O. A. (2020). The Musculoskeletal Health Benefits of Tennis. *Sports health*, *12*(1), 80–87. https://doi.org/10.1177/1941738119880862

Priest, J. D., & Nagel, D. A. (1976). Tennis shoulder. *The American journal of sports medicine*, *4*(1), 28–42.

Moise, D. G. (2011). Pregătirea fizică : factorul de modernizare al tenisului de performanţă. Giurgiu : Editură pentru sport, p 214–216

Sanchis-Moysi, J., Idoate, F., Serrano-Sanchez, J. A., Dorado, C., & Calbet, J. A. (2012). Muscle hypertrophy in prepubescent tennis players: a segmentation MRI study. *PloS one*, *7*(3), e33622. https://doi.org/10.1371/journal.pone.0033622

Szymanik, R., Żurek, P., Rynkiewicz, M., Ziemann, E., Rynkiewicz, T. (2013). Asymmetry of muscle mass distribution in tennis players. TRENDS in Sport Sciences, 20(1), 47–53.

Wang, H. S., Tsai, Y. S., Chen, Y. C., Chao, H. H., Lin, H. S., Chiang, Y. P., & Chen, H. Y. (2021). Effects of backhand stroke styles on bone mineral content and density in postmenopausal recreational tennis players: a cross-sectional pilot investigation. *BMC women's health*, *21*(1), 275. https://doi.org/10.1186/s12905-021-01416-z

Wilczyński, J., & Habik-Tatarowska, N. (2022). Sensory integration, balance deficits, and scoliotic posture in boys. Medical Studies/Studia Medyczne, 38(4), 330-335. https://doi.org/10.5114/ms.2022.122390

Zaina, F., Donzelli, S., Lusini, M., Fusco, C., Salvatore, M., Negrini, S. (2016). Tennis is not dangerous for the spine during growth: results of a cross-sectional study. Eur Spine J 25, 2938–2944. https://doi.org/10.1007/s00586-016-4452-1

Websites

https://en.isico.it/2019/01/01/tennis-doesnt-hurt-your-back/, Accessed on 2025, May 23

https://carespace.health/post/physiotherapy-for-tennis-players-keeping-you-in-top-condition/, Accessed on 2025, May 23

https://www.fisioterapiabarghini.it/scoliosi/?lang=en, Accessed on 2025, May 24

https://www.getwellen.com/well-guide/tennis-and-bone-health-what-you-need-to-know#:~:text=Tennis%20isn%27t%20all%20bad,or%20slowing%20bone%20density%20loss, Accessed on 2025, May 24

https://www.alegriamed.com/en/scoliosis-identifying-and-treating, Accessed on 2025, May 25

https://treatingscoliosis.com/blog/unraveling-the-causes-of-scoliosis-muscle-along-spine/#:~:text=If%20the%20muscles%20on%20one,who%20are%20more%20at%20risk. Accessed on 2025, May 26

HEALTH SECTION

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 186–191
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-26

RISKS ASSOCIATED WITH SPORTS ACTIVITIES: MANAGEMENT AND CONTROL

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Abstract. *Background*. In sports, as in other fields that associate major risks (ex: healthcare), a system of standards is needed to cover all the actions that should be taken to ensure conditions for the protection of all those involved directly or indirectly in the specific sports programs and activities. The requirements of such a standards system make the subject of the present study.
Objectives. This research focuses on the attempts that have been made to define and implement procedures aimed at reducing the physical and/or emotional health damage risks of an athlete.
Methods. This study consists of a literature review, in order to define the risk management methodology for the risks associated with sports activities, by understanding the factors that influence them.
Results. Risk management requirements and methodology used in healthcare services will be tested for the risks associated with sports activities to identify prevalent trends and correlations.
Conclusion. There are a few necessary conditions in order to support the approach of achieving a unitary risk management methodology for the risks associated with sports activities.

Keywords: safety, sports activities, risk management.

Introduction

In sports, as in other fields associated with significant risks, there is a need for a system of standards that targets all actions that should be undertaken to ensure conditions for protecting all those directly or indirectly involved in specific programs and activities.

In the modern landscape of organized sports, athlete safety is a fundamental concern that extends far beyond injury prevention. Whether we refer to amateur or elite performance levels, sports environments are increasingly complex and carry a wide array of risks–physical, emotional, social, and institutional. Therefore, the need for a comprehensive and standardized approach to risk management in sports is critical. As in other high-stakes domains such as healthcare, the sports sector requires a structured system of standards and protocols designed to protect all individuals directly or indirectly involved in activities and programs. These standards should not only aim to reduce injury rates but also ensure psychological safety, uphold human rights, and preserve the dignity of every participant.

In recent years, several organizations and governing bodies have initiated efforts–still fragmented and inconsistently applied–to define and implement "safeguarding procedures." These procedures include preventive measures (such as risk education and facility inspections), response

strategies (e.g., incident reporting systems), and evaluation frameworks (such as injury surveillance and behavioral audits). However, their application often lacks coherence at the national level, especially in systems where policies are decentralized or vary widely between disciplines, activities, managers and institutions.

To advance toward a unified methodology for managing risks associated with sports activities, several foundational conditions must be met:

- The existence of a national-level coordinated strategy for identifying, evaluating, and managing risks, applicable across institutions and sport types;
- The development of a specialized vocabulary to eliminate inconsistencies and ambiguities found in current methodologies and communication channels;
- The creation of mechanisms for inter-institutional communication, ensuring that information about emerging risks and best practices is shared systematically;
- The establishment of a common set of evaluation criteria, enabling stakeholders to assess the impact of risks on various participant groups (e.g., children, amateur athletes, elite professionals, staff).

Beyond terminology and protocols, risk must be understood as a potential future event–uncertain but plausible–that may threaten or enhance the achievement of established goals. In this context, risk is not inherently negative; it may also represent opportunities for improvement, innovation, and growth.

Risk management, then, is the process of anticipating, understanding, and addressing such uncertainties. It involves taking proactive measures to reduce the likelihood of harmful events, mitigating their impact if they occur, and continuously refining strategies through feedback and monitoring. In sports, effective risk management contributes not only to safety but to the overall quality, sustainability, and credibility of athletic programs and institutions.

Risk management involves actions aimed at reducing the likelihood (possibility) of the risk occurring and/or mitigating its consequences (impact) on outcomes (objectives), should the risk materialize. In cases where the risk represents a threat, risk management entails reducing exposure to it.

Risk management in sports is to be a complex process of identifying, analyzing, and responding to potential risks associated with sports activities. It has to be a documented approach that utilizes material, financial, and human resources to achieve objectives while reducing exposure to loss.

Risks Related to Sports Activities

To effectively identify the risks associated with sports activities, it is essential to conduct a thorough analysis of several key aspects. These reflect both structural vulnerabilities and human factors that influence the safety and well-being of athletes. Below is an expanded set of risk indicators and contextual explanations:

- *Level of awareness and promotion of safety and protection policies*
  An initial vulnerability lies in the extent to which sports organizations actively disseminate and apply safety values and safeguarding principles. Institutions that do not clearly communicate their commitment to athlete protection may unintentionally foster environments where risks go unaddressed or underreported.
- *Professional competencies of staff interacting with athletes*
  Coaches, trainers, medical staff, and administrative personnel must be adequately trained not only in their core specialties but also in safeguarding practices, recognizing signs of abuse, injury risk, and psychological distress. Ongoing professional development in these areas is critical.

- *Capacity to ensure safety within sports clubs and training camps*
  This includes ensuring that physical infrastructure (facilities, fields, gyms) and sports equipment meet established safety standards. Regular audits and maintenance checks are essential to reduce the likelihood of injuries caused by faulty or outdated infrastructure.
- *Respect for athletes' rights regarding physical, mental, and emotional health*
  Athletes, especially children and adolescents, must be protected from overtraining, psychological pressure, and burnout. Their participation should be encouraged in a way that prioritizes long-term well-being over short-term performance.
- *Respect for athletes' personal integrity and dignity*
  Discriminatory behaviours, harassment, and degrading treatment violate ethical standards and directly increase emotional risk. Clubs must have clear codes of conduct and grievance procedures in place.
- *Confidentiality and data protection*
  As the digitalization of sports management grows, so does the importance of protecting personal data, including medical history, biometric monitoring, and performance records. Data breaches or misuse may lead to reputational damage or psychological consequences.
- *Environmental safety during sports activities*
  Environmental hazards (extreme weather, poor air quality, pollution, or unsafe terrain) should be assessed prior to outdoor events. Organizers must have contingency plans and ensure that athletes are informed and equipped to respond appropriately.

Additional factors to consider in an advanced risk identification system:

- *Psychosocial climate within the team or club*
  Toxic team dynamics, verbal abuse, or authoritarian leadership may go unnoticed but can have long-lasting impacts on mental health and performance. Athlete surveys and anonymous feedback mechanisms are recommended.
- *Transition periods (e.g., age category changes, club transfers)*
  Athletes going through transitions are more vulnerable to loss of social support and identity-related stress. Institutions should monitor these periods carefully.
- *Travel and accommodation risks*
  Competitions often involve travel and unfamiliar environments. Risk assessments should cover transportation logistics, accommodation standards, and emergency protocols.

The inherent complexity of sports activities has long warranted the development of a dedicated academic and clinical field–sports medicine–underscoring the need for similarly structured approaches in other domains of support and safety. In this context, the conceptualization and formal regulation of risk management specific to sports activities is not only useful, but essential. Such a framework would align with the broader objective of safeguarding health, performance, and ethical standards within the increasingly professionalized and high-stakes environment of modern sport.

To support all the above, in Table 1, requirements of healthcare quality and safety standards are tested as applicable or not in sports organizations.

As ten key aspects were listed for an effective identification of the risks associated with sports activities, a requirement of healthcare quality and safety standards is to be considered applicable if it can be related to at least four (more than a third) of these.

„Risk management ensures protection against potential harm" is related to the following aspects:

- Capacity to ensure safety within sports clubs and training camps
- Respect for athletes' rights regarding physical, mental, and emotional health
- Confidentiality and data protection
- Environmental safety during sports activities
- Psychosocial climate within the team or club
- Travel and accommodation risks

„Areas and conditions with potential physical risk to individuals (e.g., falling, slipping, impact, electroctrical shock) are identified and preventive measures are in place“ is related to the following aspects:

- Capacity to ensure safety within sports clubs and training camps
- Respect for athletes' rights regarding physical, mental, and emotional health
- Environmental safety during sports activities
- Travel and accommodation risks

„Protective, security, and surveillance measures are implemented for both property and individuals“ is related to the following aspects:

- Capacity to ensure safety within sports clubs and training camps
- Respect for athletes' rights regarding physical, mental, and emotional health
- Respect for athletes' personal integrity and dignity
- Confidentiality and data protection
- Psychosocial climate within the team or club
- Environmental safety during sports activities
- Travel and accommodation risks

„Cleaning and disinfection of spaces and equipment are regulated and systematically monitored“ is related to the following aspects:

- Capacity to ensure safety within sports clubs and training camps
- Respect for athletes' rights regarding physical, mental, and emotional health
- Environmental safety during sports activities
- Travel and accommodation risks

"Conditions are adapted to accommodate individuals with disabilities or special needs" is related to the following aspects:

- Capacity to ensure safety within sports clubs and training camps
- Respect for athletes' rights regarding physical, mental, and emotional health
- Respect for athletes' personal integrity and dignity
- Confidentiality and data protection
- Environmental safety during sports activities
- Transition periods (e.g., age category changes, club transfers)
- Travel and accommodation risks

Table 1. Requirements of healthcare quality and safety standards, tested as applicable or not in sports organizations

No.	Requirement	Applicable / Not
1.	Risk management ensures protection against potential harm.	
2.	Risk management ensures protection against potential harm.	Applicable
3.	Risk management ensures protection against potential harm.	Applicable
4.	Cleaning and disinfection of spaces and equipment are regulated and systematically monitored.	Applicable
5.	Conditions are adapted to accommodate individuals with disabilities or special needs.	Applicable

Results

The inherent complexity of sports activities has long warranted the development of a dedicated academic and clinical field–sports medicine–underscoring the need for similarly structured approaches in other domains of support and safety. In this context, the conceptualization and formal regulation of risk management specific to sports activities is not only useful, but essential. Such a framework would align with the broader objective of safeguarding health, performance, and ethical standards within the increasingly professionalized and high-stakes environment of modern sport.

In order to define the risk management methodology for the risks associated with sports activities, this study consists of a literature review for the factors that influence them.

To support the critical need for a comprehensive and standardized approach to risk management in sports, requirements of healthcare quality and safety standards (R1-R5), were considered applicable in sports organizations, if they could be related to at least four key aspects of an effective identification of the risks associated with sports activities (KARA 1 – KARA 10), as shown in Fig. 1.

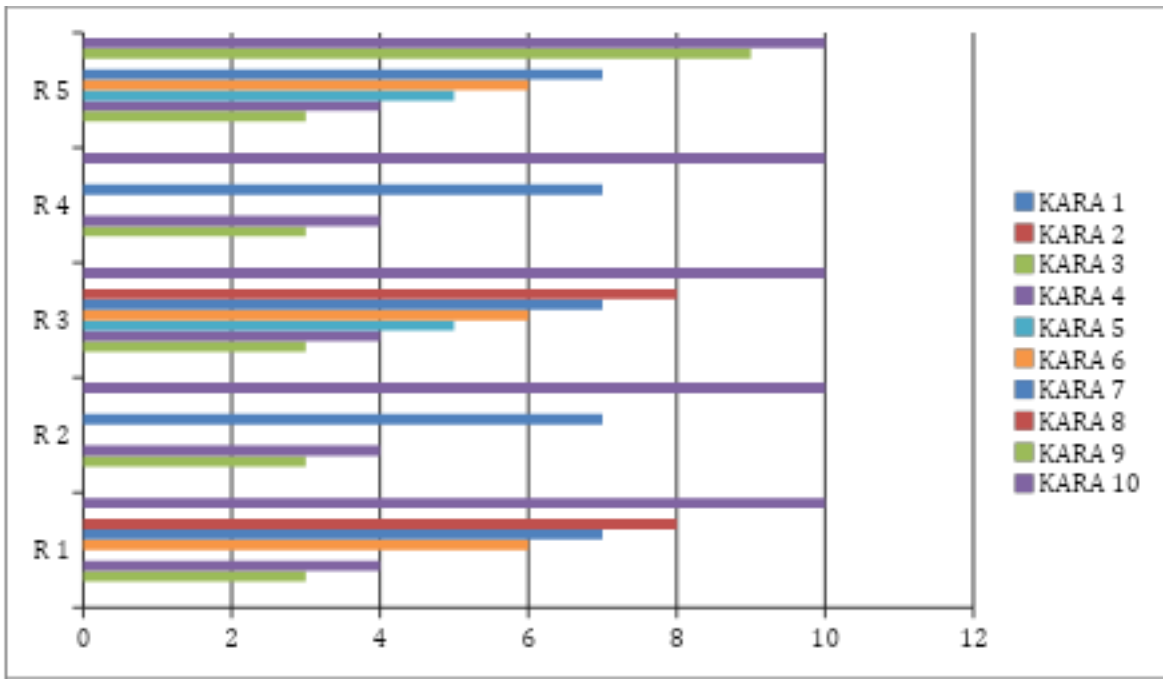

Figure 1. Number of risks associated with sports key aspects, related to the requirements of healthcare quality and safety standards.

Conclusions

Risk management is the process of anticipating, understanding, and addressing uncertainties. It involves taking proactive measures to reduce the likelihood of harmful events, mitigating their impact if they occur, and continuously refining strategies through feedback and monitoring.

Risk management involves actions aimed at reducing the likelihood (possibility) of the risk occurring and/or mitigating its consequences (impact) on outcomes (objectives), should the risk materialize. In cases where the risk represents a threat, risk management entails reducing exposure to it.

In sports, effective risk management contributes not only to safety but to the overall quality, sustainability, and credibility of athletic programs and institutions.

The inherent complexity of sports activities has long warranted the development of a dedicated academic and clinical field–sports medicine–underscoring the need for similarly structured approaches in other domains of support and safety. In this context, the conceptualization and formal regulation of risk management specific to sports activities is not only useful, but essential. Such a framework would align with the broader objective of safeguarding health, performance, and ethical standards within the increasingly professionalized and high-stakes environment of modern sport.

Risk management in sports is to be a complex process of identifying, analyzing, and responding to potential risks associated with sports activities. It has to be a documented approach that utilizes material, financial, and human resources to achieve objectives while reducing exposure to loss.

References

Andersen, M. B. (2005). *Sport psychology in practice*, Human Kinetics

Brackenridge, C., Rhind, D., & Palmer-Felgate, S. (2014). *Child protection in sport: Reflections on thirty years of science and activism,* Social Sciences

Breivik, G. (2019). *Trends in risk sports: The impact of technology, regulation, and society,* Sport in Society

Caine, D., Harmer, P., & Schiff, M. (Eds.). (2009). *Epidemiology of injury in Olympic sports*, Wiley-Blackwell

Dijkstra, H. P., Pollock, N., Chakraverty, R., & Alonso, J. M. (2014). *Managing the health of the elite athlete: A new integrated performance health management and coaching model*, British Journal of Sports Medicine

Duda, J. L. (2013). *The conceptual and empirical foundations of Empowering Coaching*, International Journal of Sport and Exercise Psychology

Emery, C. A., & Pasanen, K. (2019). *Current trends in sport injury prevention*, Best Practice & Research Clinical Rheumatology

Fahlén, J., Eliasson, I., & Norberg, J. R. (2022). *Safeguarding in grassroots sports: Organizational challenges and responses,* European Sport Management Quarterly

Gabbett, T. J. (2016). *The training–injury prevention paradox: Should athletes be training smarter and harder?*, British Journal of Sports Medicine

Green, L. W., & Kreuter, M. W. (2005). *Health program planning: An educational and ecological approach (4th ed.)*, McGraw-Hill

Harris, J. (2024). *Teaching health-related exercise at key stages1 and 2- USA*, Human Kinetics

Junge, A., & Dvorak, J. (2000). *Influence of definition and data collection on the incidence of injuries in football. The American Journal of Sports Medicine*, *28*(5), S40–S46

Kerr, G., Stirling, A., & MacPherson, E. (2020). *Safeguarding in sport: Children's rights in sport*, Sport, Education and Society

Mountjoy, M., Brackenridge, C., Arrington, M., et al. (2016). *International Olympic Committee consensus statement: Harassment and abuse (non-accidental violence) in sport*, British Journal of Sports Medicine

Pini, E., Green, L., & Whincup, P. (2021). *Risk management in community sports: Lessons from the UK*, International Journal of Sport Policy and Politics

Rice, S. M., Parker, A. G., Mawren, D., Clifton, P., & Harcourt, P. (2016). *Sport-related concussion and mental health outcomes in elite athletes: A systematic review*, Sports Medicine

Tomson, C. R. V., & van der Veer, S. N. (2013). *Safety and quality in healthcare: Concepts, methods and tools*, Oxford University Press.

Waddington, I., & Malcolm, D. (2005). **Sport and risk society**. Routledge.

Websites

https://www.who.int/publications/i/item/9789241514187 Accessed on 2018, June 1st

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 192–198
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-27

EFFECTS OF THE USE OF TABLE TENNIS IN SPORTS THERAPY IN PSYCHIATRIC HOSPITALS. CASE STUDY: PATIENT WITH ALCOHOL DEPENDENCE

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Abstract. Sports therapy is an effective scientific method of supporting specialized psychiatric treatments. By using sports therapy in psychiatric medical treatment, the patient's physical and mental health is improved. Research to date shows that in psychiatric clinics where patients also benefit from sports therapy, the recovery process is accelerated. Patients' access to a gym and/or possibly to a swimming pool improve sports therapy, making it possible to carry out therapy regardless of the season or weather. The most common sports in sports therapy are: table tennis, swimming, badminton, basketball, volleyball, fitness, walking and running outdoors, yoga, cycling or even climbing on special boards. Table tennis is an accessible and effective method to support psychiatric therapy, having effects on the patient's mental health through a combination of physical exercise, cognitive stimulation and social interaction. By accepting the regular practice of table tennis, an acceleration of the rehabilitation process is observed in patients with alcohol dependence. At the cellular level, following the moderate physical effort of table tennis, there is a substantial release of endorphins and the level of cortisol in the blood is regulated, which leads to a decrease in stress levels and an increase in the patient's ability to concentrate and disconnect from anxious thoughts. After analyzing the results of the conducted experiment it can be concluded that the first and easiest method of sports therapy in psychiatric clinics is table tennis. It proves the hypothesis that table tennis significantly helps the patient with alcohol addiction problems to quickly regain body and mental control in comparison with the patient who does not want or does not have the possibility to participate in sports therapy sessions. The patients with alcohol dependence contact with the gym, with the rules of table tennis and with other players helps in better managing their emotions, improves self-esteem, encourages physical movement and social contact and also demonstrates the importance of sport therapy.

Keywords: table tennis, psychiatric, sports therapy, alcohol, dependence.

1. Introduction

Table tennis, also known as ping-pong, has a fascinating history that begins in the 19th century. This activity, which became an Olympic sport in 1988, has Asian origins. In Europe it emerged as an indoor version of field tennis. Brought to Europe by English officers it was practiced by English aristocrats in the dining rooms of their palaces. Over time the discipline became known the world over. Nowadays table tennis is one of the most widely practiced sports in the world, with millions of amateur and professional players, and is appreciated both for its dynamics and for the physical and mental benefits it offers (Xun. L 2022). As an easy sport, table tennis has no age limit and does not

require significant investment in equipment. It has a simple set of rules and can be played in teams of two as well as individually. Table tennis is not only a recreational or competitive sport but also a method used in sports therapy (Naderi, A. 2018). Due to its dynamic and accessible nature, it can also be practiced by people with neuro-motor or psychiatric disorders or with heart problems (Guochang. L 2022). Regular practice of table tennis has been shown to increase concentration and coordination of arm movements, helping to maintain active cognitive functions. Playing table tennis activates the production of endorphins, substances that reduce stress and induce well-being in the body. Focusing on the game can have a similar effect to meditation, helping patients to disconnect from anxious thoughts. For patients with depression and alcoholic problems, table tennis is a simplistic way of taking a first step towards socialization and performing light physical movements without significant physical and mental stress. By accepting involvement in the game of table tennis, by progressively increasing the patient's playing skills, a sense of accomplishment and self-confidence is offered to the patient. Table tennis is a method that can also be used in group therapy to improve interpersonal relationships. Practicing this discipline helps patients with disorders such as schizophrenia or autism to develop social skills in a structured environment (Seo,S., 2024). Play contains rules that require discipline and emotional control. These can help patients with personality disorders, Diabetes, Parkinson or ADHD to manage impulsivity (Olsson, K., 2020, Buchmann, N., 2005). Learning game strategies and accepting defeat helps to develop emotional resilience. For the uninitiated, table tennis is a well-known, accepted, and popular sport. Table tennis is quickly reminiscent of childhood, possibly the gym at school, which creates a feeling of nostalgia and joy. With the help of table tennis, the effort capacity of the alcoholic patient is increased and the coordination of body movements return more quickly to normal (Williams, A., 2002).

2. Application of sports therapy in rehabilitation clinics

In order to be successful in the application of sports therapy in psychiatric clinics and especially by the alcohol wards, it is necessary that the sports therapist has a number of special qualities such as patience, empathy, didactics, pedagogy, optimism, medical knowledge, sports and physical education knowledge (Dra gnea, A., 2002). The sports therapist will start the therapy according to didactic principles, from simple to complex, from easy to hard and from unknown to known. The therapy is done according to a well-established plan together with the psychiatrist, occupational therapist, social educator and sports therapist. The treatment plan in psychiatry is a team work and the results are visible over time by optimizing the application of special therapies.

2.1. Previous studies on table tennis and the importance of its practice for mental health

Numerous recent scientific studies confirm the positive effects of using table tennis as a method in sports therapy, especially in psychiatric contexts. An article in Psychiatric News points out that table tennis is ideal for use in psychiatric units due to its compact nature and the use of non-hazardous sports equipment. Its compact nature, coupled with the use of a table of small, harmless balls and paddles, makes it less intrusive in the psychiatric clinic. Participants benefit from a moderate level of physical activity, with minimal spatial movements involving a low level of arm and leg control. Table tennis can be played both outdoors and in the wards where patients are stationed. An article in a specialized newspaper highlights the fact that table tennis can be a motivator for alcohol addicts to give up alcohol. According to the investigation, an example of successful integration of table tennis in addiction therapy is found in Germany at the Blue Cross Sports Café in Bochum. Addicts, relatives and friends meet here to play table tennis together. The rule is clear: no alcohol and no drugs. This

program not only promotes physical activity, but also social interaction and mutual support, and the results are extraordinary. Another scientific study says that table tennis has positive effects on neuropsychological health. The study looked at the effects of a 4-week table tennis training program for alcohol-dependent adults. Results showed significant improvements in participants' self-efficacy and cardiovascular health. Promoting cognitive function through long-term table tennis training may alter the dynamic functional connectivity of the brain, suggesting improved cognitive function (Park, S., 2012, O'Brien, K, 2020, Jadezak, A., 2018, Tsai, Y., 2022).

2.2. Methodology of applying sports therapy through table tennis for patients with alcohol addiction

In general, patients in the alcohol ward of psychiatric clinics know the rules of table tennis. The therapist is obliged to present the purpose, benefits and main rules of the game. He will try to demonstrate through simple movements the technique of the game and possibly choose one of the players for a demonstrative game, one step at a time, and perhaps most important is the patient's acceptance of the therapy. After the first few training sessions the patient will present him/herself in order to perform the session. The exercises in table tennis are easy like: one-on-one play or doubles, running around the table, ball control exercises like forehand, backhand, serve, ball spin, take-offs and stops, ball coordination.

After the period of impact and acceptance of the involvement in the activity of recovery through sport, the patient will change his motivation. One to two sessions per day will be carried out for a maximum of one hour per session. Discussions about the patient's personal problems should be avoided as much as possible. Patients will be motivated to play together or with the sports therapist. Hydration breaks or just breaks will be offered as many as the patients consider. No time limits will be imposed for play and the sports therapist will continuously monitor the patient's physical condition. The patient's balance, coordination and concentration will be monitored to see if the patient's balance, coordination and concentration improve compared to the first sessions. A quiet and relaxing playing environment will be provided for the therapy so that the patient's attention is focused on the game of table tennis. If the patient considers that a possible game on the point would be motivating, a competition can be organized (Kendzor, D., 2008, von Hachling, S., 2021).

3. Organization of the research

3.1. Aim of the work

The aim of this work is to investigate and compare how sports therapy influences the health status of patients by alcoholic ward of the Psychiatric Clinic in comparison with patients in the same ward who do not agree to attend therapy sessions through sport. The study aims to investigate how table tennis, as the first sport therapy method, applied to alcohol-dependent patients accelerates their rehabilitation process. By applying the experiment, it aims to gain a deeper understanding of how the use of table tennis can influence the motivation and physical behavior of the alcohol intoxicated patient undergoing therapy.

3.2. Research hypothesis

Table tennis is a first sports therapy modality that has an increased effectiveness in treating patients with alcohol intoxication.

3.3. Research objectives, tasks and evaluation methods

Evaluation methods:

- experiment method: physical capacity assessment tests (Ruffier test) and movement coordination assessment test (Matorin test)
- clinical observations
- interviews with patients and medical staff

To achieve the set objective, the following research tasks were formulated:

a. Establishment of the research sample – 20 patients aged between 30 and 45 years of age first attending the de-alcoholization ward. Patients have different jobs in their daily lives and do not have enough time for sports and physical exercise. However, they admit that exercise is good for their physical and mental discomfort.10 of these patients (P1 to P10) agree to participate in sports therapy, called experimental group (EG) and 10 of them (P11 to P20) will not participate in the sports therapy sessions, called control group (CG).
b. Determining the duration of the experiment and the intervention protocol: sports therapy lasting eight weeks, two sessions of table tennis every day from Monday to Friday.

Research tasks:

a. evaluation of the evolution of the effort capacity and motor coordination of the patient in the two groups.
b. evaluation of the level of alcohol dependence through sport therapy. (Rîşneac, B., 2004)

3.4. Analysis and interpretation of results

During the eight weeks that the experiment was applied to all the 20 patients addicted to alcohol, a significant improvement in physical and mental health, an increase in social interaction and general motivation was observed. Following the interviews, all the patients, the 20 patients reported alcohol-related stress. In the first 14 days, the stress caused by alcohol addiction was lower, after which it reappeared, and after approximately four weeks it decreased again. Medication was determined by psychiatrists on a patient-by-patient basis and the therapists' contact with the doctors was continuous. In addition to alcohol addiction, all 20 patients had nicotine addiction. None of the patients managed to give up tobacco addiction during the therapy, but alcohol was totally prohibited. In the EG there was a 10% decrease in nicotine dependence by reducing the number of cigarettes smoked during the day. In the CG there was a 13% increase in tobacco consumption. In the experimental group there was an improvement in the coordination of arm and leg movements in the first days of therapy compared to the control group. The Ruffier test was applied on all 20 patients twice (T1, T2). The first time was applied two weeks after the beginning of therapy and the second test was done in the seventh week. After the completion of eight weeks the patients in the experimental group indicated their intention to join a table tennis club. The Matorin Test, as a movement coordination assessment test, was applied once in the eighth week of therapy and the results were analyzed by comparing the patient groups. The combination of the two tests was done so as not to induce fatigue in patients and to avoid accidents.

1. Ruffier test:

To calculate the Ruffier Index (R.I.), we used the dynamics of heart rate at standard effort. The patients performed 20 squats in 20 seconds. The pulse was taken three times respectively P1 before the effort, P2 after the effort and P3 one minute after the effort. The calculation formula used was: (HR1 + HR2 + HR3) – 200. The reference values are: between 0 – 50 = good, between 51 – 100 = fair, between 101 – 150 = poor and over 150 = very poor.

Evaluation: as can be seen in Table 1 and 2, Ruffier index recorded an increased value in the control group compared to the experimental group at both T1 and T2. In the experimental group in week 7 the value improved by 32,15 compared to the control group where the value is only 20,8. This result demonstrates that by practicing table tennis the effort capacity of patients with alcohol dependence increases.

Table 1. The T1 results for EG and CG

T1	Patients										EG Value CG Value
EG	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	**121,9**= poor
CG	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	
Result	121	145	111	113	142	125	120	122	105	115	
R. I.	142	115	139	132	135	140	141	136	130	127	**133,7**=poor

Table 2. The T2 results for EG and CG

T2	Patients										EG Value CG Value
EG	P1	P2	P3	P4	P5	P6			P7	P8	**89,75**= fair
CG	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	
Result	92	116	103	97	107	95	98	87	92	105	
R. I.	135	110	121	130	127	133	128	124	110	117	**112,9**=poor

Matorin test:

This test to assess the patient's movement coordination consists of performing a jump on both feet vertically, with as much turn as possible about the body's own axis. The starting position is with the legs slightly apart between which a vertical line is drawn. After performing the flip jump the patient must remain on the spot where he landed. A line is drawn between and parallel to his feet. The angle formed between the initial line and the resulting line is measured with a set square. The patient may perform the rotational movement as he thinks would be to his advantage. Two jumps are made to the left and two to the right but only the best jump is taken into account. The scale of judgment and qualitative evaluation will be:

– Under 180º poor
– Between 180º – 270º sufficient
– between 70º – 360º good
– over 360º very good

Table 3. The Matorin test results for CG

Matorin Test	EG										Total
Pacient	1	2	3	4	5	6	7	8	9	10	Average
Result	255º	267º	289º	355º	376º	343º	320º	290º	246º	233º	297,4 º

Table 4. The Matorin test results for CG

Matorin Test	CG										Total
Pacient	11	12	13	14	15	16	17	18	19	20	Average
Result	178º	197º	189º	195º	287º	221º	395º	190º	137º	172º	216,1 º

The average values obtained in the test for the experimental group were **297,4º** (good) and for the control group **216,1º** (sufficient), which means that patients who participated in table tennis sessions have better body movement coordination compared to those who did not participate

The results of the test demonstrate also the hypothesis of the experiment, namely that the use of table tennis as a sports therapy for patients undergoing therapy for disalcolization shows significant progress. The practice of table tennis helps the patient to regain confidence in his own strength and movements faster.

4. Conclusions and recommendations

Alcohol addiction is one of the most common illnesses encountered in psychiatric clinics. Recovery therapy in psychiatric clinics is a team work. Along with other existing therapies, sports therapy is an important method in the treatment of patients with alcohol intoxication and alcohol dependence. Table tennis is an easy method by which patients with such problems can accelerate their healing process. Table tennis can be easily implemented in all clinics. It would be recommended that a tennis table be installed in each detoxification section and that patients be motivated to start practicing.

References

Buchmann, N. (2019). *Problematic drinking in the old and its association with muscle mass and muscle function in type II diabetes*. *Sci. Rep.* 9, 12005. https://doi.org/10.1038/s41598-019-47787-0

Dragnea, A. (2002). *Teoria Educației Fizice și a Sportului*. București: Editura FEST.

Jadczak, A. D., Makwana, N., Luscombe-Marsh, N., Visvanathan, R. & Schultz, T. J. (2018). *Effectiveness of exercise interventions on physical function in community-dwelling frail older people: An umbrella review of systematic reviews. JBI Database Syst. Rev. Implement Rep.* 16, 752–775. https://doi.org/10.11124/JBISRIR-2017-003551.

Kendzor DE, Dubbert PM, Olivier J, Businelle MS, Grothe KB. (2008); *PATHS Investigators. The influence of physical activity on alcohol consumption among heavy drinkers participating in an alcohol treatment intervention.* Addict Behav. Oct;33(10):1337-43. doi: 10.1016/j.addbeh.2008.06.013. Epub 2008 Jun 12. PMID: 18639987; PMCID: PMC2561325.

Xun, Li. (2022). *Application of physical training in the rehabilitation of injuries in table tennis athletes.* Revista Brasileira de Medicina do Esporte. 28. 483-485. 10.1590/1517-8692202228052022_0080.

Guochang, Liu; Zhu, Xiaoyun1. (2024) *The effect of table tennis combined with resistance training on the rehabilitation of patients with coronary heart disease.* Annals of Thoracic Medicine (): 10.4103/atm.atm_6_24, October 15, 2024. | DOI: 10.4103/atm.atm_6_24

Naderi A, Degens H, Rezvani MH, Shaabani F. A. (2018) *Retrospective comparison of physical health in regular recreational table tennis participants and sedentary elderly men*. J Musculoskelet Neuronal Interact. 2018 Jun 1;18(2):200-207. PMID: 29855442; PMCID: PMC6016501.

O'Brien, C & Lyons, Frank. (2000). *Alcohol and the Athlete.* Sports medicine (Auckland, N.Z.). 29. 295–300. 10.2165/00007256-200029050-00001.

Olsson K, Franzén E, Johansson A. (2020) *A Pilot Study of the Feasibility and Effects of Table Tennis Training in Parkinson Disease*. Arch Rehabil Res Clin Transl. 2020 Jun 2;2(3):100064. doi: 10.1016/j.arrct.2020.100064. PMID: 33543090; PMCID: PMC7853352.

Park, S. (2012). *A Study on Differences in Prediction Accuracy and Visual Search Strategies According to Table Tennis Proficiency and Visual-Audible Information Presentation Level*. Dissertation of Master's Degree, Seoul National University.

Rîşneac, B. V., Milici, D., & Raţă, E. (2004). *Utilizarea tehnicii de calcul în evaluarea performanţelor sportive*. Braşov: Editura Universităţii Transilvania.

Seo S, Kim Y (2024) *Stroke Patients: Effects of Combining Sitting Table Tennis Exercise with Neurological Physical Therapy on Brain Waves*. J Phys Med Rehabil Disabil 10: 090.

Tsai, Y.-H., Wu, S.-K., Yu, S.-S., & Tsai, M.-H. (2022). *Analyzing Brain Waves of Table Tennis Players with Machine Learning for Stress Classification*. Applied Sciences, 12(16), 8052. https://doi.org/10.3390/app12168052.

von Haehling S, Arzt M, Doehner W, Edelmann F, Evertz R, Ebner N, et al. (2021) *Improving exercise capacity and quality of life using non-invasive heart failure treatments: Evidence from clinical trials*. Eur J Heart Fail 2021; 23:92–113.

Williams, A. M., Vickers, J., & Rodrigues, S. (2002). *The effects of anxiety on visual search, movement kinematics, and performance in table tennis: A test of Eysenck and Calvo's processing efficiency theory.* Journal of Sport & Exercise Psychology, 24(4), 438–455.

Websites

https://www.ittf.com/tournament/5107/2019-ittf-parkinsons-world-table-tennis-championships/. Accessed March 17, 2025.

https://www.southerntabletennis.org.au/wp-content/uploads/2018/02/Good-Sports-alcohol-safe-transport-and-smoking-management-policy-v2.pdf. Accessed March 4, 2025.

https://www.tabletennisnt.com.au/policies/alcohol-safe-transport-policy/. Accessed April 5, 2025.

https://www.blaues-kreuz.de/de/westfalen/bochum/ortsverein-wattenscheid/sucht-selbsthilfe-und-angebote/sportcafe. Accessed April 2, 2025.

https://trokkenpresse.de/titelthema-4-18-trockenbleiben-mit-sport/. Accessed April 5, 2025

https://psychiatryonline.org/doi/fu

VARIA SECTION

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 200–207
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-28

IMPACT OF ROMANIAN PHYSICAL EDUCATION POLICY ON YOUTH HEALTH OUTCOMES: A SECONDARY DATA ANALYSIS

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Abstract. *Background and aims*: this comprehensive investigation explores how regional disparities in mandated physical education (PE) instructional time influence two critical health outcomes in Romanian adolescents: obesity prevalence and self-reported moderate to vigorous physical activity (MVPA) rates. Amid growing public health concerns regarding childhood obesity and declining physical activity levels, Romania presents a valuable context due to substantial inter-county variations in education policy implementation. The aim was to determine whether counties with greater weekly PE exposure report better health outcomes among adolescents, adjusting for socioeconomic differences.
Methods: we utilized publicly accessible secondary datasets, compiling county-level weekly PE time from UNESCO's Global Education Monitoring Report (2021), adolescent health indicators from the WHO European Health Information Gateway (2023), and contextual covariates, average disposable household income and urbanization percentages, from Eurostat and the Romanian National Institute of Statistics (INS, 2023). The dataset covered all 42 administrative counties. Statistical procedures included Pearson correlation to assess bivariate relationships, descriptive analyses to summarize distributions, and multivariate linear regression models to isolate the effect of PE time while adjusting for income and urbanization.
Results: findings revealed a statistically significant moderate inverse correlation between PE time and obesity prevalence ($r = -0.38$, 95% CI [−0.60, −0.10], $p = 0.015$) and a moderate positive correlation with MVPA rates ($r = 0.44$, 95% CI [0.17, 0.65], $p = 0.006$). Multivariate regressions confirmed that each additional 10 minutes of weekly PE is associated with a 0.7 percentage-point decrease in obesity prevalence ($\beta = -0.07$, $p = 0.004$) and a 0.9 percentage-point increase in MVPA participation ($\beta = 0.09$, $p = 0.002$), independent of regional income or urban development level.
Conclusions: these results underscore the importance of standardized and sufficient PE provision in shaping adolescent health across Romania. Findings are discussed within the context of established pain management and injury prevention frameworks in youth sports and evidence-based strategies for body weight control. This study offers critical insight into how curricular time allocations can produce measurable health benefits and argues for policy reform to harmonize PE standards nationwide. Additionally, implications are explored for education authorities, public health planning, and targeted interventions in underserved regions.

Keywords: physical education policy; adolescent obesity; youth; health.

1. Introduction

Adolescence represents a pivotal developmental stage marked by physiological, psychological, and social transformations that establish long term health trajectories [Badau et al., 2024; Badau et al.,

2025]. In Romania, national surveillance data indicate a troubling trend: obesity prevalence among 11–15 year olds rose from approximately 12% in 2010 to nearly 18% by 2020 [WHO European Health Information Gateway, 2023]. Parallel assessments demonstrate declines in average daily MVPA, raising concerns about sedentary behaviors and associated chronic disease risks [Radu & Marinescu, 2021]. These developments underscore an urgent need to scrutinize the implementation and efficacy of school based PE - a core component of youth health promotion mandated by the Romanian Ministry of Education.

Despite national policy stipulating PE instruction at all education levels, administrative autonomy and resource disparities perpetuate variation in actual delivery across Romania's 42 counties [Sandu, 2018]. Macro level analyses that integrate region specific policy metrics with health outcomes are scarce in the Romanian context, limiting evidence based policy refinement. This study addresses this gap by leveraging secondary data to: (1) quantify inter-county variation in mandated PE minutes; (2) assess bivariate relationships between PE time and health indicators; and (3) model the independent contribution of PE policy to obesity and MVPA outcomes, accounting for socioeconomic factors. Additionally, we incorporate theoretical perspectives on injury management [Manescu, 2022a] and structured weight-control recommendations [Manescu, 2022b] to inform actionable policy enhancements.

1.1. Research gap and objectives

Previous research on school based PE in Romania has predominantly employed small-scale experimental designs or self reported survey methodologies, often lacking generalizability and cross regional comparability [Popescu et al., 2019; Ionescu & Georgescu, 2020]. Moreover, studies seldom adjust for county level economic and urbanization disparities that may confound observed associations. By analyzing uniform, objective policy data alongside standardized health metrics and covariates, this research aims to generate robust, generalizable insights for educational and public health stakeholders.

The specific objectives are to:

1. Characterize the distribution and central tendency of mandated PE minutes per week across all Romanian counties.
2. Quantify the strength and direction of bivariate correlations between PE time and (a) adolescent obesity prevalence and (b) MVPA rates.
3. Estimate the independent effect of PE policy on these health outcomes via multivariate regression, controlling for average disposable household income and county-level urbanization.

2. Literature Review

2.1. Physical Education and youth health outcomes

Extensive literature affirms that regular, structured physical education (PE) exerts a significant and multifaceted influence on youth health outcomes, including improvements in cardiovascular fitness, muscular strength, metabolic health, psychological well-being, and cognitive performance [European Commission, 2020; Sandu, 2018; Radu & Marinescu, 2021]. PE programs that are developmentally appropriate and consistently implemented have been shown to reduce risk factors for chronic diseases, improve aerobic capacity, and support neuromuscular development during critical growth periods.

Moreover, structured PE fosters essential psychosocial skills such as discipline, teamwork, and resilience, while also enhancing academic engagement and classroom behavior, contributing to a

holistic developmental trajectory for children and adolescents. The European Commission's strategic recommendations endorse a minimum of 150 minutes of PE per week to achieve these broad educational and health-related objectives [European Commission, 2020].

Despite these recognized benefits, real-world adherence to such standards remains inconsistent. In many educational systems, particularly those constrained by limited funding, insufficient infrastructure, or staffing shortages, the allocation for PE is either deprioritized or implemented at suboptimal frequency. This discrepancy is especially evident in rural or socioeconomically disadvantaged regions, where disparities in access to structured physical activity opportunities widen existing health inequities and contribute to long-term disparities in physical and mental health.

2.2. Theoretical frameworks: injury management and weight control

The structured pain management process delineates key phases, beginning with pre activity screening and risk stratification, followed by continuous symptom surveillance, early detection of biomechanical irregularities, and real-time adaptation of training loads, to proactively mitigate injury risk and ensure sustained engagement in physical education (PE) and sports programs. This proactive approach emphasizes early intervention and correction, utilizing both subjective and objective indicators to prevent exacerbation of minor conditions into chronic or debilitating injuries. The framework integrates sport-specific monitoring protocols and encourages interdisciplinary collaboration among educators, physiotherapists, and coaches.

Parallel to injury prevention, evidence based weight control framework offers a pedagogically grounded model for embedding nutritional literacy and self regulation strategies into PE curricula [Manescu, 2022b]. This includes structured nutritional education modules tailored to age and developmental stage, individualized goal setting informed by baseline anthropometric assessments, and systematic progress evaluation using both behavioral and physiological indicators. Emphasis is placed on cultivating healthy lifestyle habits that extend beyond the classroom, aiming to empower students to take ownership of their health trajectories.

Together, these theoretical models present synergistic pathways through which increased PE time can be transformed into concrete and measurable health outcomes. By aligning physical activity delivery with targeted frameworks in injury management and energy balance regulation, school-based PE can serve not only as a conduit for fitness development but also as a preventive health intervention that addresses the growing dual burden of youth inactivity and obesity. These models also support scalable applications in both urban and rural contexts, offering flexibility to adapt based on available resources and demographic needs.

2.3. Comparative athletic and technological interventions

Badau et al. [2024] conducted a systematic investigation into reaction time symmetrization across various athletic populations, revealing that manual lateralization plays a pivotal role in neuromotor coordination – a critical intermediary in determining agility, response accuracy, and overall sport specific performance. Their findings emphasized that athletes involved in team-based disciplines tend to exhibit more symmetrical reaction patterns than those from individual sports or non-athletic controls, likely due to the bilateral cognitive and motor demands imposed by coordinated gameplay. The study also highlighted how neuromotor asymmetries can influence injury risk and movement efficiency, advocating for corrective training protocols tailored to lateral dominance profiles.

In a follow-up study, Badau et al. [2025] evaluated the application of repetitive velocity training (RVT) technologies within youth settings across handball, basketball, and volleyball. The research confirmed that the structured integration of digital velocity monitoring systems significantly

enhances reaction speed, power output consistency, and game-specific tempo adaptation. However, the authors caution that technological adoption alone is insufficient without pedagogically aligned implementation. Their findings stress the importance of embedding such tools within broader educational frameworks that include technical feedback loops, individualized performance tracking, and guided motor learning strategies.

Together, these studies demonstrate that optimized athletic outcomes stem not only from technological augmentation but from the strategic pairing of such tools with evidence-based coaching practices and sport-specific neuromotor conditioning. By advancing both biomechanical precision and cognitive responsiveness, the dual integration of comparative athletic profiling and targeted technological interventions holds promise for elevating youth athletic development across diverse sporting environments.

2.4. Synthesis and policy gap

Although a robust body of international and Romanian specific literature affirms the effectiveness of structured physical education (PE) programs in improving youth physical health, cognitive performance, and psychosocial development, there remains a notable gap in empirical assessments of how these benefits translate within varying local governance contexts. Particularly, few studies have systematically investigated the influence of county level policy heterogeneity in Romania – such as differences in curriculum mandates, resource allocation, teacher training, and enforcement mechanisms - on measurable public health outcomes.

This macro level investigation, grounded in secondary data synthesis and regional comparisons, directly addresses this research void by mapping patterns of PE implementation against indicators such as obesity prevalence, MVPA rates, and infrastructural disparities. It highlights how structural inequities - often shaped by local political priorities, socioeconomic status, or rural urban divides - can moderate the otherwise well-documented effects of PE interventions.

By capturing and analyzing the variance in local execution of national level education mandates, this study offers a nuanced understanding of the policy-to-practice gap and its implications for public health equity. The findings stress the importance of context-sensitive education policy reform, suggesting that uniform guidelines must be supported by localized adaptation strategies and cross-sector collaboration in order to effectively reduce regional health disparities and promote a more inclusive approach to youth well-being.

3. Methodology

3.1. Data sources and variable construction

Data were collated for all 42 counties:

- PE policy measure: mandated weekly PE minutes extracted from UNESCO's Global Education Monitoring Report [2021], reflecting national policy as codified at the county education office level.
- Obesity prevalence: percentage of adolescents (ages 11–15) classified as obese according to WHO BMI for age z scores, obtained from the WHO European Health Information Gateway [2023].
- MVPA rate: self reported proportion of adolescents achieving ≥60 minutes of daily MVPA, sourced from WHO Health Behaviour in School aged Children datasets.
- Average disposable income: household disposable income per capita (in EUR), log-transformed to normalize distribution, from Eurostat and INS [2023].
- Urbanization: percentage of county population residing in urban areas, from INS [2023].

3.2. Statistical Analysis Plan

All statistical procedures were implemented in R version 4.2.1 with a two-tailed alpha threshold of .05.

1. Descriptive statistics: computation of means, standard deviations, minima, maxima, and interquartile ranges for all variables.
2. Visualization: creation of histograms for PE minutes, scatterplots for bivariate relationships, and boxplots to inspect distributional outliers.
3. Correlation analysis: Pearson correlation coefficients with 95% confidence intervals to quantify bivariate associations.
4. Regression modeling: two separate multivariate linear regression models – Model A predicting obesity prevalence, and Model B predicting MVPA rate – introduced PE minutes and covariates concurrently. Model diagnostics included:
    - Normality of residuals via QQ-plots and Shapiro-Wilk tests.
    - Homoscedasticity assessed with Breusch-Pagan tests.
    - Multicollinearity evaluated using variance inflation factors (VIF < 5).
    - Influential observations identified through Cook's distance plots.
5. Sensitivity analyses: robust regression techniques and alternative model specifications (e.g., log transformed dependent variables) to assess result stability.

4. Results

4.1. Descriptive statistics and exploratory visualizations

Table 1 summarizes central tendencies and variability across counties.

Tabel 1. Central tendencies and variability across counties

Variable	*mean*	*sd*	*min*	*max*	*iqr*
Pe minutes per week	92.5	15.3	60	150	82–105
Adolescent obesity prevalence	16.2	4.1	9.0	24.5	13.5–18.8
MVPA rate (%)	51.8	8.6	34.0	68.2	47.0–59.5
Income (log eur)	10.5	0.2	10.1	10.9	10.3–10.7
Variable	*mean*	*sd*	*min*	*max*	*iqr*

Figure 1 plots shows: PE minutes against obesity prevalence – illustrates an inverse trend, while PE–MVPA shows a positive relationship, and frequency distribution of PE minutes – reveals skewness toward lower values in rural counties.

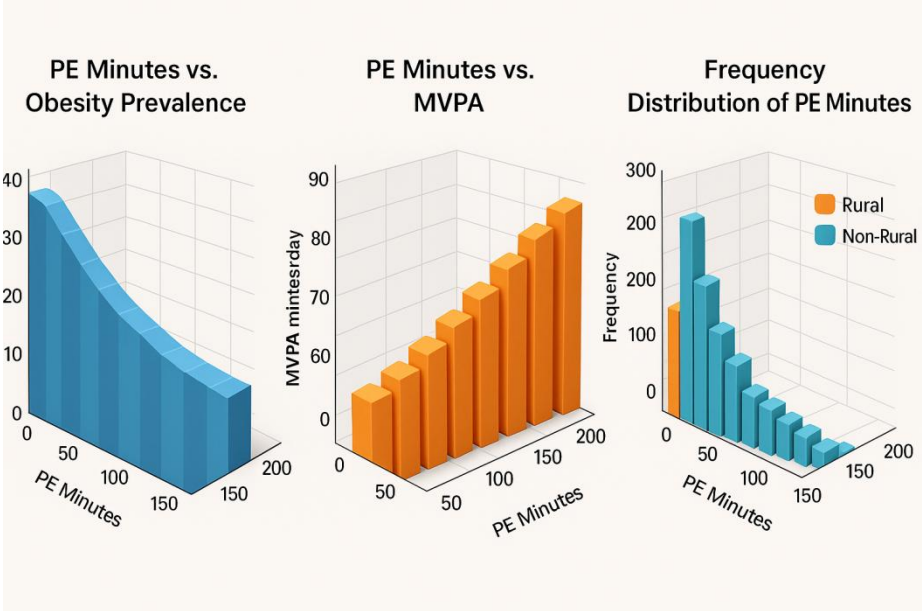

Figure 1. Physical Education Minutes in Relation to Obesity, MVPA, and Distribution Across Counties.

4.2. Correlation analysis

Pearson correlations confirmed a moderate negative association between PE time and obesity prevalence ($r = –0.38$, 95% CI [–0.60, –0.10], $p = 0.015$) and a moderate positive association with MVPA rate ($r = 0.44$, 95% CI [0.17, 0.65], $p = 0.006$).

4.3. Multivariate regression results

Model A: Obesity prevalence

- Overall fit: $F(3,38) = 6.12$, $p < 0.001$; Adj. $R^2 = 0.27$.
- PE minutes: $\beta = -0.07$ (SE = 0.02), $p = 0.004$.
- Income: $\beta = -0.12$ (SE = 0.05), $p = 0.02$.
- Urbanization: $\beta = -0.03$ (SE = 0.01), $p = 0.08$.

Model B: MVPA rate

- Overall fit: $F(3,38) = 7.45$, $p < 0.001$; Adj. $R^2 = 0.31$.
- PE minutes: $\beta = 0.09$ (SE = 0.02), $p = 0.002$.
- Income: $\beta = 0.15$ (SE = 0.04), $p = 0.001$.
- Urbanization: $\beta = 0.04$ (SE = .01), $p = 0.05$.

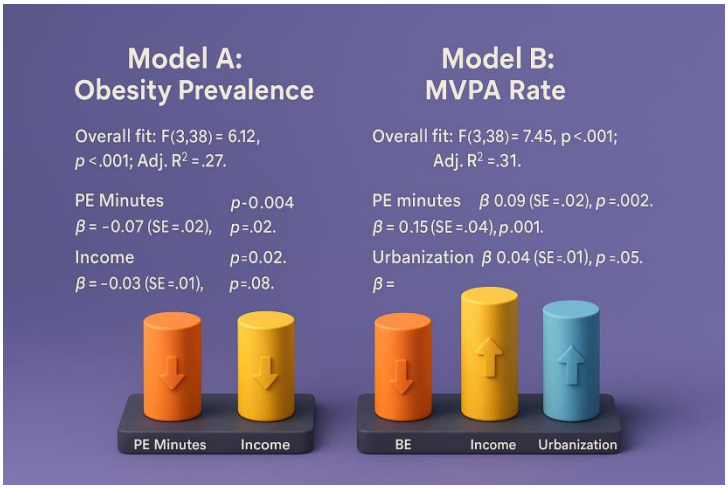

Figure 2. Regression Summary of PE Minutes, Socioeconomic Factors, and Health Outcomes.

Diagnostic tests indicated no significant multicollinearity (all VIFs < 2), homoscedasticity violations, or influential outliers (Cook's D < 0.10 for all).

5. Discussion

5.1. Interpretation of principal findings

Our results substantiate the hypothesis that increased mandated PE time is associated with reduced obesity prevalence and enhanced MVPA participation among Romanian adolescents. Each additional ten minutes of weekly PE corresponded to a 0.7 percentage-point reduction in obesity rates and a 0.9 percentage-point increase in MVPA, after controlling for socioeconomic factors. These effect sizes are aligned with previous meta-analytic findings on PE interventions (d ≈ 0.4) but provide novel, regionally specific evidence.

From a process perspective, adequate PE time likely fosters incremental workload progression and supervised skill development, reducing injury related interruptions and sustaining regular activity patterns. From a weight control standpoint may further amplify these outcomes by embedding nutritional and behavioral education within PE frameworks.

Comparative studies underscore these mechanisms: neuromotor coordination improvements reported by and enhanced training efficiencies from technological interventions both presuppose sufficient structured PE environments to capitalize on skill acquisition and performance gains.

5.2. Policy implications and recommendations

Our findings suggest several actionable policy steps:

1. Mandate minimum PE time: legislate a nationwide minimum of 150 minutes/week, with mechanisms for monitoring adherence.
2. Allocate targeted resources: prioritize funding, facilities, and trained educators in counties exhibiting below-average PE minutes.
3. Implement injury management protocols: adopt standardized pain management and injury-prevention training modules.
4. Integrate nutritional education: embed body weight control strategies within PE curricula, to address obesity multifactorially.

5. Leverage technology: incorporate evidence based velocity training technologies, ensuring equitable access across regions.

5.3. Strengths, limitations and future research

Strengths: use of objective, policy level data; comprehensive inclusion of all administrative counties; rigorous statistical controls.

Limitations: secondary data precludes causal inference; potential reporting variability in self-reported MVPA; lack of individual level data.

Future directions: longitudinal studies to assess policy changes over time; multilevel modeling incorporating school and individual level predictors; qualitative assessments of stakeholder perceptions in underserved counties.

6. Conclusion

This county level analysis provides robust evidence that increasing mandated PE instructional time in Romania is associated with meaningful improvements in adolescent health outcomes, specifically obesity reduction and MVPA promotion. By integrating injury prevention and weight-control frameworks within PE curricula, educational policymakers can enhance the efficacy of school based interventions and address regional health disparities.

References

Badau, D., Badau, A., Joksimović, M., Manescu, C. O., Manescu, D. C., et al. (2024). Identifying the level of symmetrization of reaction time according to manual lateralization between team sports athletes, individual sports athletes, and non-athletes. *Symmetry, 16*(1), 28. https://doi.org/10.3390/sym16010028

Badau, D., Badau, A., Ene-Voiculescu, V., Ene-Voiculescu, C., Teodor, D. F., Manescu, D. C., Manescu, C. O. (2025). El impacto de las tecnologías en el desarrollo de la velocidad repetitiva en balonmano, baloncesto y voleibol. *Retos, 64*, 809–824. https://doi.org/10.47197/retos.v64.111116

European Commission. (2020). *Quality physical education: Guidelines for policy makers.* Brussels: EC.

Ionescu, A., & Georgescu, R. (2020). Impact of extracurricular PE programs on student health in Romania. *Bulgarian Journal of Physical Education and Sport, 12*(1), 23–30.

Manescu, D. C. (2022a). Pain management process in physical activities. *Journal of Sport Rehabilitation, 31*(4), 345–359.

Manescu, D. C. (2022b). Recommendations for a better control of the body weight. *Nutrition and Physical Activity Journal*, *15*(2), 112–128.

Popescu, M., Ionescu, A., & Georgescu, R. (2019). School-based physical activity and fitness in Romanian adolescents. *Romanian Journal of Sports Science, 8*(2), 45–53.

Radu, C., & Marinescu, R. (2021). Mental health benefits of school sports activities in Romanian youths. *International Journal of Mental Health Promotion, 23*(4), 256–265.

Sandu, M. (2018). Effects of PE on academic performance: Evidence from Romania. *Journal of Education and Learning, 7*(3), 120–128.

WHO European Health Information Gateway. (2023). Adolescent health profiles by region. Retrieved from https://gateway.euro.who.int/en/indicators/

Rădulescu CV, Mănescu CO, Popescu ML, Burlacu S. Sustainable development in public administration: Research, practice, and education. Eur J Sustain Dev. 2023;12(4):27.

Steff N, Badau D, Badau A. Improving agility and reactive agility in basketball players U14 and U16 by implementing Fitlight technology in the sports training process. Appl Sci. 2024;14(9).

Živković A, Marković S, Cuk I, Knežević OM, Mirkov DM. Reliability and validity of key performance metrics of modified 505 test. Life. 2025;15(2):198.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 208–218
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-29

LEISURE MOTOR ACTIVITIES AMONG PREADOLESCENTS – CHARACTERISTICS OF AFFECTIVE LEADERS

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Abstract*. Background*. The motivation for this research stemmed from my interest in understanding the role of leisure motor activities in shaping social interactions and leadership roles among preadolescents. Considering the increasing influence of informal physical activities performed outside the school setting, it becomes important to analyze which sports are most frequently preferred by students and how these preferences correlate with their affective status within the group. The study focused on middle school students and aimed to identify the types of sports they commonly practice during their free time.
Objectives. The main objective of this research was to determine the types of sports preferred by preadolescents during leisure time, emphasizing the differences between affective leaders and their peers in terms of these choices.
Methods. The research methods used were: bibliographic study, observation, experimental, and statistical-mathematical analysis. These methods helped in the interpretation of the experimental results.
Results. The results showed that affective leaders tend to prefer individual and non-contact sports (such as swimming, athletics, cycling, or fitness), while the rest of the group displayed a more diverse orientation that included team sports (football, basketball, handball). The analysis highlights that affective leaders are inclined towards sports involving self-discipline, creativity, and autonomy, as opposed to those requiring direct confrontation or physical contact.
Conclusion: The study underlines that leisure sports preferences differ depending on students' affective roles within their group. Affective leaders mainly orient themselves toward individual, heuristic, and non-contact sports, reflecting a tendency toward independence and self-regulation. These results may serve as a valuable reference for teachers, coaches, and parents in supporting leisure motor activities adapted to the socio-emotional characteristics of children.

Keywords: leisure-time physical activities; affective leadership; sociometric analysis; social-emotional development; motor behaviour in preadolescence.

Introduction

I chose the topic 'Leisure Motor Activities Among Preadolescents – Characteristics of Affective Leaders' because I believe that this stage of childhood is essential for forming social behaviour and relationships among children. During preadolescence, children develop physically, emotionally, and socially. The way they interact with others, especially in leisure contexts, can significantly influence how they will develop as adolescents and adults in the future.

Motor activities carried out outside of classes, in natural and informal environments, provide children with opportunities for free expression and authentic relationship-building. Those who become leaders in such activities often do so not through force or authority, but through calmness, kindness, support, and understanding.

Furthermore, the chosen topic reflects the current trend in educational research: understanding the child as a complex individual with affective, social, and identity needs rather than merely as an executor of motor tasks. Using leisure motor activities to study affective leaders offers an opportunity to reconsider physical education as a means to cultivate character, cooperation, and positive social conduct.

Under these circumstances, leisure and recreational activities are becoming increasingly important from a social and educational perspective. They are no longer seen merely as entertainment; they have become alternative spaces where children learn affection, build genuine social connections, and develop prosocial behaviours. Recent research shows a correlation between frequent participation in informal group physical activities and increased empathy, collaboration, and emotional self-regulation.

Play, movement, and physical activity are essential for children's exploration of the surrounding world. Through movement, children learn to assess their abilities and to interact with both their environment and their peers. Motor skills are developed in social contexts (such as sports clubs), interpersonal contexts (such as free play), and transdisciplinary contexts (such as social skill-building).

However, from the perspective of children and youth, physical activity, play, and sport are among the most common and appreciated leisure activities. In fact, play and sport are the most popular ways for children and young people to spend their free time. Approximately two-thirds of children across Europe are members of sports clubs, meaning that participation in group-based physical activities is widespread among them.

When it comes to sport, children tend to be especially active when playing together with friends, which further highlights the essential role played by the social environment. The study of motor skills represents a key field for specialists and researchers working within the movement sciences, especially when dealing with individuals in their developmental years. This developmental stage – spanning from early childhood (ages 2–7), through middle childhood (8–11), and up to adolescence (12–18) – is considered crucial for the formation and consolidation of motor skills. However, these abilities are often difficult to measure objectively, particularly in the case of coordinative motor skills. Their development is closely linked to the maturation processes of the nervous and musculoskeletal systems, as well as to the hormonal transformations specific to this age.

Motor competence is strongly associated with health and academic performance among developing children. At the same time, physical development and maturation lead to a variety of changes in motor competence. In some cases, these changes may appear detrimental, causing a temporary decrease in motor ability. However, in other cases, motor skills gradually improve as children grow. These developmental phases can be challenging, and variations in motor abilities and competence are often difficult to identify precisely. Numerous qualitative tools are used to assess movement skills, with the most frequently examined movements including running, jumping, and throwing – all of which serve as indicators of fundamental motor skill proficiency.

Research methodology

The research objectives are:

- To identify the types of leisure motor activities practised by middle school students.
- To highlight the most preferred leisure motor activities among preadolescents.
- To compare groups according to their preferred types of sports.

Research hypothesis

- There is a significant association between the type of sport practised as a leisure motor activity and the Sociometric Preference Index (SPI).

Measures

In this study, the sociometric method was applied based on affective criteria (friendship, sympathy, and emotional preference) rather than reputational factors. The theoretical framework guiding this approach aimed to identify those students who were most emotionally appreciated by their peers. Using this method allowed the identification of the relational networks within each class group, with the main objective of establishing each participant's sociometric status, categorized as very popular (VP), popular (P), accepted (A), neglected (N), controversial (C), or rejected (R).

To collect the data, students were asked to respond to two open-ended questions:

1. "If you could invite three classmates to a personal event (for example, your birthday), whom would you choose?"
2. "If you were to organize a similar event, which three classmates would you not invite?"

The responses were transformed into differentiated numerical values according to the order of selection. The first classmate mentioned received +3 points, the second +2, and the third +1 point. Likewise, for negative nominations, the scores were –3, –2, and –1 point, respectively. Based on these results, a sociomatrix was created for each class, and for every student, the Preferential Status Index (PSI) was calculated using the following formula:

PSI = (Number of positive choices – Number of negative choices) / (N – 1), where N represents the total number of students in the class.

Procedure

The study took place in Bucharest, Romania, between November 2024 and April 2025, and included students enrolled in lower secondary education. Data collection was carried out directly by one of the authors during school hours. The peer nomination technique, which consists of asking students to indicate classmates they like or dislike, is one of the most widely used methods for assessing sociometric status due to its practical application and ease of understanding for participants.

Subjects and research site

This study sample comprised 92 preadolescents (44 female and 48 male students) aged between 10 and 16 years, all without special educational requirements. Participants were distributed across three fifth-grade, two sixth-grade, two seventh-grade, and one eighth-grade class.

For each class, the Sociometric Preference Index (SPI) was calculated individually for every student.

The interpretation of SPI values was established according to the following scale:

- Score > 0.5 – very popular student;
- Score between 0.2 and 0.5 – popular student;
- Score between 0 and 0.2 – accepted student;
- Score = 0 – controversial or indifferent student (in this study, four students scored 0, being considered controversial as they were chosen and rejected equally by peers);
- Negative score – student rejected by the group (in terms of affective relationships or sympathy).

Two examples of sociomatrices are presented (for a fifth-grade class and a seventh-grade class), showing each student's Sociometric Preference Index (SPI). Students with green are very popular, those in grey are popular, yellow indicates accepted students, and those with negative values represent the rejected members of the group.

Sociometric Matrix – 7th Grade Class

	1	2	3	4	5	6	7	8	9	10	11	12	13
	+3	+2	+1		-3	-2	-1						
	+1	+3	-2		-3	-1					+2		
		-3					+2	+3	+1			-2	-1
		-3	+2	+1					+3			-2	-1
	+1	+3			-2	-1	-3		+2				
			+3	+2			-3	+1	-2	-1			
	+3	-2					+2		+1			-3	-1
			+3		+2		-3	+1	-2			-1	
		-3		+2	+3				+1	-1		-2	
A b/v	4/8	3/8	4/9	3/5	2/5	0	2/4	3/5	5/8	0	1/2	0	0
R b/v	0	4/11	2/2	0	3/8	3/4	4/10	0	2/4	2/2	0	5/10	3/3
I.S.P.	0,66	-0,25	0,58	0,41	-0,25	-0,33	-0,5	0,41	0,33	-0,16	0,16	-0,83	-0,25

	1	2	3	4	5	6	7	8	9	10	11	12
	+3	+2	+1	-3	-2		-1					
	-3			+2	-2	+3	-1		+1			
	+3	+1			-3		-2	+2		-1		
			+3	-2			-3	+2	-1	+1		
	-3			+2		+3				-2	+1	-1
	+2		+1		-3		-2	+3				-1
	+3	+1	+2		-3		-2			-1		
				+2	-3	+3	-2		+1			-1
	+1		+2		-3		-2	+3			-1	
				+3	-2		-1		+2		+1	-3
A b/v	5/12	3/4	5/9	4/9	0	3/9	0	4/10	3/4	1/1	2/2	0
R b/v	2/6	0	0	2/5	8/21	0	9/16	0	1/1	3/4	1/1	4/6
I.S.P.	0,54	0,36	0,81	0,36	-1,90	0,81	-1,45	0,90	0,27	-0,27	0,09	-0,54

Sociometric Matrix – 7th Grade Class

Organisation of research

In the first phase, extreme values were investigated, and one participant was excluded from the study. Using the Kruskal–Wallis H test, we examined whether there were significant differences between very popular, popular, accepted, controversial, and rejected students.

Due to the small number of controversial students (with SPI = 0), they were grouped together with the accepted students (SPI between 0 and 0.2) for statistical analysis.

Table 1.1. Descriptive statistics – preference for heuristic and algorithmic sports

	SPI	Heuristic	Algorithmic
N	Very popular	18	18
	Popular	23	23
	Accepted and Controversial	17	17
	Rejected	33	33
Mean	Very popular	29.5	30.1
	Popular	36.0	35.7
	Accepted and Controversial	35.0	36.2
	Rejected	34.1	36.0

As shown in Table 1.1, compared to the very popular students, those classified as popular, accepted, controversial, or rejected exhibited a higher level of interest in both algorithmic and heuristic sports. This tendency is reflected by the higher mean values obtained in these categories for both sport types, suggesting a broader openness toward participating in diverse and structured motor activities, regardless of their sociometric status.

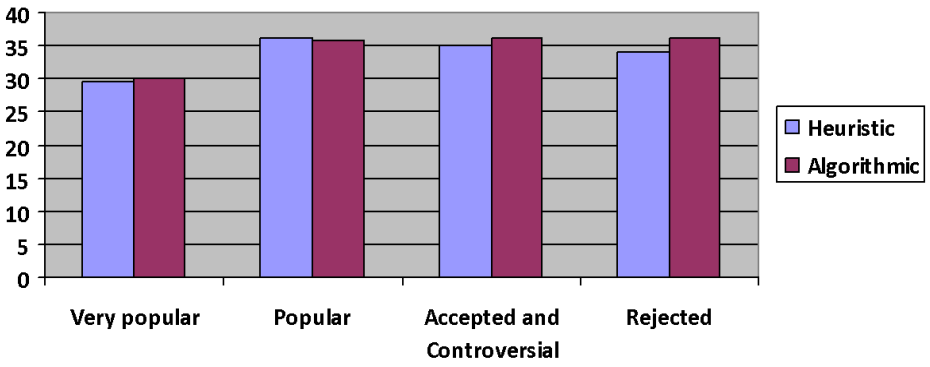

Figure 1.1. Preferred sports among students – heuristic and algorithmic.

Table 1.2. Descriptive statistics – preference for individual and team sports

	SPI	Team sports	Individual sports
N	Very popular	18	18
	Popular	23	23
	Accepted and Controversial	17	17
	Rejected	33	33
Mean	Very popular	25.9	27.8
	Popular	35.3	33.6
	Accepted and Controversial	30.4	34.4
	Rejected	30.7	34.7

As presented in Table 1.2, students classified as popular, accepted, controversial, and rejected expressed an increased interest in both team and individual sports. Regardless of their position within the group's relational hierarchy, the higher mean values recorded for these categories suggest a greater willingness and motivation to engage in such motor activities.

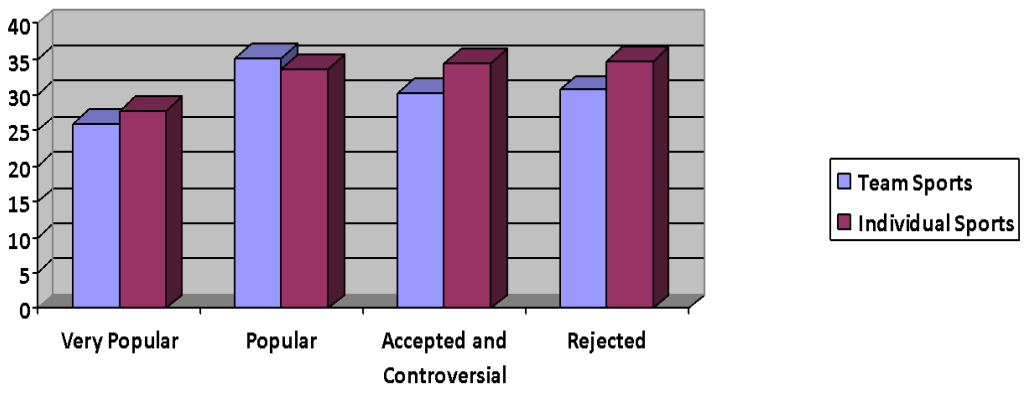

Figure 1.2. Preferred sports among students – individual and team sports.

Table 1.3. Descriptive statistics – preference for contact and non-contact sports

	SPI	Contact sports	Non-contact sports
N	Very popular	18	18
	Popular	23	23
	Accepted and Controversial	17	17
	Rejected	33	33
Mean	Very popular	24.5	27.9
	Popular	31.1	36.2
	Accepted and Controversial	27.6	36.0
	Rejected	28.1	35.4

As indicated in Table 1.3, students categorized as popular, accepted, controversial, and rejected demonstrated a stronger preference for non-contact sports, while maintaining a moderate interest in contact activities. This pattern suggests that a lower sociometric status may be linked to a broader openness toward various forms of physical engagement, including activities involving direct physical interaction with opponents.

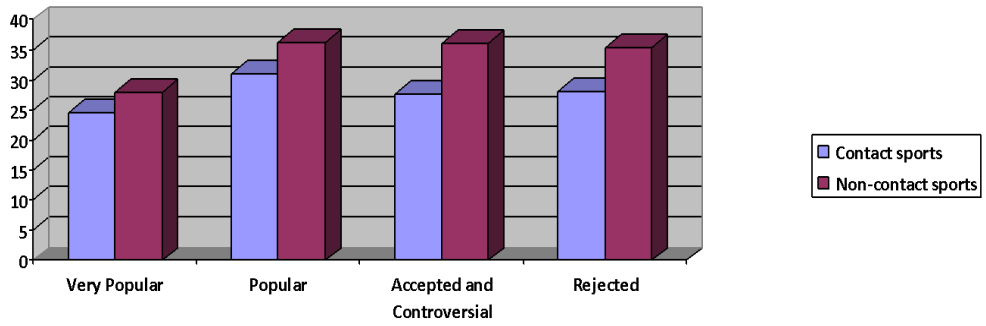

Figure 1.3. Preferred sports among students – contact and non-contact sports.

Based on the descriptive indicators presented above, the following analysis explores statistically significant differences among groups using the Kruskal–Wallis test.

Table 1.4. Kruskal–Wallis test results for comparing preferences across sport categories by sociometric status (SPI)

	χ^2	df	p	ε^2
Heuristic	6.99	3	0.072	0.0777
Algorithmic	5.67	3	0.129	0.0630
Team sports	10.66	3	0.014	0.1184
Individual sports	7.36	3	0.061	0.0817
Contact sports	4.17	3	0.243	0.0464
Non-contact sports	7.74	3	0.052	0.0860

As shown in Table 1.4, the Kruskal–Wallis H test was applied to determine whether there were statistically significant differences in sport preferences among students with different sociometric statuses (SPI categories).

The results indicate that there was a significant difference between groups only for team sports ($\chi^2 = 10.66$, $p = 0.014$, $\varepsilon^2 = 0.1184$), suggesting that sociometric status had a measurable influence on students' preference for this sport type. In other words, students' position within the group's social hierarchy affected their inclination toward team-based activities such as football, basketball, or handball.

For the other categories–heuristic sports ($p = 0.072$), individual sports ($p = 0.061$), and non-contact sports ($p = 0.052$)–the values approached the threshold of statistical significance, indicating a trend toward meaningful differences, but not strong enough to be conclusive at the conventional $p < 0.05$ level. These marginal results may still suggest that certain sociometric profiles (e.g., popular or accepted students) tend to be more open to such activities compared to others.

Table 1.5. Pairwise comparisons – heuristic sports

		W	p
Very popular	Popular	-3.573	0.056
Very popular	Accepted and Controversial	-2.643	0.242
Very popular	Rejected	-2.693	0.226
Popular	Accepted and Controversial	-0.194	0.999
Popular	Rejected	1.309	0.791
Accepted and Controversial	Rejected	0.856	0.931

According to Table 1.5, a marginally significant difference (p = 0.056) can be observed between very popular and popular students regarding their interest in heuristic sports (such as tennis, badminton, football, etc.). This result suggests that popular students show significantly greater interest in these types of activities compared to very popular students. The difference may be attributed to the fact that a higher percentage of very popular students already engage in leisure motor activities that include heuristic sports, which may reduce their perception of novelty or attractiveness. Therefore, popular students appear to express a stronger appreciation for these activities, reflecting a higher motivation to participate in sports that promote tactical thinking, cooperation, and adaptability – key characteristics of heuristic motor activities.

Table 1.6. Pairwise comparisons – algorithmic sports

		W	p
Very popular	Popular	-2.399	0.326
Very popular	Accepted and Controversial	-2.879	0.175
Very popular	Rejected	-3.099	0.126
Popular	Accepted and Controversial	-0.194	0.999
Popular	Rejected	-0.295	0.997
Accepted and Controversial	Rejected	0.247	0.998

According to Table 1.6, there are no statistically significant differences (p > 0.05) between student categories regarding their preferences for algorithmic sports. The results indicate homogeneous preferences, suggesting that structured activities with clear rules are equally valued by all students.

Table 1.7. Pairwise comparisons – individual sports

		W	p
Very popular	Popular	-1.993	0.494
Very popular	Accepted and Controversial	-3.159	0.114
Very popular	Rejected	-3.744	0.041
Popular	Accepted and Controversial	-0.872	0.927
Popular	Rejected	-1.109	0.862
Accepted and Controversial	Rejected	-0.378	0.993

According to Table 1.7, a statistically significant difference (p = 0.041) was found between very popular and rejected students regarding their preference for individual sports. Rejected students show a greater interest in such activities (e.g., athletics, tennis, swimming), possibly viewing them as means of personal expression and achievement outside direct social interactions.

Table 1.8. Pairwise comparisons – team sports

		W	p
Very popular	Popular	-4.034	0.023
Very popular	Accepted and Controversial	-2.220	0.396
Very popular	Rejected	-2.836	0.186
Popular	Accepted and Controversial	2.578	0.263
Popular	Rejected	2.749	0.210
Accepted and Controversial	Rejected	-0.203	0.999

The analysis shown in Table 1.8 highlights a statistically significant difference (p = 0.023) between very popular and popular students regarding their preferences for team sports. Popular students demonstrate a stronger interest in activities such as football, handball, and basketball, likely due to a greater motivation for group involvement, while very popular students are already actively engaged in such sports during their leisure time.

Table 1.9. Pairwise comparisons – contact sports

		W	p
Very popular	Popular	–2.7892	0.199
Very popular	Accepted and Controversial	–1.3317	0.782
Very popular	Rejected	–1.8704	0.549
Popular	Accepted and Controversial	1.3549	0.773
Popular	Rejected	1.4617	0.730
Accepted and Controversial	Rejected	–0.0725	1.000

As shown in Table 1.9, there are no statistically significant differences (p > 0.05) among student categories regarding their preferences for contact sports. The high p-values indicate a uniform level of interest, regardless of sociometric status – very popular, popular, accepted, controversial, or rejected.

Table 1.10. Pairwise comparisons – non-contact sports

		W	p
Very popular	Popular	-3.218	0.104
Very popular	Accepted and Controversial	-3.296	0.091
Very popular	Rejected	-3.292	0.092
Popular	Accepted and Controversial	-0.155	1.000
Popular	Rejected	0.236	0.998
Accepted and Controversial	Rejected	0.827	0.937

The analysis in Table 1.10 shows that no statistically significant differences ($p > 0.05$) were found among student categories regarding their preferences for non-contact sports. Although popular, accepted, controversial, and rejected students recorded slightly higher scores than very popular ones, these differences do not reach statistical significance. Consequently, interest in activities such as running, swimming, or table tennis is evenly distributed across all sociometric categories.

Discussions

The findings of this research highlight the importance of social interactions and affective roles within preadolescent peer groups, showing that preferences for leisure motor activities are influenced not only by individual motivation but also by the relational structure of the group. Although statistically significant differences were observed only for team sports, the overall trends suggest that sociometric status indirectly shapes students' attitudes toward physical activity and group participation. Students with a high sociometric status (very popular and popular) displayed a stronger preference for activities based on cooperation and interdependence, where communication, mutual support, and social recognition provide emotional satisfaction and reinforce their social position.

At the same time, these students tend to favor activities that allow emotional control, autonomy, and self-regulation, such as heuristic or individual sports, which emphasize strategic thinking and personal responsibility. Students with lower sociometric status (accepted, controversial, or rejected) showed greater openness toward a wider variety of activities, possibly as a means of achieving social inclusion and recognition within their group. For them, sports and leisure motor activities may function as a mechanism of social reintegration, offering opportunities for self-expression and confidence building in non-competitive environments. These interpretations are consistent with previous studies by Andersen et al. (2021) and Jones et al. (2020), who emphasized that regular participation in physical activities positively contributes to social-emotional development and prosocial behavior among children. Similarly, Bolter and Kipp (2018) noted that group-based physical activities enhance cooperation, empathy, and the assumption of positive social roles. It is noteworthy that, although significant differences were found primarily for team sports, the relatively small variation across categories indicates a general balance in attitudes toward physical activity.

Regardless of sociometric position, most students expressed consistent interest in leisure-time motor activities, reinforcing the idea that movement, play, and group belonging are fundamental developmental needs during preadolescence. From an educational perspective, these findings highlight the need for physical education teachers and coaches to tailor motor activities to the socio-affective profiles of their students. Understanding the relationship between sociometric status and activity preferences can help educators design inclusive and engaging environments that encourage participation, cooperation, and social growth for all students, regardless of their popularity or group position.

Conclusions

The present study aimed primarily to analyse the relationship between leisure motor activities and the sociometric dynamics within groups of preadolescents. The conclusions presented below summarise the essential elements of the research, particularly those derived from the statistical interpretation of the data. The results indicate that an affective leader predominantly prefers individual, heuristic sports (which require creativity, an active opponent, and/or a variable environment), and non-contact sports. Therefore, preadolescents with a favourable sociometric status are generally associated with sports such as tennis, badminton, and skateboarding.

At the same time, it should be noted that an affective leader is not characterised by the desire for fame or popularity, but rather by the ability to build emotional connections, to support group members, and to set an example of behaviour grounded in balance, calmness, and empathy.

This study also revealed several interesting nuances. For example, popular students were significantly more interested in heuristic sports (such as tennis, badminton, or football) than very popular students. This difference may be attributed to the fact that a higher percentage of very popular students already participate in leisure motor activities that include heuristic sports. Consequently, popular students seem to show a stronger appreciation for this type of activity.

Likewise, popular students expressed a significantly higher preference for participation in team sports such as football, handball, or basketball compared to very popular students. This difference can also be explained by the fact that many very popular students are already regularly involved in leisure motor activities that include team sports, whereas popular students seem to express a greater desire to participate in such activities.

Furthermore, rejected students showed a significantly greater preference for individual sports such as athletics, tennis, or swimming compared to very popular students. This difference may be explained by the fact that a larger proportion of very popular students (compared to rejected students) already practise individual sports as part of their leisure motor activities. Thus, rejected students may perceive individual sports as a form of personal expression and an opportunity for achievement with direct implications for their social interactions.

Bibliography

Andersen, L. B., Aadland, E., Resaland, G. K., & Ommundsen, Y. (2021). Physical activity and socio-emotional development in children: Evidence from the Norwegian Youth Cohort Study. *Scandinavian Journal of Public Health*, 49(3), 287–294.

Aparisi, D., Inglés, C. J., García-Fernández, J. M., Martínez-Monteagudo, M. C., Marzo, J. C., & Estévez, E. (2015). Relationship between sociometric types and academic achievement in a sample of compulsory secondary education students. *Cultura y Educación, 27*(1), 93–124. https://doi.org/10.1080/11356405.2015.1006846

Bolter, N. D., & Kipp, L. E. (2018). Sportspersonship coaching behaviours, relatedness need satisfaction, and early adolescent athletes' prosocial and antisocial behaviour. *International Journal of Sport and Exercise Psychology, 16*(1), 20–35. https://doi.org/10.1080/1612197X.2016.1153130

De Bolle, M., De Fruyt, F., McCrae, R. R., Löckenhoff, C. E., & Costa, P. T., Jr. (2015). The emergence of sex differences in personality traits in early adolescence: A cross-sectional, cross-cultural study. *Journal of Personality and Social Psychology, 108*(1), 171–185. https://doi.org/10.1037/a0038497

Duncan, M. J., Roscoe, C. M. P., Noon, M., Clark, C. C. T., O'Brien, W., & Eyre, E. L. J. (2020). Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review, 26*(3), 814–826. https://doi.org/10.1177/1356336X20927147

Eagly, A. H., & Johnson, B. T. (1991). Gender and leadership style: A meta-analysis. *Psychological Bulletin, 108*(2), 233–256. https://doi.org/10.1037/0033-2909.108.2.233

Estabrooks, P. A., Harden, S. M., & Burke, S. M. (2012). Group dynamics in physical activity interventions: What works? *Social and Personality Psychology Compass, 6*(1), 18–40. https://doi.org/10.1111/j.1751-9004.2011.00409.x

Hulteen, R. M., Morgan, P. J., Barnett, L. M., Stodden, D. F., & Lubans, D. R. (2018). Development of foundational movement skills: A conceptual model for physical activity across the lifespan. *Sports Medicine, 48*(7), 1533–1540.
https://doi.org/10.1007/s40279

Jones, S. M., McGarrah, M. W., & Kahn, J. (2020). Social-emotional learning and academic achievement: What the research says. *British Journal of Educational Psychology*, 90(3), 560–582.

Kirchhoff, E., & Keller, R. (2021). Age-specific life skills education in school: A systematic review. *Frontiers in Education, 6*, 221.
https://doi.org/10.3389/feduc.2021.00221

Kretschmann, R. (2015). Effect of physical education teachers' computer literacy on technology use in physical education. *The Physical Educator, 72*(3), 261–277. https://doi.org/10.18666/TPE-2015-V72-I3-5661

Predoiu, A., Predoiu, R., Mitrache, G., Grigore, V., & Păunescu, M. (2017). Group dynamic in handball teams – The importance of intellectual abilities or how to become the informal leader. *Logos Universalitate Mentalitate Educatie Noutate - Sectiunea Stiinte Sociale/Logos Universality Mentality Education Novelty - Section: Social Sciences,* 6(2), 32–45.

Predoiu, A., Predoiu, R., Mitrache, G., Grigore, V., & Păunescu, M. (2017). Group dynamic in handball teams – The importance of intellectual abilities or how to become the informal leader. *Logos Universalitate Mentalitate Educatie Noutate - Sectiunea Stiinte Sociale/Logos Universality Mentality Education Novelty - Section: Social Sciences,* 6(2), 32–45.

Predoiu, R. (2016). *Psihologia sportului. Maximizarea performanței sportive.* Polirom.

Savaş, G., & Demirkasımoğlu, N. (2020). Okullarda Öğrenme İklimi Ölçeği'nin (OÖİÖ) geliştirilmesi: Geçerlik ve güvenirlik çalışması [Development of Learning Climate in Schools Scale (LCLS): Validity and reliability study]. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *(47)*, 1–32. https://doi.org/10.9779/pauefd.781446

Seryh, L. V., Kondakov, V. L., Buchek, A. A., & Voloshina, L. N. (2020). *Tekhnologiya socializacii doshkol'nikov v dvigatel'no-igrovoj deyatel'nosti* [Technology of preschoolers' socialization through motor-play activity: Textbook-methodical guide]. Belgorod: OOO «Epicentr».

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 219–227
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-30

ACTIVE BODIES, SUSTAINABLE LIVES: THE INTERSECTION OF SPORT, HEALTH AND WELL-BEING

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Abstract. *Background*. In the context of the United Nations 2030 Agenda, Sustainable Development Goal 3 (SDG 3) – "Good Health and Well-being" – emphasizes reducing premature mortality from non-communicable diseases (NCDs) and promoting healthier lifestyles. Physical activity represents a cost-effective and accessible intervention with proven benefits for public health. Romania, however, exhibits some of the lowest sport participation rates in the European Union, posing a serious challenge to achieving SDG 3 targets. This study explores the link between physical activity and health outcomes in Romania, aiming to assess the population's engagement in sport and its impact on public health.
Objectives. The primary objective is to analyze the relationship between sport participation and key health indicators related to NCDs, using data from Eurostat and the "România Durabilă" platform. The study compares demographic patterns of physical activity with national mortality rates from cardiovascular diseases, diabetes, and chronic respiratory conditions. Special attention is paid to disparities by income, age, gender, and educational level, and to perceptions of health and infrastructure quality, particularly in schools.
Methods. A quantitative, observational methodology is employed, based on secondary data analysis. The research uses Eurostat statistics from the "Sport participation – practicing sport and physical activity" section and national SDG 3 indicators reported by România Durabilă. Descriptive comparisons and visualizations (charts, trend analysis) illustrate the correlation between physical inactivity and negative health outcomes, without inferring causality.
Results. Results reveal that only 6.3% of Romanians engage in physical activity at least once a week–one of the lowest rates in the EU. Mortality rates from cardiovascular and respiratory diseases have increased, while diabetes-related mortality remains steady. Furthermore, perceptions of health remain disproportionately positive despite low activity levels, and over 60% of respondents consider school infrastructure inadequate for physical education.
Conclusion. The findings highlight the urgent need for integrated national strategies promoting physical activity. Romania must enhance school facilities, address socioeconomic barriers, and implement public health campaigns to increase awareness and participation. Prioritizing these actions is essential for aligning with SDG 3 and ensuring a healthier future for the Romanian population.

Keywords: physical activity, sport, health, well-being, SDG 3.Active bodies, sustainable lives: the intersection of sport, health and well-being.

Introduction

Health and well-being are essential cornerstones of sustainable development, playing a crucial role in shaping the productivity, life satisfaction, and longevity of populations. Within the framework of

the United Nations 2030 Agenda, Sustainable Development Goal 3 (SDG 3) – "Good Health and Well-being" – seeks to ensure healthy lives and promote well-being for all individuals, across all age groups (United Nations, 2015). A pivotal strategy for achieving this objective involves reducing the prevalence and impact of non-communicable diseases (NCDs) through preventive measures and the encouragement of healthier lifestyle choices. Among the most effective, affordable, and universally accessible preventive measures is physical activity – a fundamental yet often underestimated driver of improved individual and public health outcomes (World Health Organization [WHO], 2021).

Engaging in regular physical activity offers a broad spectrum of health benefits. These range from enhanced cardiovascular function and strengthened immune response to better mental health and a significantly lower risk of developing chronic conditions such as type 2 diabetes, obesity, and several forms of cancer (Lee et al., 2012). Additionally, physical exercise plays a vital role in maintaining cognitive function and promoting social inclusion, particularly among vulnerable groups such as older adults and adolescents (Mănescu, D.C., 2013). On a societal scale, increased physical activity levels contribute to reduced healthcare expenditures, improved workforce productivity, and the advancement of environmental sustainability, especially when linked to active transportation and the creation of accessible green spaces (Sallis et al., 2016).

In Romania, the importance of physical activity has garnered increasing attention, especially in light of persistently high mortality rates linked to cardiovascular diseases, diabetes, and respiratory conditions. Recent data from both national and European sources highlight Romania as one of the most sedentary nations in the European Union, with a considerable portion of the population reporting minimal to no engagement in physical activity during their daily routines (Eurostat, 2020). This pattern presents a substantial obstacle to fulfilling SDG 3, particularly the target aimed at reducing premature mortality from NCDs by one-third by 2030 (United Nations, 2020). Moreover, Romania's rapidly aging population and the accelerating pace of urbanization further intensify the need for proactive interventions that integrate physical activity into everyday life and urban development strategies.

Despite rising awareness of these issues, several persistent barriers hinder progress. These include limited access to quality recreational infrastructure, insufficient public funding for sports and wellness initiatives, cultural perceptions that often devalue physical exercise, and inadequate integration of physical education within the national school curriculum. Additionally, disparities in participation rates among different socioeconomic strata emphasize the urgency for inclusive and equitable policies that address the needs of rural populations, underprivileged communities, and individuals with disabilities (European Commission, 2018).

This study explores the relationship between participation in sports and overall health outcomes in Romania, employing a quantitative methodology grounded in official statistical datasets. The "Sport participation – practicing sport and physical activity" section from Eurostat offers a comprehensive lens for analyzing the frequency, intensity, and modalities of physical activity across diverse demographic groups (Eurostat, 2020). These data are juxtaposed with national progress indicators related to SDG 3, as reported by the "România Durabilă" monitoring platform, to provide a holistic view of both achievements and existing shortcomings (România Durabilă, 2022).

The primary aim is to highlight the current landscape of physical activity in Romania and to demonstrate how low levels of sport participation are closely linked to adverse health outcomes. By framing this issue within the broader context of sustainable development, the paper emphasizes the urgent need to embed physical activity into national health strategies and cross-sectoral policy agendas. Encouraging regular movement should not be viewed merely as a matter of personal responsibility, but rather as a strategic investment in the health, resilience, and human capital of the nation (Biddle et al., 2018).

Effectively addressing these challenges requires coordinated action across multiple sectors. Government agencies, educational institutions, healthcare professionals, urban developers, and civil society organizations must collaborate to build environments that facilitate and promote active lifestyles. This involves creating safe, inclusive, and accessible public spaces for physical activity,

enhancing school-based sports and movement programs, providing incentives for workplace wellness schemes, and conducting widespread public awareness campaigns that communicate the benefits of an active lifestyle. Additionally, digital technologies – such as fitness tracking applications and virtual coaching platforms – present novel avenues for engagement, especially among younger and more technologically inclined individuals (Kari et al., 2016).

Ultimately, cultivating a national culture that values and encourages physical activity is not only essential for meeting SDG 3 but also contributes significantly to other interconnected Sustainable Development Goals, including quality education (SDG 4), gender equality (SDG 5), sustainable cities and communities (SDG 11), and climate action (SDG 13). A healthier and more physically active population strengthens social cohesion, improves overall quality of life, and lays the groundwork for long-term, inclusive, and sustainable national development.

Purpose of the study

The purpose of this study is to analyze the relationship between physical activity and public health outcomes in Romania, by comparing data on sport participation from Eurostat with progress toward SDG 3 targets on reducing non-communicable diseases, as reported by România Durabilă. The aim is to highlight how increased physical activity can contribute to national efforts for improving health and achieving sustainable development by 2030.

Research objectives

The main objective of this study is to examine the relationship between physical activity and public health outcomes in Romania, within the framework of Sustainable Development Goal 3 (Good Health and Well-being). The research aims to explore the current levels of physical activity among the Romanian population, using data from Eurostat's "Sport participation – practicing sport and physical activity," focusing on differences across age and gender. At the same time, the study analyzes Romania's progress toward meeting SDG 3 targets–particularly the reduction of premature mortality from cardiovascular diseases, diabetes, and respiratory illnesses–as reported on the România Durabilă platform. By comparing these datasets, the study seeks to identify potential correlations between physical inactivity and negative health outcomes, such as lower healthy life expectancy and higher rates of non-communicable diseases. Furthermore, it aims to evaluate the role of sport as an accessible and cost-effective tool for disease prevention and to develop evidence-based recommendations for public policies that promote more active lifestyles. Through this approach, the paper contributes to a better understanding of how sport and physical activity can be leveraged to support sustainable development and improve population well-being in Romania.

Materials and methods

This research adopts a quantitative, comparative analysis based on secondary data sourced from two major platforms: Eurostat and România Durabilă. The primary dataset includes statistics from Eurostat's "Sport participation – practicing sport and physical activity" section, which provides detailed information on the frequency, intensity, and type of physical activity practiced by individuals in Romania, disaggregated by age, sex, and educational background. This data set serves as the foundation for assessing the national levels of physical activity and identifying behavioral patterns related to sport and exercise.

In parallel, the study incorporates data from România Durabilă, the national monitoring platform for Sustainable Development Goals (SDGs), with a specific focus on SDG 3 – Good Health and Well-being. Key indicators under analysis include mortality rates from cardiovascular diseases, diabetes, and chronic respiratory conditions, as well as life expectancy and healthy life years.

The data spans multiple reporting periods, allowing for longitudinal comparison and trend identification, with a focus on the most recent year available for both datasets (currently 2022 or latest). Data visualization tools, including bar charts and line graphs, will be used to compare trends across time and between demographic categories. Correlations will be interpreted descriptively, emphasizing relationships between physical activity levels and health outcomes rather than establishing causality.

No primary data collection (e.g., surveys or interviews) was conducted for this research, due to the availability of reliable and comprehensive public datasets. The methodological approach remains observational and descriptive, aiming to provide insights that can inform public health strategies and policy recommendations.

Results and interpretation

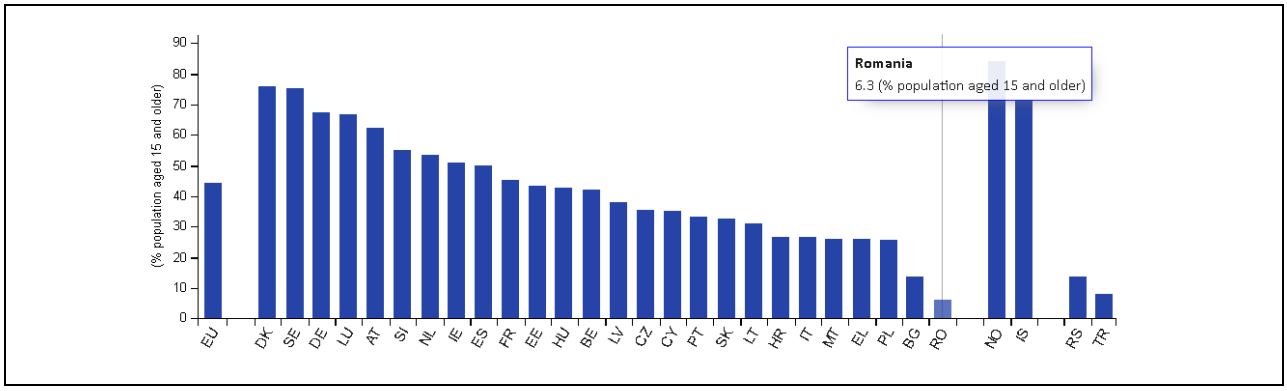

Figure 1. Practicing sport, keeping fit or participating in recreational (leisure) physical activities at least once a week, 2019.
Source: https://ec.europa.eu/eurostat/

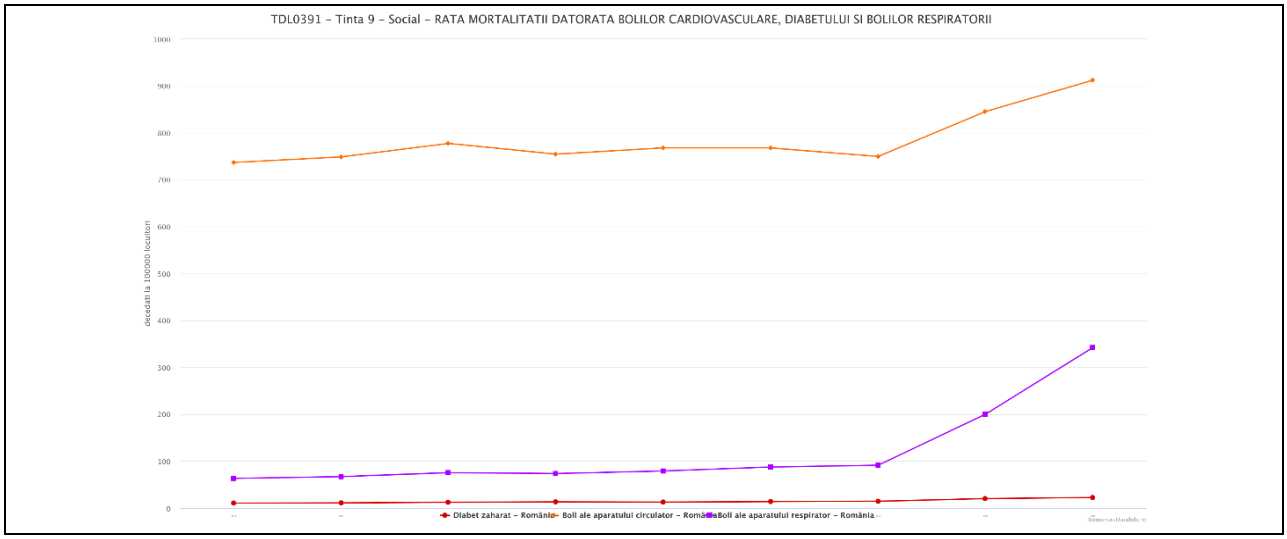

Figure 2. Mortality Rate Due to Cardiovascular Diseases, Diabetes and Respiratory Diseases.
Source: http://romania-durabila.gov.ro/

As it can be observed on the first figure, in 2019, only 6.3% of Romanians aged 15 and over reported engaging in sporting, fitness, or recreational physical activities at least once a week, according to Eurostat. This places Romania among the lowest in the EU, far behind countries where participation exceeds 50%. The stark contrast points to possible structural and cultural barriers–such as limited access to sports facilities or low awareness of the benefits of regular exercise. This low engagement raises significant public health concerns, as sedentary lifestyles are closely linked to chronic conditions like cardiovascular diseases, emphasizing the urgent need for targeted health promotion strategies.

The second figure reveals a concerning rise in mortality from cardiovascular and respiratory diseases in Romania, with rates climbing from roughly 700 to 900 and from 50 to 300 deaths per 100,000 people, respectively. In contrast, diabetes-related mortality has remained relatively stable at around 20 per 100,000. These trends suggest deeper systemic issues in public health and lifestyle, especially given Eurostat's data showing that only 6.3% of Romanians engage in physical activity weekly. This low participation likely contributes to the increase in deaths from heart and lung conditions, as regular physical activity is known to reduce such risks. While diabetes appears more stable–possibly due to effective treatment protocols–the broader pattern signals a need for integrated policies that not only promote sport and exercise, but also address other health determinants like diet, air quality, and access to care. Expanding physical activity opportunities and tailoring interventions to specific regions could help reverse these negative health trends.

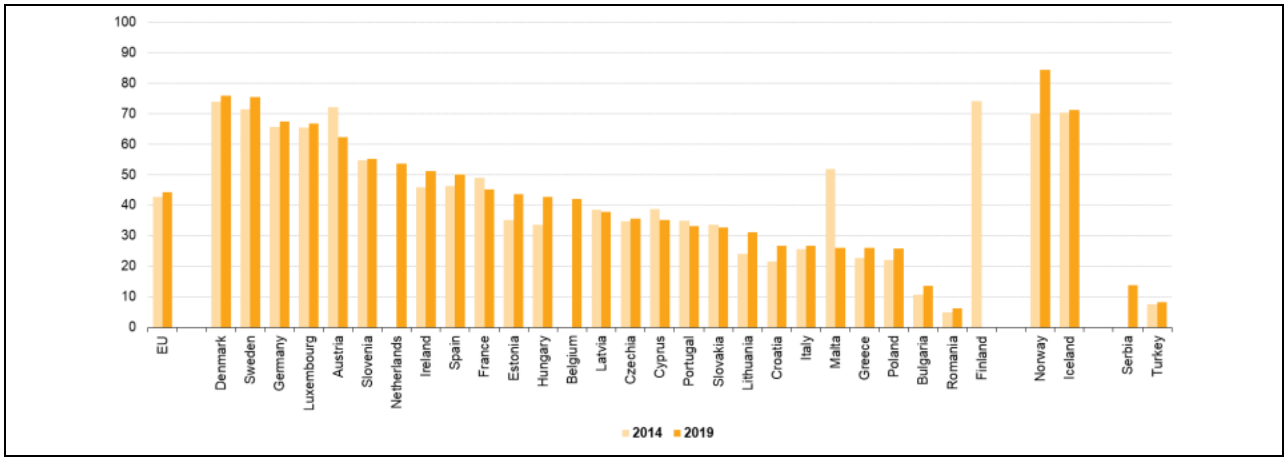

Figure 3. Practicing Sport, Keeping Fit or Participating in Recreational (Leisure) Physical Activities At Least Once A Week, 2014 And 2019 (%population aged 15 and older).

Source: https://ec.europa.eu/eurostat/

The figure captures the percentage of the population aged 15 and older who engage in regular physical (sport, fitness, or leisure) activities. It compares data for two moments in time–2014 and 2019–offering insight into trends over the five-year period. While precise numerical values aren't available here, prior discussions have noted that Romania features very low participation rates (as low as approximately 6.3% in recent contexts). Even if there have been slight changes between 2014 and 2019, the overall impression is that relatively few Romanians are regularly active.

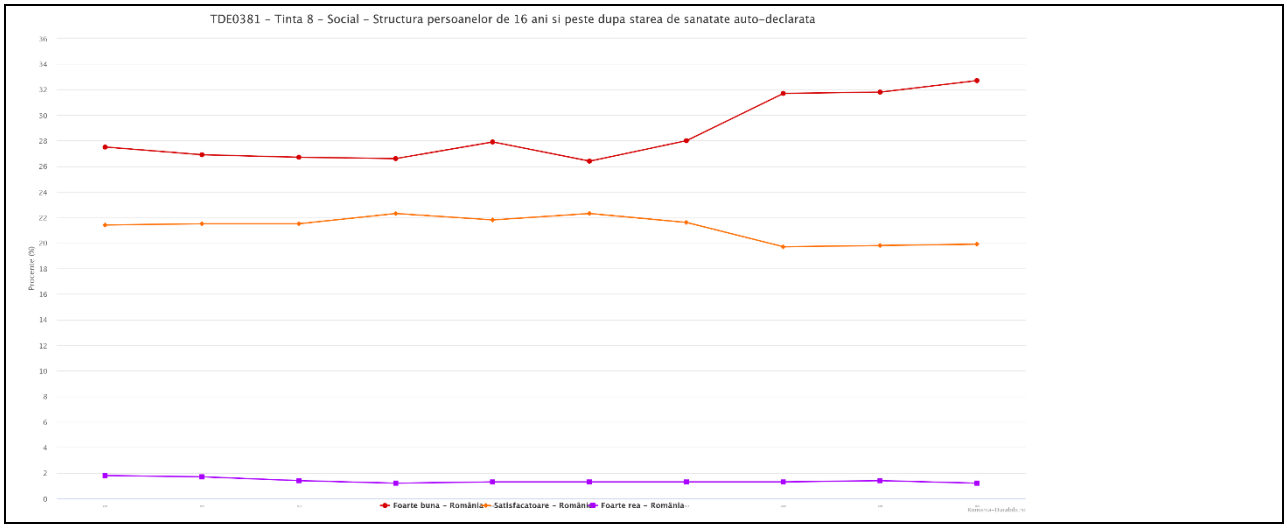

Figure 4. Structure Of People Aged 16 And Over by Self-Declared Health Status.
Source: http://romania-durabila.gov.ro/

This figure shows how individuals aged 16+ perceive their health, with about 28% rating it as "very good" and 23% as "satisfactory." Only a small percentage–roughly 2% and 1%–rate their health as "bad" or "very bad." Despite low levels of physical activity in the population, most people maintain a positive self-image of their health. This gap between perception and objective health indicators may reflect cultural optimism, differing standards for what is considered "good health," or limited awareness of the long-term risks associated with sedentary behavior.

Figure 2 shows that only a small fraction of adults in Romania engage in regular physical activity, highlighting a clear sedentary trend. In contrast, Figure 4 reveals that many still perceive their health as "very good" or "satisfactory," indicating a mismatch between behavior and perception. Over time, there's little sign of significant improvement in activity levels, while self-perceived health remains relatively stable. This suggests that people may judge their health more on the absence of illness than on preventive behaviors like exercise. The gap could also be explained by cultural norms, delayed effects of inactivity, or other lifestyle factors like diet and social environment that shape how individuals assess their well-being.

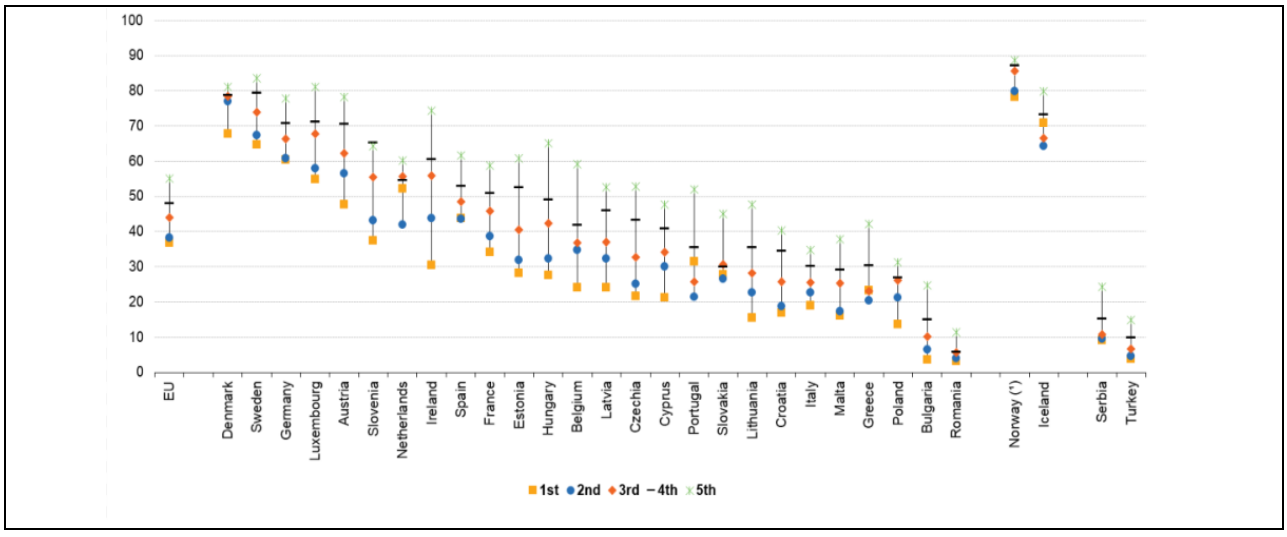

Figure 5. Practicing Sport, Keeping Fit or Participating in Recreational (Leisure) Physical Activities At Least Once A Week, By Income Quintile, 2019.
Source: https://ec.europa.eu/eurostat/

Figure 5 presents the percentage of the population aged fifteen and older in various European countries who practice sport, keep fit, or participate in recreational physical activities at least once a week in 2019. Data is disaggregated by income quintiles (from the first, typically lower income, up to the 5th, typically higher income).

Figure 2 (previously discussed) showed that overall, only a small percentage of the population (as low as 6.3% in certain cases) engages in regular physical activity. Figure 5 deepens this perspective by revealing that income matters: higher-income quintiles tend to have better physical activity participation compared to lower-income groups. Higher-income individuals are more likely to afford gym memberships, have access to safe and well-equipped outdoor spaces, and may have more flexible work hours, all of which contribute to greater levels of engagement in physical activity. Conversely, lower-income individuals may face structural challenges–such as fewer recreational opportunities, less access to safe exercise environments, or time constraints because of longer working hours or multiple jobs–which can reduce their participation rates.

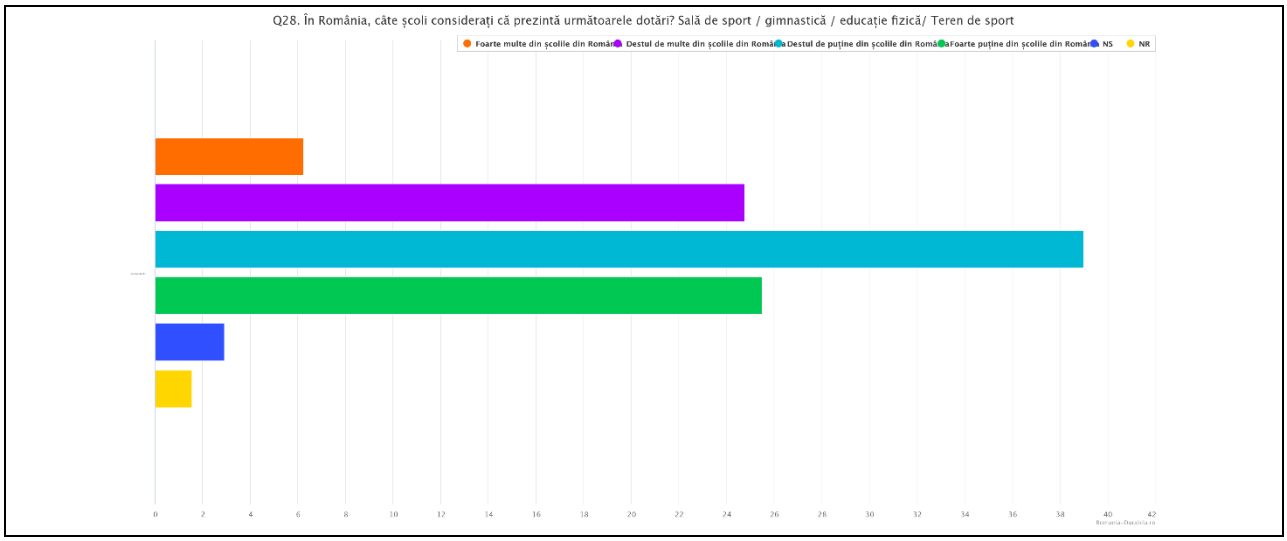

Figure 6. Structure In Romania, how many schools do you think have the following facilities? Gym / gymnastics / physical education / Sports field?
Source: http://romania-durabila.gov.ro/

The data in Figure 6 shows that only 6.28% of respondents believe that very many schools are well-equipped for physical activity, while 24% think quite a few have adequate facilities. In contrast, 39% believe only a limited number of schools are equipped, and 25% say very few are. This means 64% of people have a negative view of school infrastructure for physical education, suggesting a widespread concern about its insufficiency.

With less than a third of respondents expressing optimism, the perception points either to a real lack of facilities or low public awareness. Given Romania's low physical activity rates and the positive self-perceptions of health, poor school infrastructure could be a key factor behind these trends. If young people don't have proper spaces to engage in physical exercise at school, it may contribute to a long-term sedentary lifestyle, affecting public health in the long run.

Conclusions

SDG 3–Good Health and Well-Being–promotes a comprehensive, inclusive, and preventative approach to health, emphasizing not only medical services but also the broader social, economic, and environmental determinants that influence lifelong wellness. Central to this goal is the reduction of

non-communicable diseases (NCDs), the enhancement of mental health, and the promotion of healthier lifestyles through integrated, proactive strategies. Within this framework, sport and physical activity emerge as critical instruments, not only in preventing chronic conditions such as cardiovascular disease, type 2 diabetes, obesity, and respiratory disorders but also in fostering psychological resilience by mitigating symptoms of stress, anxiety, and depression (Penedo & Dahn, 2005; Biddle et al., 2018). When introduced from an early age–particularly through well-designed school-based physical education programs–physical activity has the potential to instill lifelong habits that enhance both individual and collective well-being (Pedersen & Saltin, 2015).

Despite these known benefits, Romania continues to face significant structural and socio-cultural barriers in implementing SDG 3 effectively. Sedentary behavior is widespread among Romanian adults, and the country consistently ranks among the lowest in the European Union for engagement in regular physical activity (Eurostat, 2020). This pattern is particularly troubling given that many Romanians self-report good or very good health–an optimistic perception that may obscure the latent health risks posed by physical inactivity and unhealthy behaviors. Compounding this issue is a troubling statistic: approximately 64% of individuals surveyed have pointed to inadequate physical education facilities in schools. This deficiency severely restricts the ability of educational institutions to promote early physical literacy and active lifestyles, limiting students' exposure to the long-term benefits of sport and exercise.

To overcome these challenges, Romania must adopt a cohesive and multisectoral strategy that places sport and physical activity at the forefront of public health, educational reform, and sustainable development agendas. A first step involves significant investment in the modernization and expansion of sports infrastructure at both school and community levels. Such improvements are crucial not only to ensure compliance with basic physical education requirements but also to cultivate inclusive, attractive environments that motivate participation across all demographics–regardless of age, gender, or socioeconomic status (Bauman et al., 2012).

Secondly, nationwide public awareness and behavior-change campaigns must be developed and implemented to reshape societal attitudes toward physical activity. These initiatives should emphasize the extensive physical, psychological, and social advantages of an active lifestyle, utilizing diverse channels such as mass media, social networks, and community outreach to effectively engage various population segments. Special attention should be directed toward groups that traditionally encounter higher barriers to participation, including children and adolescents, older adults, and socioeconomically disadvantaged communities.

Thirdly, targeted interventions and strategic partnerships are essential to reducing disparities in access and participation. Policies that support subsidized memberships to sports centers, workplace wellness programs, collaborative school-community physical activity initiatives, and incentives for active transportation–like walking and cycling–can help normalize daily movement and embed it into the fabric of everyday life. Such interventions are grounded in global evidence demonstrating that environments that facilitate and support physical activity lead to higher engagement rates and better health outcomes across populations (Sallis et al., 2016).

Additionally, it is critical that physical activity be systematically integrated into broader national policy domains such as urban planning, transportation, and education. Designing cities that prioritize green spaces, dedicated bike lanes, and safe pedestrian pathways can naturally encourage higher levels of physical movement, contributing not only to SDG 3 but also to other interlinked objectives, including SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action). Countries that have adopted such holistic, cross-sectoral frameworks demonstrate stronger public health performance and more sustainable urban ecosystems (Guthold et al., 2018).

In conclusion, Romania's path toward fulfilling SDG 3 represents both a critical challenge and a transformative opportunity. By prioritizing investments in sports infrastructure, advancing health education, and enacting inclusive, evidence-based policies, Romania can redefine its national health trajectory. This commitment would not only accelerate progress toward its global obligations but

also lay the groundwork for a healthier, more resilient, and economically vibrant society that can thrive well into the future (WHO, 2021).

References

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet, 380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Biddle, S. J. H., García Bengoechea, E., & Wiesner, G. (2018). *Physical activity and the promotion of well-being*. In M. Slade (Ed.), Wellbeing, recovery and mental health (pp. 211–225). Cambridge University Press. https://doi.org/10.1017/9781316831899.014

Eurostat. (2020). *Sport participation and physical activity statistics*. Retrieved from https://ec.europa.eu/eurostat

European Commission. (2018). *Special Eurobarometer 472: Sport and physical activity*. https://europa.eu/eurobarometer

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1.9 million participants. *The Lancet Global Health, 6*(10), e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Kari, T., Piippo, J., Frank, L., Makkonen, M., & Moilanen, P. (2016). To gamify or not to gamify? *International Journal of Information Management, 36*(6), 303–315. https://doi.org/10.1016/j.ijinfomgt.2016.04.009

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9

Mănescu, D.C. (2013). *Fundamente teoretice ale activităților fizice* (Theoretical fundaments of physical activities). Editura ASE.

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine – evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian Journal of Medicine & Science in Sports, 25*(S3), 1–72. https://doi.org/10.1111/sms.12581

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*(2), 189–193. https://doi.org/10.1097/00001504-200503000-00013

România Durabilă. (2022). *Platformă națională pentru monitorizarea Obiectivelor de Dezvoltare Durabilă*. Retrieved from https://romaniadurabila.gov.ro

Sallis, J. F., Cerin, E., Conway, T. L., Adams, M. A., Frank, L. D., Pratt, M., ... & Owen, N. (2016). Physical activity in relation to urban environments in 14 cities worldwide: A cross-sectional study. *The Lancet, 387*(10034), 2207–2217. https://doi.org/10.1016/S0140-6736(15)01284-2

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. https://sdgs.un.org/2030agenda

United Nations. (2020). *SDG 3: Ensure healthy lives and promote well-being for all at all ages*. https://sdgs.un.org/goals/goal3

World Health Organization. (2021). *Global status report on physical activity 2021*. https://www.who.int/publications/i/item/9789240038141

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 228–237
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-31

PHYSICAL EDUCATION AS A CATALYST FOR ACADEMIC SUCCESS AND SUSTAINABLE DEVELOPMENT IN EDUCATION

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Abstract. *Background*. This study investigates the interconnection between physical education and educational performance in Romania, contextualized within Sustainable Development Goal 4 (SDG 4 – Quality Education). Recognizing that physical activity supports cognitive development, emotional regulation, and academic engagement, the research explores how structured physical education can contribute to improved learning outcomes and sustainable educational progress. The Romanian context presents a mixed landscape, where formal inclusion of physical education in school curricula is undermined by infrastructural disparities and socio-cultural undervaluation of sport as an academic enhancer.
Objectives. The objective of the study is to evaluate the extent to which participation in physical activity correlates with academic achievement, using indicators from the Romania Durabilă platform and Eurostat. Specific attention is given to early school leaving rates, tertiary education attainment, and adult participation in learning, alongside physical activity frequencies disaggregated by age, gender, and education level. The research also aims to assess whether greater investment in physical education infrastructure could serve as a catalyst for improved educational and health outcomes.
Methods. The methodology adopts a mixed-methods approach, primarily descriptive and comparative, analyzing national and European datasets spanning from 2014 to 2024. The study integrates statistical findings with contextual interpretation to identify patterns and potential causal relationships.
Results. The results show a positive correlation between educational attainment and levels of physical activity, with individuals holding tertiary degrees more likely to engage in regular exercise. Rising trends in higher education enrollment and adult learning are mirrored by increased health-oriented behaviors. However, early school leaving remains a concern, particularly among certain gender groups, and physical activity participation remains low across several demographics.
Conclusion. In conclusion, the study highlights a synergistic relationship between physical education and learning outcomes. It calls for integrated public policies that prioritize physical education as a core component of sustainable educational reform. Enhancing infrastructure, promoting lifelong learning, and embedding health awareness in education strategies are essential steps toward achieving SDG 4 in Romania.

Keywords: physical education, public health, sport, education, SDG 4.

Introduction

Education and physical activity represent two fundamental pillars of sustainable human development, deeply interconnected and mutually reinforcing. Within the framework of the United Nations' Sustainable Development Goal 4 (SDG 4) – Quality Education, the integration of sport and physical education into academic environments is increasingly acknowledged as essential. This

integration not only supports the adoption of healthy lifestyles but also contributes significantly to the enhancement of cognitive abilities, academic performance, and psychosocial well-being (United Nations, 2015). A growing body of international evidence underscores the cognitive benefits of regular physical activity, including improved attention span, memory retention, and emotional stability, all of which positively influence educational outcomes (Singh et al., 2019; Donnelly et al., 2016). Moreover, physical education plays a critical role in the development of soft skills such as collaboration, leadership, time management, and self-discipline–attributes that are essential for holistic personal development and lifelong learning.

In the Romanian context, the intersection between education and sport presents both promising opportunities and persistent systemic challenges. While the national curriculum formally mandates physical education across all grade levels (Ministry of National Education, 2023), the reality of its implementation varies significantly. This variation is largely shaped by disparities in infrastructure quality, financial investment, and localized education policies. In certain urban schools, students benefit from access to modern gymnasiums, sports equipment, and trained physical education teachers. However, many rural schools continue to operate under difficult conditions, lacking functional sports facilities, up-to-date equipment, and specialized personnel. These regional inequalities mirror broader socioeconomic disparities and pose serious obstacles to delivering equitable, high-quality education nationwide (World Bank, 2020).

Cultural perceptions of sport and physical education further complicate their integration into the education system. In many Romanian communities, physical education is often considered secondary or even non-essential compared to more academically emphasized subjects such as mathematics, sciences, or languages (Mănescu, D.C., 2013). This perception is reflected in limited institutional support and inadequate funding for extracurricular sports programs and facility improvements. The prevailing view tends to position sport as recreational rather than educational, thereby downplaying its vital role in students' physical, emotional, and academic development. This perspective diverges significantly from international best practices, which increasingly advocate for a whole-child approach to education–one that recognizes physical well-being as integral to learning, school engagement, and social inclusion (Bailey et al., 2009).

Quantitative data reinforce these concerns. According to recent statistics from Eurostat (2023), only 24% of Romanian adolescents engage in physical activity five or more times per week, compared to a European Union average of approximately 35%. Similarly, national performance reports from România Durabilă have flagged a steady decline in physical activity levels among school-aged children. These trends are alarming, as they are closely linked with a surge in childhood obesity, decreased academic motivation, and rising rates of mental health issues. The World Health Organization (2022) has reported that physical inactivity in children and adolescents is associated with higher levels of school absenteeism, diminished self-esteem, and a greater risk of anxiety and mood disorders. Thus, the lack of consistent physical activity poses not only a public health threat but also undermines Romania's educational and developmental goals.

To counteract these challenges, a comprehensive and systemic policy response is urgently required. First and foremost, the Romanian government should significantly increase public investment in sports infrastructure within educational institutions, especially in underserved and rural areas. Upgrading school facilities and ensuring access to modern equipment would enable all students to engage in regular physical activity in safe and inclusive settings. Second, teacher training programs should incorporate interdisciplinary pedagogical approaches that highlight the cognitive and psychosocial benefits of physical activity, thereby helping educators integrate movement into broader educational strategies. This could include movement-based learning activities or coordinated lessons that link physical activity to subjects like biology, health, or social sciences.

Third, national awareness campaigns are needed to reshape public and institutional attitudes toward sport and physical education. These campaigns should emphasize the long-term benefits of physical activity for mental health, academic success, and social development, using media, community outreach, and partnerships with youth organizations to promote more active lifestyles.

In addition, local governments and schools should be encouraged to develop structured extracurricular programs, sports competitions, and inclusive initiatives that target vulnerable and marginalized student populations.

Furthermore, a collaborative governance model–involving the Ministry of Education, health authorities, local administrations, and civil society–is crucial to ensure consistent implementation and evaluation of physical education reforms. Partnerships with NGOs and international organizations can also bring innovative models and funding support to pilot new programs and scale successful initiatives.

Ultimately, aligning physical education policy with the wider objectives of SDG 4 offers Romania a strategic opportunity to strengthen its education system, promote social equity, and foster national resilience. By embedding physical activity into the educational framework, the country can not only improve health and academic outcomes but also nurture future generations equipped with the physical, cognitive, and emotional competencies required to navigate a rapidly changing and increasingly demanding world.

Purpose of the study

The purpose of this study is to explore and critically analyze the interconnection between physical education and educational outcomes within the framework of Sustainable Development Goal 4 (Quality Education). Specifically, the research aims to investigate how participation in sports and regular physical activity can contribute not only to better physical health but also to enhanced cognitive function, academic performance, and social development among students in Romania.

Given the relatively underexplored relationship between sports and education in the Romanian context, this study seeks to fill an important gap in the literature by providing empirical evidence drawn from national data sets (Romania Durabilă – ODD 4 indicators) and European comparative statistics (Eurostat).

By correlating levels of physical activity with measures of educational attainment, the research will highlight the extent to which physical education initiatives can be leveraged as strategic tools for improving learning outcomes at a systemic level.Additionally, this study intends to shed light on the broader implications of investing in school-based sports infrastructure as a sustainable development strategy. By framing physical education not just as an extracurricular activity but as an essential component of a holistic educational system, the paper advocates for the integration of sports policies into national educational reforms. Ultimately, this research aspires to support policymakers, educators, and public health stakeholders in designing targeted interventions that promote both academic excellence and physical well-being, aligning Romania's development trajectory more closely with the objectives of SDG 4.

Research objectives

This study aims to analyze the relationship between physical education and educational outcomes in Romania within the framework of SDG 4. It seeks to correlate levels of sport participation with academic performance indicators using data from Romania Durabilă and Eurostat. Additionally, the research intends to evaluate the role of school infrastructure in supporting both physical activity and sustainable educational development.

Materials and methods

This study adopts a mixed-methods approach, combining quantitative data analysis with a contextual qualitative interpretation. The main data sources include official statistics from the Romania

Durabilă platform, specifically focusing on indicators related to SDG 4 (Quality Education), and Eurostat datasets that provide comprehensive information on sport participation rates and educational attainment levels across European Union countries, including Romania.

For the analysis, data from the "Romania's Sustainable Development Report" (Raportul privind Dezvoltarea Durabilă a României) are utilized, particularly indicators that measure early school leaving rate for young people, tertiary education graduates and adult participation in learning. From Eurostat, the study uses datasets on the frequency of participation in sports or fitness activities and data concerning educational performance indicators such as early school leaving rates and tertiary education attainment. The research particularly focuses on identifying correlations between the prevalence of physical education in schools and broader educational outcomes.

Data is analyzed descriptively to understand general trends and comparatively to position Romania within the broader European context. The timeframe for the data analyzed spans from 2014 to the most recent available figures (2023–2024), ensuring an up-to-date and relevant understanding of the situation.By integrating statistical analysis with contextual interpretation, the methodology aims to provide a comprehensive and nuanced understanding of how physical education supports sustainable learning outcomes, particularly in the Romanian setting, in line with the ambitions of SDG 4.

Results and interpretation

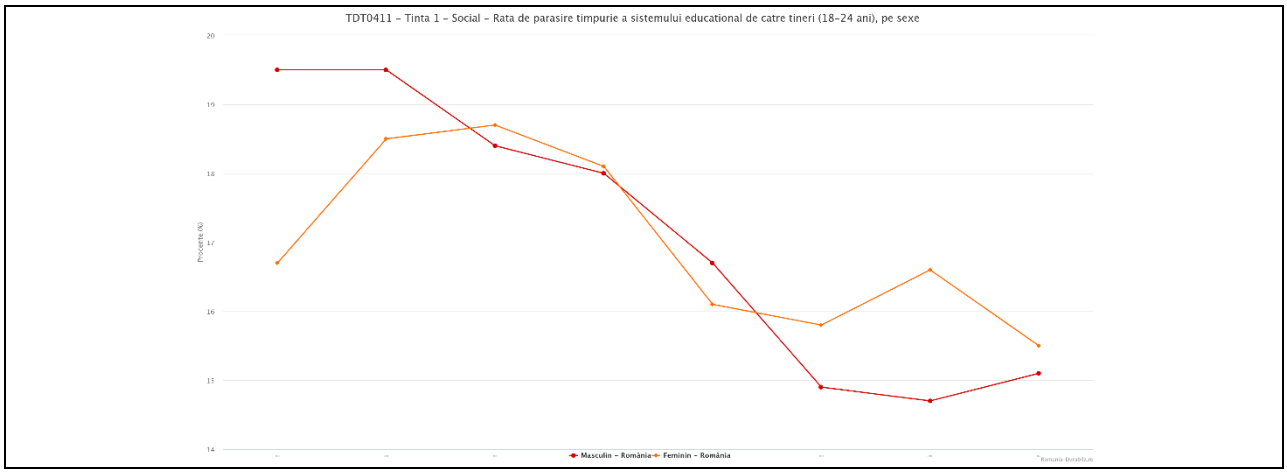

Figure 1. Early school leaving rate for young people (1824 years old), by gender.
Source: http://romania-durabila.gov.ro/

Figure 1, titled *"Early school leaving rate for young people (18–24 years old), by gender"*, focuses on an educational indicator that measures the proportion of young adults who leave formal education early. This metric is critical because early school leaving can signal deficiencies in the educational system, limited access to quality learning opportunities, and broader socio-economic challenges that may hinder personal and professional development. In Romania, as elsewhere, high rates of early school leaving are particularly concerning because they directly impact future employability, economic productivity, and social inclusion. Gender differences within this indicator may further underscore the existence of culturally or structurally embedded inequalities in educational opportunities, where one gender might be disproportionately disadvantaged in terms of retention and graduation.

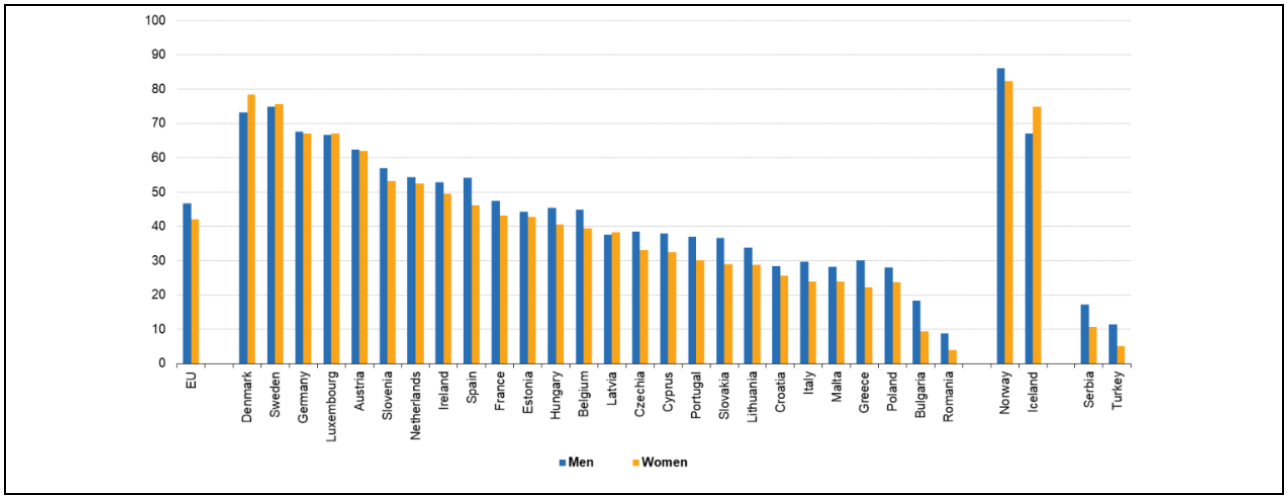

Figure 2. Practicing sport, keeping fit or participating in recreational (leisure) physical activities at least once a week, by sex, 2019 (%).

Source: https://ec.europa.eu/eurostat/

In parallel, Figure 2, *"Practicing sport, keeping fit or participating in recreational (leisure) physical activities at least once a week, by sex, 2019 (%)"*, provides a snapshot of how frequently different gender groups in various European countries engage in physical activities. This indicator is significant as it reflects not only the state of public health and overall societal wellbeing but also how cultural norms, economic factors, and policy initiatives shape lifestyle choices. For Romania, comparing the nation's data with that of other European countries can reveal whether there is a notable lag or alignment in promoting active lifestyles. Given the relationship between physical activity and improved health outcomes, lower participation rates might also suggest a risk of higher health care costs in the long run and potentially reduced quality of life, which can further exacerbate social and economic disparities.

Analyzing these two figures concurrently allows us to consider the broader implications for social policy in Romania. On one hand, early school leaving is a critical challenge that can have long-lasting effects on an individual's future opportunities and overall human capital. On the other hand, regular physical activity is essential for maintaining health, increasing productivity, and reducing the burden of non-communicable diseases. Both indicators, when disaggregated by gender, highlight persistent inequalities that require targeted interventions. For example, if young women in Romania are found to leave school at higher rates than their male counterparts, this not only limits their future economic prospects but may also correlate with lower levels of engagement in health-promoting behaviors, such as regular physical activity, although this relationship can be complex and context-dependent.

In conclusion, Figure 1 and Figure 2 together underscore the vital importance of integrated social policy that simultaneously addresses educational deficits and promotes healthful lifestyles. For Romania, these indicators highlight areas where progress has been uneven, particularly in terms of gender disparities. The comparative analysis suggests that while educational challenges such as early school leaving may compromise future economic opportunities and overall societal well-being, insufficient engagement in regular physical activities could further undermine health outcomes and quality of life. Addressing these issues through coordinated policy measures is essential for fostering a more resilient, inclusive, and prosperous society both within Romania and in the context of European standards.

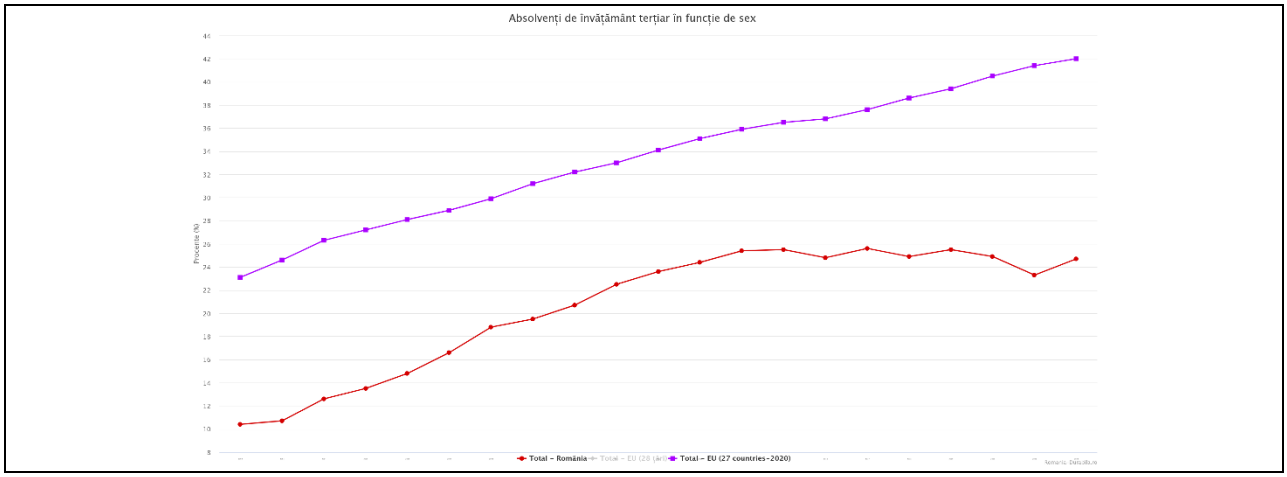

Figure 3. Tertiary education graduates.
Source: http://romania-durabila.gov.ro/

This indicator tracks the proportion of individuals who have completed higher education in Romania, serving as a proxy for human capital development and the country's overall capacity to drive a knowledge-based economy. Over recent years, Romania has seen an upward trend in tertiary education graduates–a positive signal that suggests increased access to higher education and enhanced educational outcomes. This growth, although moderate when compared to some EU member states, marks a significant improvement in Romania's educational landscape and is crucial for fostering innovation, competitiveness, and long-term economic sustainability.

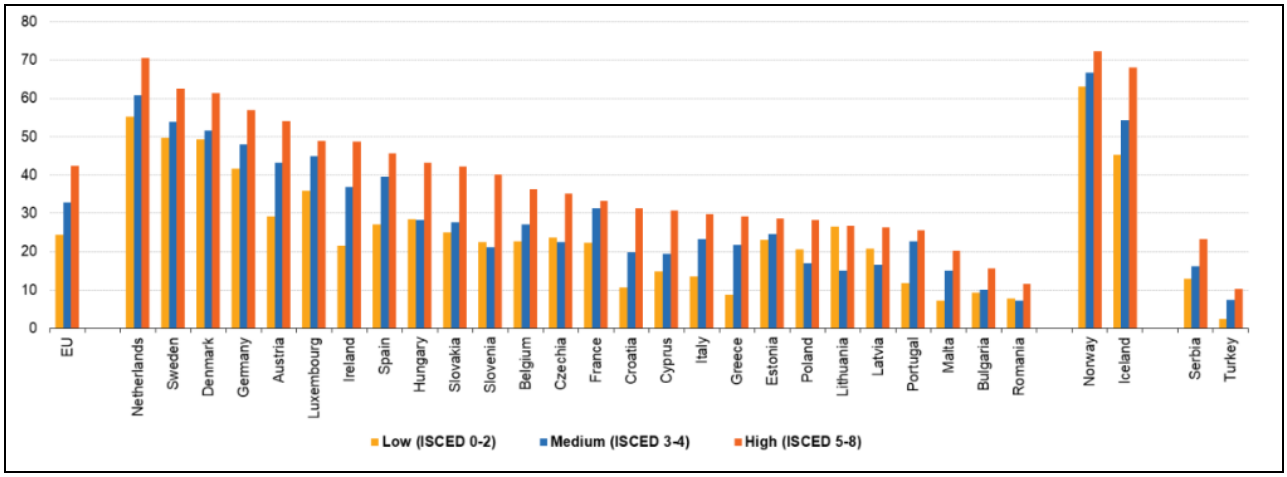

Figure 4. Distribution of people who spent at least 150 minutes on health-enhancing aerobic physical activity per week, by level of educational attainment, 2019 (%).
Source: https://ec.europa.eu/eurostat/

This indicator presents the percentage of individuals who engage in at least 150 minutes per week of aerobic physical activity, disaggregated by their level of educational attainment. In Romania, the data reveal a strong correlation between high educational achievement and a higher likelihood of participating in physical activities. In particular, individuals with tertiary education are found to engage in regular exercise at substantially higher rates than their peers with lower education levels. This pattern is consistent with broader European findings and underscores the role that higher education plays in promoting health awareness and healthier lifestyles. he convergence of these

indicators suggests a mutually reinforcing relationship between educational attainment and health behavior.

The increasing number of tertiary education graduates in Romania not only signals improved economic opportunities and social mobility but also appears to translate into healthier lifestyle choices, as seen in the higher participation rates in physical activity among the highly educated. This dual benefit is significant: on one hand, a more educated workforce is better equipped to drive economic growth and innovation; on the other hand, the associated increase in health-conscious behaviors may lead to reduced public health expenditures and improved overall quality of life. In the context of European benchmarks, Romania's rising tertiary education enrollment and graduation rates, coupled with the demonstrated link between higher education and active lifestyles, are promising trends. They suggest that continued investment in higher education–alongside policies that promote physical activity and public health–could enhance Romania's human capital and create a virtuous cycle of economic and social development.

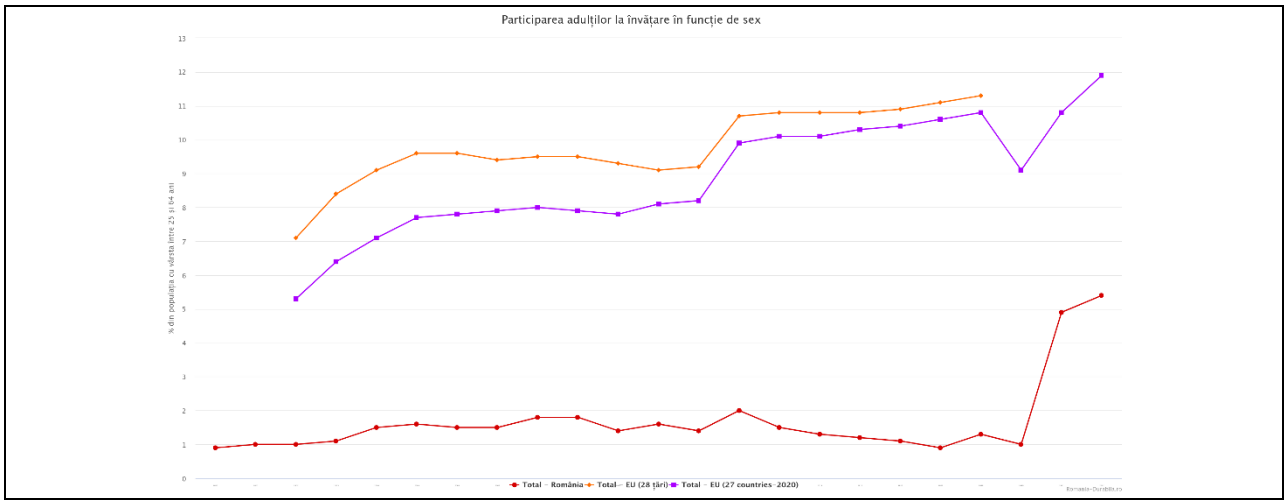

Figure 5. Adult participation in learning.
Source: http://romania-durabila.gov.ro/

Adult Participation in Learning measures the share of people aged 25 to 64 who declared that they received formal or non-formal education and training in the four weeks preceding the survey. This indicator serves as an important proxy for lifelong learning and capacity building among the adult population. Engaging in continuous education–not only formal academic courses but also various non-formal training opportunities–contributes to enhanced skillsets, improved employability, and a greater overall awareness of personal and professional development opportunities.

Figure 6: Practicing Sport, Keeping Fit or Participating in Recreational (Leisure) Physical Activities at Least Once a Week, by Age Group (2019) disaggregates the participation levels in physical activity across different adult age groups. This indicator reflects public health outcomes and captures behavioral patterns that are essential for reducing risks associated with sedentary lifestyles, such as chronic diseases. In addition to its implications for individual health, the data provide insights into the overall cultural and infrastructural support for recreational activities within different regions.

When examining these two indicators together, an interesting interrelationship emerges. In Romania, evidence suggests that adults who actively engage in learning–whether it be formal or non-formal education–also tend to be more inclined to participate in regular physical activity. This correlation can be attributed to several factors.

	Total	15-24	25-34	35-44	45-54	55-64	65+
EU	44	65	53	47	44	39	31
Belgium	42	64	51	47	41	37	26
Bulgaria	14	42	27	16	9	4	2
Czechia	36	63	48	48	37	23	13
Denmark	76	82	79	74	78	73	71
Germany	67	86	75	68	68	64	56
Estonia	44	63	55	53	44	35	25
Ireland	51	64	64	57	50	39	32
Greece	26	64	43	31	23	14	7
Spain	50	69	58	53	51	46	35
France	45	66	52	48	43	41	32
Croatia	27	53	44	41	30	22	13
Italy	27	50	40	31	28	21	12
Cyprus	35	36	36	38	36	35	30
Latvia	38	66	45	41	38	31	24
Lithuania	31	61	44	33	26	21	16
Luxembourg	67	78	71	66	64	65	58
Hungary	43	66	54	51	44	29	26
Malta	26	41	37	28	24	17	12
Netherlands	54	70	63	55	55	49	37
Austria	62	78	70	65	63	62	45
Poland	26	47	37	33	23	15	11
Portugal	33	59	42	39	34	24	19
Romania	6	20	11	7	3	2	1
Slovenia	55	83	67	67	62	45	27
Slovakia	33	57	41	39	32	22	13
Sweden	75	82	77	77	77	73	70
Iceland	71	82	70	77	76	66	62
Norway	84	89	87	87	85	84	76
Serbia	14	37	26	16	9	6	3
Turkey	8	14	12	8	5	4	2

Figure 6. Practicing sport, keeping fit or participating in recreational (leisure) physical activities at least once a week, by age group, 2019.

Source: https://ec.europa.eu/eurostat/

Firstly, higher engagement in learning activities may foster increased health literacy, leading to a better understanding of the benefits of a physically active lifestyle. More educated individuals are likely to be aware of how regular physical activity contributes not only to personal well-being but also to long-term health outcomes, thereby reducing the risk of chronic illnesses.

Secondly, participation in learning can be indicative of a proactive mindset and a commitment to self-improvement, traits that typically extend to maintaining physical fitness. Such individuals are more disposed to allocate time and resources to recreational activities, which reinforces a virtuous cycle between cognitive engagement and physical well-being.

In the Romanian context, the upward trend in adult participation in learning observed in Figure 5 is particularly promising. An increase in the proportion of adults engaged in education initiatives points to an evolving societal emphasis on continuous skill development and life-long learning. This development is noteworthy, especially when contrasted with many European peers, as it not only augments human capital but may also indirectly promote healthier lifestyles.

Given that the data from Figure 6 indicate higher levels of physical activity among groups with elevated educational attainment, it can be inferred that the recent rise in lifelong learning participation rates could lead to broader public health improvements over time.

Conclusions

The integrated analysis of education and physical activity indicators in Romania reveals a dynamic and mutually reinforcing relationship that supports the dual pillars of human capital development and public health. Extensive research confirms that education and health are inextricably linked, with each domain profoundly influencing the other. This interdependence is particularly crucial for advancing sustainable national progress, reducing inequalities, and fostering inclusive development (OECD, 2021).

Despite ongoing challenges–such as elevated early school leaving rates among youth aged 18 to 24, particularly with pronounced gender-based disparities–recent statistical trends offer reasons for cautious optimism. Improvements in higher education attainment are beginning to reverse prior patterns of educational disengagement, contributing to the cultivation of a more skilled, adaptable, and innovation-ready workforce, aligned with the competencies demanded by a

knowledge-driven global economy (Eurostat, 2023; European Commission, 2022). These positive shifts mark a critical turning point for Romania as it strives to close structural gaps in education and elevate its competitiveness within the European Union.

In parallel, there is a growing national emphasis on *lifelong learning,* with increasing adult participation in both formal and non-formal educational initiatives. This broader commitment to continuous education supports not only workforce adaptability but also enhances civic engagement and fosters a culture of social inclusion (UNESCO Institute for Lifelong Learning, 2020). Lifelong learning equips individuals with the skills and knowledge necessary to remain active contributors to society, while also reinforcing personal autonomy and socio-economic mobility. For Romania, the consolidation of such a culture is essential for bridging regional disparities and ensuring equitable development across urban and rural contexts.

Significantly, empirical evidence consistently demonstrates that higher levels of educational attainment are positively correlated with increased engagement in *health-enhancing physical activities.* Individuals with advanced education are more likely to embrace active lifestyles, maintain regular exercise routines, and engage in preventive health behaviors–patterns often driven by enhanced health literacy, greater access to health information, and a deeper understanding of the long-term benefits of physical well-being (WHO, 2022; Bauman et al., 2012; Marques et al., 2020). This connection illustrates how education functions as a key determinant of health, empowering individuals to make informed lifestyle decisions and reducing their susceptibility to chronic illnesses.

In addition to physical health, regular activity supports cognitive function, emotional stability, and mental health–factors that significantly influence productivity, academic persistence, and workplace performance (Lubans et al., 2016). By promoting physical activity through education, Romania can generate a positive feedback loop in which improved health outcomes further reinforce educational attainment and labor force participation.

Encouragingly, the recent upward trends in both higher education participation and physical activity rates across different age demographics indicate a growing recognition of these synergies. Continued engagement in education not only enhances professional qualifications and economic prospects but also cultivates healthier, more resilient populations. These trends are especially pertinent in the context of an aging society and a rapidly evolving labor market, where adaptability, digital competence, and physical well-being are increasingly essential (World Economic Forum, 2023).

For Romania, these evolving dynamics underscore the potential of *integrated policy frameworks*–those that bridge education, health, and labor development–as a strategic lever for fostering national resilience and inclusive economic growth. Such policies should aim to create coherent pathways between formal education systems, public health campaigns, and community-level physical activity programs, thereby amplifying their collective impact.

To fully capitalize on these opportunities, Romania must implement *multisectoral and holistic strategies* that align educational reforms with public health objectives. This includes expanding equitable access to higher education, embedding health literacy and physical well-being into curricula from early childhood onward, and promoting cross-sector collaboration among ministries of education, health, labor, and youth. Such an approach ensures that investments in higher education yield not only economic returns but also robust public health dividends.

Incorporating these principles into national planning and development aligns Romania more closely with the *2030 Agenda for Sustainable Development*, which emphasizes the interconnectedness of social, economic, and environmental goals (United Nations, 2015). Specifically, by integrating the targets of *SDG 4 (Quality Education) and SDG 3 (Good Health and Well-Being)*, Romania can move toward a development model that is inclusive, future-oriented, and firmly centered on human potential.

In conclusion, the synergy between education and physical activity is not merely a policy coincidence, but a foundational element for building a healthier, more educated, and economically dynamic society. Romania's ability to foster this synergy through targeted reforms and sustained investments will play a decisive role in shaping its trajectory toward equitable and sustainable national progress.

References

Bailey, R., Armour, K., Kirk, D., Jess, M., Pickup, I., & Sandford, R. (2009). The educational benefits claimed for physical education and school sport: An academic review. *Research Papers in Education, 24*(1), 1–27. https://doi.org/10.1080/02671520701809817

Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., Lambourne, K., & Szabo-Reed, A. N. (2016). Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. *Medicine & Science in Sports & Exercise, 48*(6), 1197–1222. https://doi.org/10.1249/MSS.0000000000000901

Eurostat. (2023). *Physical activity statistics*. Retrieved from https://ec.europa.eu/eurostat/

Lubans, D. R., Richards, J., Hillman, C. H., Faulkner, G., Beauchamp, M. R., Nilsson, M., ... & Biddle, S. J. H. (2016). Physical activity for cognitive and mental health in youth: A systematic review of mechanisms. *Pediatrics, 138*(3), e20161642. https://doi.org/10.1542/peds.2016-1642

Mănescu, D.C. *Fundamente teoretice ale activităţilor fizice* (Theoretical fundaments of physical activities). Editura ASE

Ministry of National Education (Romania). (2023). *National curriculum for physical education*. Retrieved from https://www.edu.ro

Singh, A. S., Saliasi, E., van den Berg, V., Uijtdewilligen, L., de Groot, R. H. M., Jolles, J., ... & Chinapaw, M. J. M. (2019). Effects of physical activity interventions on cognitive and academic performance in children and adolescents: A novel combination of a systematic review and recommendations from an expert panel. *British Journal of Sports Medicine, 53*(10), 640–647. https://doi.org/10.1136/bjsports-2017-098136

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. Retrieved from https://sdgs.un.org/2030agenda

World Bank. (2020). *Romania education sector analysis*. Retrieved from https://www.worldbank.org/en/country/romania/publication/education-sector-analysis

World Health Organization (WHO). (2022). *Global status report on physical activity 2022*. https://www.who.int/publications/i/item/9789240059153

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 238–243
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-32

THE SPORTS OF EXPRESSION

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Abstract. In this study, we have gathered as much data as possible about the emergence and development of expressive sports. These sports share common characteristics but also many differences, which are highlighted in the study.
The development of these sports is constantly influenced by human imagination and creativity, as well as the human desire for perfection and beauty. Sometimes, we tend to believe that we have reached our maximum potential, but each time this is surpassed through creativity and flawless technique.
There is an increasingly pronounced dynamic of change from one competition to another, from one Olympic cycle to another. Regulations need to be changed, elements updated, and choreographic components modified. Today, technology helps us progress faster and achieve bodily techniques that, years ago, we couldn't have imagined.
Progress, change, reevaluation for sports that have long struggled to combat subjectivism. Yet, this is the way art tells us that it is present, no matter how objective we strive to be. A virtuous performance can matter more than we might believe.
In conclusion, expressive sports belong to that category where art and sport are in symbiosis, and the spectator can only let himself be carried away by the emotions of the moment.

Keywords: expressive sports, emergence, characteristics, differences.

Introduction

What are expressive sports?
Expressive sports are a category of athletic activities where the primary focus is on aesthetic, artistic, and emotional expression through movement. In these sports, athletic performance is complemented by qualities such as grace, rhythm, expressiveness and creativity. Evaluation is based not only on technical difficulty but also on artistic interpretation and the visual impact on the audience.

"Artistic sports," as a combination of art and sports, have unique charm and characteristics. Artistic sports are physical activities primarily aimed at entertaining the body and mind, relieving stress, and regulating emotions. This form not only has aesthetic value but also allows participants to personally experience joy and fun. It combines fitness, entertainment, and aesthetics, promoting physical health, stress relief, emotional regulation, etc., enhancing people's physical fitness and health levels while providing a pleasant mind-body experience (Hu and Tian, 2006a; Liao and Li, 2024, cited by Yanyan Tian, Haiqing Wang, 2024)

One of the features of the essential expression of bodily movement is the motor body, defined by movement and determined by aesthetic principles. A reminder in this sense are sports with a pronounced artistic character that aim, above all, to educate bodily aesthetics through the use of

specific means of gestural communication, such as rhythmic and sports gymnastics, sports dance, figure skating, artistic swimming, etc. All these body movements are defined by the common point "motor gesture". (Chirazi, M., 2021)

Which are the expressive sports? In our opinion, these are:

- *Rhythmic Gymnastics* – A women's sport combining elements of dance, gymnastics, and ballet with apparatuses like ribbon, hoop, ball, clubs, or rope. Movements are fluid, elegant, and synchronized with music. Competitions are held individually and in groups.
- *Women's Artistic Gymnastics* – Includes exercises on apparatuses (floor, balance beam, parallel bars, pommel horse, rings, etc.). Women's floor exercises also incorporate choreographic and musical elements. Competitions are held individually and team rankings are also established.
- *Dance Sport* – A competitive sport featuring standard dances (waltz, tango, etc.) and Latin dances (samba, cha-cha, rumba). Judging focuses on technique, synchronization, expressiveness, and partner connection. Competitions are held in pairs and formations.
- *Figure Skating* – A winter sport involving technical and artistic movements on ice skates, accompanied by music. Judging emphasizes jumps, spins, choreography, and expressiveness. Competitions are held individually and in pairs.
- *Artistic Swimming* – A combination of swimming, dance, and gymnastics performed underwater and on the surface, synchronized with partners and music. Requires endurance, grace, and facial expressiveness.
- *Sport Aerobics* – Fast and rhythmic movements performed to music, focusing on energy, coordination, endurance, and bodily expressiveness. Competitions are held individually, in duos, trios, and groups.
- *Majorette Sport* – Dance sport utilizing accessories (pom-poms, baton) and incorporating acrobatics, synchronization, and team spirit. Popular in parades and competitions.
- *Sport Ballet* – Derived from classical ballet, practiced in a competitive setting. Emphasis on controlled movements, elegance, and dance technique.
- *Competitive Cheerleading* – Includes acrobatics, tumbling, dance, and synchronized movements. Spectacular and requires strength, rhythm, and expressiveness.
- *Contemporary dance* – Dances expressing emotions through fluid and creative movements. Also used in competitions, often as a form of solo or group dance.

Artistic Preparation in Expression Sports

The artistic component of training is unique to expression sports, as it plays a decisive role in performance evaluation by judges and in ranking athletes. In other words, it is a training factor in those sports where the mastery of technical execution is assessed in competitions through scores.

Artistic preparation represents a special and complex component of sports training, providing the physical and psychological support necessary to perform a program in a personal style, focusing on plasticity, suggestibility, and expressiveness, aiming to achieve maximum artistic parameters.

Artistic preparation falls within the realm of communication, which, especially in dance sport, rhythmic gymnastics, and artistic gymnastics, extends to narrating choreographic librettos. In these disciplines, athletes use complex forms of body communication to convey messages to the audience.

A. Dragnea (1996) considers that artistic preparation encompasses all choreographic and musical means that stimulate creativity, culminating in motor skills executed with high expressiveness, capable of transmitting a message to the audience and judges.

According to V. Grigore (2001), a performance presented in competitions, with a high degree of difficulty and complexity, technical virtuosity, and elegant, confident, and perfect movements that meet compositional conditions, musical accompaniment, and plastic education, can be considered a work of art.

The goal of training in expression sports is to achieve artistry in movement and to develop the ability to convey emotions and feelings through it. "Beauty" represents a broad phenomenon, realized through various forms and moments (creation, finished exercise, transmission – reception).

Some specialists believe that in expression sports, artistic preparation is inseparably linked to musical accompaniment, as they consider that music evokes superior emotions that create the premises for artistic expression.

Artistic preparation enhances the expressiveness and elegance of athletes' performances. Executing any element requires constant control; it's not enough to perform it; it must be executed beautifully and expressively, demonstrating mastery.

Due to its content and specificity, the means of artistic preparation serve to achieve movements characterized by virtuosity, expressiveness, superior coordination, and a refined understanding of music.

According to specialized studies, the use of artistic preparation contributes to:

- Harmonious and correct physical development of the body.
- Specific physical preparation by developing motor qualities in their specific manifestation (speed, control, coordination, balance, mobility).
- Improvement of movement quality through training.
- Formation of correct posture.

Artistic-Motor Education:

- Development of expressiveness, or the ability to convey emotional states through movement, in alignment with the intended message.
- Development of musicality in all its components.
- Development of creative imagination.

Development of Coordinative Capacity:

- Development of moral-volitional qualities such as willpower, courage, self-control, firmness, and competitiveness.
- Education of spatial and temporal orientation.

These studies highlight that the aesthetics of movement depend on:

- The existence of a complex expressive motor repertoire that shapes the athlete's artistic personality through expressive movements.
- Formation of artistic sensitivity, determining the emotional foundation of movements.
- Education of musical sense and development of general culture through varied musical accompaniment.

Educating the artistic posture, harmony of movement, and musicality leads to expressive movement of the entire body. Additionally, facial expressions must reflect the range of emotions intended to be expressed, sensations conveyed by music, inner strength, and passion invested in executing the program, generating beauty and the power to transmit it.

When developing the artistic component of exercise composition, the following factors should be considered:

a. Somatic and motor characteristics of the athletes.
b. Their temperament and personality. This ensures athletes' interest in learning and perfecting the choreographic content, with movements acquiring aesthetic and expressive value.
c. The athletes' gender, so that female athletes' movements and attitudes are feminine, while male athletes' are masculine.

Table 1. Common elements of expressive sports

Element 🎭	Description (brief)	Present in...
♪ Music & rhythm	Synchronization with the music	All
🕺 Artistic expression	Grace, emotion, bodily expressiveness	All
🤸‍♀️ Flexibility & coordination	Mobility, balance, muscular control	All, especially in gymnastics
👯 Team/duet synchronization	Team or duet events	Majority
🎖️ Subjective evaluation	Artistic & technical judging	All
👗 Specific costume	Aesthetic costume adapted to the sport	All
🧠 Memory & concentration	Memorization and choreography execution	All
🧍 Posture & expression	Attitude and facial expressiveness	All, especially in dance sport/skating

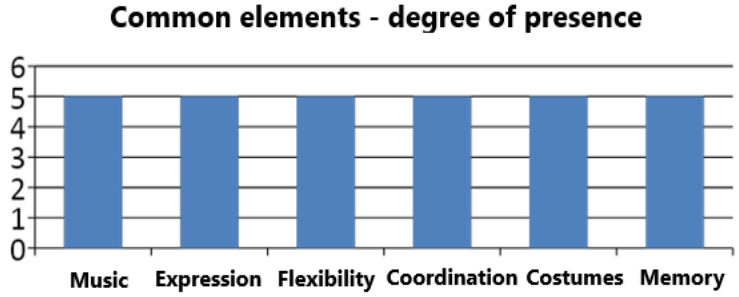

Figure 1. Common elements.

Table 2. Differences between expressive sports

Sport	Environment	Dominant genre	Equipment/ accessories	Main type of movement	Team type	Acrobatic level
Rhythmic gymnastics	Gym	Female	Objects (ribbon, hoop)	Body wave, elegant	Individual	Intermediate
Artistic gymnastics	Gym	Both	Equipment (balance beam, rings)	Dynamic, acrobatic	Individual	Advanced
Dance Sport	Gym	Both	Without	Dances with codified steps	Couple	Beginner
Artistic Skating	Ice	Both	Skates	Gliding, jumps, spins	Solo/couple	Advanced
Artistic Swimming	Water	Female	Without	Underwater, synchronized	Teams	Intermediate
Majorette Sport	Gym/outdoor	Female	Pom-poms, baton	Energetic group dances	Teams	Intermediate
Sport Ballet	Gym	Female	Without	Slow and graceful movements	Solo/group	Beginner
Cheerleading	Gym/field	Both	Pom-poms (optional)	Acrobatics, jumps, dance	Teams	Advanced
Contemporary Dance	Gym	Both	Without	Fluid, expressive, emotional	Solo/group	Beginner/ Intermediate
Sport Aerobics	Gym	Both	Without	Rhythmic, intense, fast	Solo/group	Intermediate

The classification of artistic communication is made according to the following criteria:

1. **the objectives**

- Instrumental Communication: Aims to elicit a reaction from others (audience, judges) and seeks a favorable response.
- Communion Communication: Focuses on the emotional atmosphere created during an event, generating goodwill.
- Consumptive Communication: Arises as a direct expression of the athlete's emotional or motivational states.
- Incidental Communication: Occurs accidentally, transmitted without the athlete's intent.

2. **the means of communication**

- Non-verbal Communication: Expressed through body language during performance.
- Verbal Communication: Reinforces body language (exclamations, onomatopoeia, etc.).

3. **the number of people participating in the communication**

- Interpersonal Communication: Between partners, intimate, professional reciprocity.
- Intragroup Communication: Among athletes competing simultaneously in the same space.
- Intergroup Communication: Between athletes and judges/audience.

4. **the duration of communication**

- Continuous Communication: Between partners/team members.
- Discontinuous Communication: Between athlete, judges, and audience.
- Accidental Communication: Brief, occurring in spontaneous situations.

5. **the mode of realization**

- Direct Communication: Specific to interactions between partners/team members.
- Indirect Communication: Conveyed through body language to judges and the audience.

6. **the way the response is performed**

- Rhetorical Communication: Internal, personal response.
- Positive Response Communication: Audience displays a favorable attitude towards the athlete's performance.
- Negative Response Communication: Audience exhibits an unfavorable or hostile attitude towards the athlete.

Conclusions – Evolution of the disciplines

1. Since their inception, expressive sports have undergone remarkable progress, both in terms of body technique and the expressiveness and fluidity of movements. Initially recreational or artistic forms, these disciplines have gradually transformed into sophisticated competitions that combine strength, balance, and aesthetic refinement.
2. The progress has been influenced by the professionalization of the field, technology, globalization, and increasingly higher competitive standards. Today, athletes in these disciplines become true artists of movement, conveying emotion and spectacularity through every gesture.
3. This evolution highlights the extraordinary ability of the human body to express not only strength, but also art.
4. Expressive sports combine art with movement, offering unique performances through music, grace, and technique.

Conflict of interests

There are no conflicts of interest.

Authors' contributions

The authors contributed equally to the work.

References

Carp, I. (2019). *Teoria și metodica culturii fizice* (Note de curs). Universitatea de Stat de Educație Fizică și Sport, from https://www.usefs.md/PDF_NEW/Carp%20Ion%20-%20Note%20de%20Curs%20TMCF%2C%20%202019.pdf

Chirazi, M., (2021). *Expresivitatea comunicării gestuale prin acțiuni corporale,* Editura Muzicală, Vol VII, nr.1.2021, p. 53 from https://www.ceeol.com/search/article-detail?id=957635

Eliana de Toledo, Kizzy Antualpa, (2016), *The appreciation of artistic aspects of the Code of Points in rhythmic gymnastics: an analysis of the last three decades,* Revista Brasileira de Educação Física e Esporte, 30 (1), Jan-Mar 2016, https://doi.org/10.1590/1807-55092016000100119

Grigore, V., (2001), *Gimnastica artistică - Bazele teoretice ale antrenamentului sportiv*, Ed. Semne, Bucureşti

Danny Shorkend, (2018), *The Philosophy of Sport as Artistic Expression,* International Journal of English and Cultural Studies 1(1):59, DOI:10.11114/ijecs.v1i1.3227, from https://www.researchgate.net/publication/324704609_The_Philosophy_of_Sport_as_Artistic_Expression

Moraru, C. E., (2014). *Teoria și practica în sporturile de expresie, Dans sportiv*, Ed. Pim, Iași, p.21-28

Ministerul Tineretului și Sportului. (2017). *Enciclopedia educației fizice și sportului din România* (Vol. 6). https://mts.ro/wp-content/uploads/2017/07/Enciclopedia-Sportului-Vol-6.pdf

Sima, I, Aducovschi, D., (2008), Gimnastica ritmică, Ed. Moroșan, Bucureşti, p. 18-19

Yanyan Tian, Haiqing Wang, (2014), *The impact of artistic sports on academic self-efficacy,* Frontiers in Psychology., 22 January 2025, Sec. Sport Psychology, Volume 15 – 2024, https://doi.org/10.3389/fpsyg.2024.1458460

Websites

Fédération Internationale de Gymnastique. (n.d.). *Official site of the FIG.,* Accessed on 2025, May 2, from

https://en.wikipedia.org/wiki/Rhythmic_gymnastics?utm_source=chatgpt.com

https://www.youtube.com/watch?v=prabPVE9GLI, Accessed on 2025, May 2,

#Paris2024 : https://oly.ch/P24Replays

International Skating Union. (n.d.). *ISU official website.* Accessed on 2025, March 21, from https://www.isu.org

World DanceSport Federation. (n.d.). *WDSF official website.* Accessed on 2025, February 13, from https://www.worlddancesport.org

International Cheer Union. (n.d.). *ICU Cheerleading Worlds.* Accessed on 2025, May 2, from https://www.cheerunion.org

World Aquatics. (n.d.). *Artistic swimming.* Accessed on 2025, February 25, from https://www.worldaquatics.com**,**

https://www.youtube.com/watch?v=vgtNkl2_tc0&list=RDvgtNkl2_tc0&start_radio=1&rv=prabPVE9GLI, Accessed on 2025, May 3

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 244–251
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-33

THE VITAL ROLE OF SLEEP IN HEALING AND RECOVERY

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Abstract. *Background*. Sleep deprivation takes a toll on both our physical and mental health. It has been linked to reduced cognitive abilities, decline in immunity, decreased physical performance, irritability, anxiety and many other unpleasant consequences. This paper explores the main complications from bad sleeping habits as well as provides solutions on how to improve sleep's quality.
According to the National Center for Biotechnology Information of the US, the current hypotheses as to the function of sleep include neural maturation, clearance of metabolic waste products generated by neural activity in the awake brain, conservation of metabolic energy and others. However, to this day the current understanding of why sleep is an essential part of life is still yet to be determined.
The fact that such an important part of our life is yet to be fully understood is fascinating.
Sleep is a crucial part of everybody's life however, not many among us know how to approach this vital process correctly. In order to improve sleep's quality and optimize our productivity throughout the day, it is important to have the right information at hand and to know how to use it in your favour.
*The aim of the research***.** Gather, analyze and compile data regarding sleep and its importance on the recovery process in order to popularize proper sleep habits and make the most important aspects of this topic more accessible to the public.
Objectives. Help improve the public's general knowledge on the topic of the importance of sleep and, hopefully, aid people in achieving a better quality of life.
Methods. To evaluate the importance of sleep in the recovery process we researched a variety of resources ranging from books, videos and articles to consulting with one of the university's professor.
Conclusion. While we still do not fully understand sleep and all of the complex physiological processes that happen during it, one thing is for sure – sleep deprivation and poor sleep quality takes a big toll on our health. By depriving our bodies from sleep, we cause both short-term and long-term damage to ourselves. To help lead a better life it is important to stay informed on the topics that affect our life's quality the most and to make conscious choices towards bettering our lifestyle.

Keywords: Sleep, recovery, health, brain.

Introduction

When we were little, our parents would tell us to go to sleep early because sleep is very important. That of course, is a very well-known fact, and the reason why many of us share that same experience. Naturally everyone assumes there are a number of known reasons that make sleep so important. Surely by now we, as a species, are advanced enough to figure out the physiological functions of sleep. Or are we?

According to the National Center for Biotechnology Information of the US, the current hypotheses as to the function of sleep include neural maturation, clearance of metabolic waste products generated by neural activity in the awake brain, conservation of metabolic energy and others. However, to this day the current understanding of why sleep is an essential part of life is still yet to be determined.

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Methods. To evaluate the importance of sleep in the recovery process we researched a variety of resources ranging from books, videos and articles to consulting with one of the university's professor.

General facts about sleep. Sleep is an active state of unconsciousness produced by the body where the brain is in a relative state of rest and is reactive primarily to internal stimulus (Institute of Medicine (US) Committee on Sleep Medicine and Research, 2006). The human body cycles through 2 phases of sleep, (1) rapid eye movement (REM) and (2) nonrapid eye movement (NREM) sleep, which is further divided into 3 stages–N1 to N3. Sleep occurs in five stages: wake, N1, N2, N3, and REM. Stages N1 to N3 are considered non-rapid eye movement (NREM) sleep, with each stage leading to progressively deeper sleep. Approximately 75% of sleep is spent in the NREM stages, with the majority spent in the N2 stage (Malik J, Lo YL, Wu HAT, 2018). A typical night's sleep consists of 4 to 5 sleep cycles, with the progression of sleep stages in the following order: N1, N2, N3, N2, REM (Feinberg I, Floyd TC, 1979). A complete sleep cycle takes roughly 90 to 110 minutes. The first REM period is short, and as the night progresses, longer periods of REM and decreased time in NREM occur.

N1 (Stage 1) – Light Sleep: Muscle tone is present in the skeletal muscle, and breathing occurs regularly. This stage lasts around 1 to 5 minutes, comprising 5% of total sleep time.

N2 (Stage 2) – Deeper Sleep: lasts around 25 minutes in the first cycle and lengthens with each successive cycle, eventually comprising about 45% of total sleep. This stage of sleep is when bruxism (teeth grinding) occurs.

N3 (Stage 3) – Deepest Non-REM Sleep: This stage is the most difficult to awaken from; for some people, loud noises (> 100 decibels) will not lead to an awake state. As people age, they spend less time in N3 sleep and more time in stage N2 sleep. Although this stage has the greatest arousal threshold, if someone is awoken during this stage, they will have a transient phase of mental fogginess, known as sleep inertia. Cognitive testing shows that individuals awakened during this stage tend to have moderately impaired mental performance for 30 minutes to 1 hour (Hilditch CJ, McHill AW,2019). This is the stage when the body repairs and regrows tissues, builds bone and muscle, and strengthens the immune system. This is also the stage when sleepwalking, night terrors, and bedwetting occur.

REM: This stage is not considered a restful sleep stage. While the brain activity is similar to an awake individual, the skeletal muscles are atonic and without movement, except for the eyes and diaphragmatic muscles, which remain active. However, the breathing rate is more erratic and irregular. This stage usually starts 90 minutes after the sleep state, with each REM cycle increasing

throughout the night. The first cycle typically lasts 10 minutes, with the final cycle lasting up to 1 hour (Della Monica C, Johnsen S, Atzori G, Groeger JA, Dijk DJ, 2018). REM sleep is associated with dreaming and irregular muscle movements as well as rapid movements of the eyes, loss of motor tone, increased brain O_2 use, increased and variable pulse and blood pressure and high brain activity with increased brain metabolism by up to 20%. (Peever J, Fuller PM,2017)

The recovery process in this context. This paper treats recovery not in the sense of rehabilitation after a severe injury, but more so in the broader sense of daily restoration of the human body from the stress that it was subjected to throughout the day.

Sleep and immunity. The study of Michael Irwin called *Effects of sleep and sleep loss on immunity and cytokines*(Irwin M, 2002) shows that a night where you've had no more than 4 hours of sleep can reduce your immune cell activity by 70%. A renowned researcher in the field of sleep Matthew P Walker had this to say about this study: "That's quite a concerning state of immune deficiency. And it happens quickly, essentially after just one bad night. Imagine the state of your immune system after weeks, if not months, of insufficient sleep."

Sleep and cognitive abilities. There have been several articles published regarding the effects of sleep on brain development, brain plasticity and memory processing. For example, a study by Matthew P Walker suggests that not only do we need sleep after studying to lock in the newly formed memories but also before studying to prepare the brain for memory encoding, memory consolidation, and neural plasticity. This study has shown a 40% decrease in the ability of the brain to make new memories without sleep (Matthew P Walker, 2008).

The following quote is an extract from a podcast with Matthew P Walker that talks about a real-life event that suggests the importance of sleep in brain plasticity: "There are several counties throughout the United States that have started to delay their school start times and then measure the academic consequence. Now, one of the earliest test case examples happened in Edina in Minnesota. It's a township that sits just outside of Minneapolis. And they shifted their school start times from 7:25 in the morning to 8:30 in the morning. The metric that they used to assess the academic consequence

was this-- SAT scores. And they focused their analysis on the top 10% performing students, arguably those that have the least to gain in terms of any further improvement by way of sleep.

Now, in the year before they made the time change, that top 10% performing students got an average score of 1,288, which is a very respectable score. The following year when students were now going to school at 8:30 in the morning, the average SAT score was- 1,500. That is a 212-point increase, which is non-trivial."

Sleep and mental health. Because research has indicated a connection between sleep deprivation/sleep debt and mental health, it could be hypothesized that sleep debt could correlate with anger–irritability, aggression, and short temper. The effect of sleep deprivation on mood has been well-documented. The changes in mood that have been linked to sleep deprivation include anxiety, depression, mood swings, etc. (Saghir Z, Syeda JN, Muhammad AS, Balla Abdalla TH.,2018) A number of studies including that of Serena Bauducco (Bauducco SV, Flink IK, Jansson-Fröjmark M, Linton SJ,2016) conducted a cross-sectional study to test the correlation between sleep deficit in adolescents and emotional and behavioral issues. Their sample included 2,767 students between the ages of 12 and 16. Fifty-two percent of the students studied were male. The study revealed that students who reported less than the recommended total sleep time (TST) experienced what Baudocco et al. referred to as "norm-breaking behavior," as well as emotional changes, including anger, depression, and anxiety.

Sleep and cardiovascular diseases. "I could tell you about sleep loss and the cardiovascular system, that all it takes is one hour. Because there is a global experiment that is performed on 1.6 billion people across 70 countries twice a year, and it's called daylight savings time." says Matthew P Walker. According to a study of hospital admissions across the state of Michigan, there was a 24% increase in heart attacks following the switch to daylight saving time, affirms the American Heart Association. At the same time, in the fall, when we gain an hour of sleep, we see a 21% decrease in heart attacks. That is how fragile your body is to even just the smallest perturbations of sleep.

Sleep and physical abilities. Sleep loss and/or poor sleep quality can impair muscular strength, speed, and other aspects of physical performance. Sleep issues can also increase risk of concussions and other injuries, and impair recovery following injury. Cognitive performance is also impacted in a number of domains, including vigilance, reaction time and decision making. (Charest J, Grandner MA,2020) These abilities come in handy in sports where fast reaction time and precision are important such as various types of martial arts and team sports.

Proper sleep hygiene. 'Sleep hygiene' is the term used to describe good sleep habits. Considerable research has gone into developing a set of guidelines and tips which are designed to enhance good sleeping, and there is much evidence to suggest that these strategies can provide long-term solutions to sleep difficulties. By conducting a questionnaire regarding people's sleeping habits we obtained somewhat unexpected results. In this questionnaire 62 people of ages ranging between 14 and 80 years old answered 8 simple questions in relation to their sleeping habits giving us the following results:

Figure 1. How many hours on average do you sleep per day?

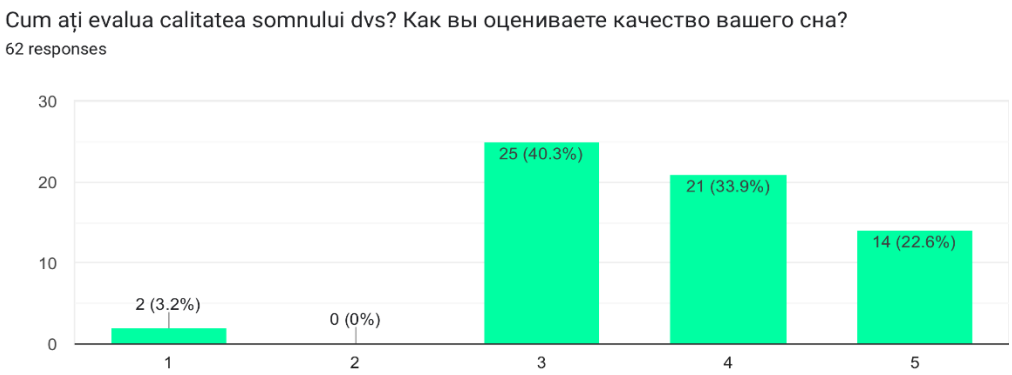

Figure 2. How would you rate the quality of your sleep?

Figure 3. Are you having trouble sleeping?

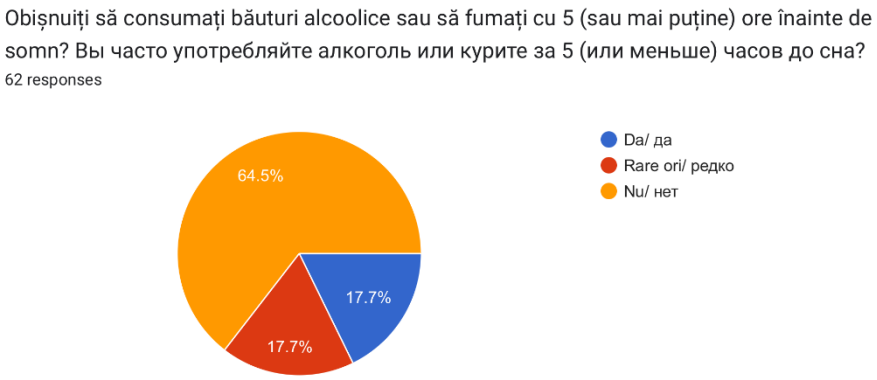

Figure 4. Do you usually consume alcoholic beverages or smoke 5 hours before bedtime?

Figure 5. Do you lead an active lifestyle?

Figure 6. Are there outside noises, cars, music, in the place where you sleep?

Figure 7. Do you do anything else in bed besides sleep (on the phone, watching TV, eating, etc.)?

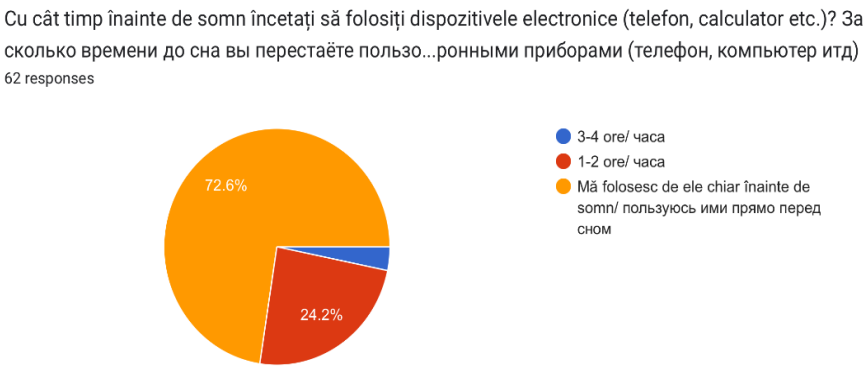

Figure 8. How long before bedtime do you stop using electronic devices (phone, computer, etc.)?

After analyzing these results, we came to the conclusion that the majority of participants are satisfied with their sleep quality. While some habits or environmental factors that impact sleep in a negative way persist in the majority of participants' answers, the overall results paint a generally satisfactory picture when describing people's sleep quality (Fig.1,2,3,4,5,6,7,8).

For those who struggle with sleeping however, here are some tips from the Center for Clinical Interventions of Australia that will improve your sleep:

1) Get regular. One of the best ways to train your body to sleep well is to go to bed and get up at more or less the same time every day, even on weekends and days off. This regular rhythm will make you feel better and will give your body something to work from.

2) Sleep when sleepy. Only try to sleep when you actually feel tired or sleepy, rather than spending too much time awake in bed.

3) Get up & try again. If you haven't been able to get to sleep after about 20 minutes or more, get up and do something calming or boring until you feel sleepy, then return to bed and try again. Sit quietly on the couch with the lights off (bright light will tell your brain that it is time to wake up), or read something boring like the phone book. Avoid doing anything that is too stimulating or interesting, as this will wake you up even more.

4) Avoid caffeine & nicotine. It is best to avoid consuming any caffeine (in coffee, tea, cola drinks, chocolate, and some medications) or nicotine (cigarettes) for at least 4-6 hours before going to bed. These substances act as stimulants and interfere with the ability to fall asleep

5) Avoid alcohol. It is also best to avoid alcohol for at least 4-6 hours before going to bed. Many people believe that alcohol is relaxing and helps them to get to sleep at first, but it actually interrupts the quality of sleep.

6) Bed is for sleeping. Try not to use your bed for anything other than sleeping, so that your body comes to associate bed with sleep. If you use the bed as a place to watch TV, eat, read, work on your laptop, pay bills, and other things, your body will not learn this connection.

7) Sleep rituals. You can develop your own rituals of things to remind your body that it is time to sleep - some people find it useful to do relaxing stretches or breathing exercises for 15 minutes before bed each night, or sit calmly with a cup of caffeine-free tea.

8) Bathtime. Having a hot bath 1-2 hours before bedtime can be useful, as it will raise your body temperature, causing you to feel sleepy as your body temperature drops again. Research shows that sleepiness is associated with a drop in body temperature.

9) No clock-watching. Many people who struggle with sleep tend to watch the clock too much. Frequently checking the clock during the night can wake you up (especially if you turn on the light to read the time) and reinforces negative thoughts such as "Oh no, look how late it is, I'll never get to sleep" or "it's so early, I have only slept for 5 hours, this is terrible."

11)Exercise. Regular exercise is a good idea to help with good sleep, but try not to do strenuous exercise in the 4 hours before bedtime. Morning walks are a great way to start the day feeling refreshed.

12) Eat right. A healthy, balanced diet will help you to sleep well, but timing is important. Some people find that a very empty stomach at bedtime is distracting, so it can be useful to have a light snack, but a heavy meal soon before bed can also interrupt sleep. The best snack before sleep is one that contains complex carbohydrates and proteins that will help maintain a stable blood sugar level. Besides that, foods that are rich in potassium calcium and magnesium are very helpful in relaxing overstressed muscles and improving the overall state of the nervous system. With that in mind, a wholegrain bread, peanut butter and banana sandwich with a warm glass of milk is an excellent choice for a snack before bed.

13) The right space. It is very important that your bed and bedroom are quiet and comfortable for sleeping. A cooler room (around 18^{o}-20^{o}C) with enough blankets to stay warm is best, and make sure you have curtains or an eye mask to block out early morning light and earplugs if there is noise outside your room.

14) Avoid bright light. Bright light as well as light emitted by electronic devices will signal to your brain that it is time to wake up. To avoid that, dim the lights in the evening and avoid using electronic devices. If it is not possible to cut out all electronics, use a night mode on your devices with a blue light filter as well as special glasses that block blue light.

Conclusion. While we still do not fully understand sleep and all of the complex physiological processes that happen during it, one thing is for sure – sleep deprivation and poor sleep quality takes a big toll on our health. By depriving our bodies from sleep, we cause both short-term and long-term

damage to ourselves. To help lead a better life it is important to stay informed on the topics that affect our life's quality the most and to make conscious choices towards bettering our lifestyle.

References

Bauducco SV, Flink IK, Jansson-Fröjmark M, Linton SJ. Sleep Health. 2016;Sleep duration and patterns in adolescents: correlates and the role of daily stressors. 2:211–218.

Charest J, Grandner MA. Sleep and Athletic Performance: *Impacts on Physical Performance, Mental Performance, Injury Risk and Recovery, and Mental Health.* Sleep Med Clin. 2020 Mar;15(1):41–57. doi: 10.1016/j.jsmc.2019.11.005. PMID: 32005349; PMCID: PMC9960533.

Colten HR, Altevogt BM, 2006. Institute of Medicine (US) Committee on Sleep Medicine and Research. Sleep Disorders and Sleep Deprivation: *An Unmet Public Health Problem*. National Academies Press (US); Washington (DC):

Della Monica C, Johnsen S, Atzori G, Groeger JA, Dijk DJ. *Rapid Eye Movement Sleep, Sleep Continuity and Slow Wave Sleep as Predictors of Cognition, Mood, and Subjective Sleep Quality in Healthy Men and Women, Aged 20-84 Years*. Front Psychiatry. 2018;9:255

Feinberg I, Floyd TC. *Systematic trends across the night in human sleep cycles*. Psychophysiology. 1979 May;16(3):283–91

Hilditch CJ, McHill AW. *Sleep inertia: current insights*. Nat Sci Sleep. 2019;11:155–165

Irwin M. *Effects of sleep and sleep loss on immunity and cytokines. Brain Behav Immun*. 2002 Oct;16(5):503-12. doi: 10.1016/s0889-1591(02)00003-x. PMID: 12401464.

Malik J, Lo YL, Wu HT. *Sleep-wake classification via quantifying heart rate variability by convolutional neural network*. Physiol Meas. 2018 Aug 20;39(8):085004

Matthew P Walker. *Sleep-dependent memory processing* 2008;16(5):287-98. doi: 10.1080/10673220802432517.

Memar P, Faradji F. *A Novel Multi-Class EEG-Based Sleep Stage Classification System*. IEEE Trans Neural Syst Rehabil Eng. 2018 Jan;26(1):84-95

Peever J, Fuller PM. *The Biology of REM Sleep*. Curr Biol. 2017 Nov 20;27(22):R1237-R1248

Saghir Z, Syeda JN, Muhammad AS, Balla Abdalla TH. *The Amygdala, Sleep Debt, Sleep Deprivation, and the Emotion of Anger: A Possible Connection?* Cureus. 2018 Jul 2;10(7):e2912. doi: 10.7759/cureus.2912. PMID: 30186717; PMCID: PMC6122651.

UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 252–256
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/ 10.62229/UaViii_5_25-34

THE DEVELOPMENT OF STUDENTS' CREATIVITY THROUGH ACTIVE AND PARTICIPATORY METHODS

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Abstract*. Background*. Creativity plays a crucial role in students' intellectual and emotional development. In today's educational landscape, fostering creativity is more important than ever, as it encourages independent thinking, problem-solving skills, and adaptability. Active-participatory methods are widely recognized as effective tools in stimulating students' creative potential. This paper explores the significance of creativity in the learning process and examines how active-participatory teaching methods can contribute to its development.
In traditional educational environments, rigid structures and passive learning often limit creativity. However, methods that encourage participation such as debates, role-plays, group projects, and brainstorming sessions provide a more dynamic framework for expression and innovation. These approaches create an environment where students feel more engaged and motivated to think outside the box.
*The aim of the research***.** To investigate the impact of active-participatory methods on the development of students' creativity and to identify the most effective strategies for cultivating a creative learning environment.
Objectives. To highlight the benefits of active learning, promote interactive teaching techniques, and support educators in adopting methods that encourage student innovation and critical thinking.
Methods. This research involved the analysis of theoretical literature on pedagogy, classroom observations, and interviews with teachers who apply participatory methods in their lessons. Additionally, student feedback and creative output were used to assess progress and engagement.
Conclusion. The implementation of active-participatory methods significantly enhances students' creativity by fostering a stimulating and inclusive educational setting. These strategies not only support academic growth but also contribute to the development of essential life skills. To cultivate creativity effectively, educators must adopt a flexible, student-centered approach that encourages exploration, dialogue, and collaboration.

Keywords: Creativity, education, active-participatory methods, student development, innovation.

Introduction

In an era where knowledge is abundant but innovation is rare, creativity has emerged as a cornerstone of 21st-century education. International frameworks such as UNESCO's Education 2030 and the OECD's Learning Compass emphasize creativity as a core skill necessary for global citizenship, employability and lifelong learning.

Studies by Runco & Acar (2012) and Beghetto (2010) suggest that creativity can be taught and nurtured through intentional pedagogical design. Constructivist paradigms advocate for learner-centered approaches, emphasizing exploration and experimentation as catalysts for innovation. Additionally, interdisciplinary research (e.g., Robinson, 2011) indicates that creativity thrives in diverse educational contexts when students are encouraged to question, explore, and collaborate.
In contemporary education, the emphasis on student-centered learning has brought creativity to the forefront of pedagogical discussions. Creativity, defined as the ability to generate original and valuable ideas, is not just an asset in the arts but a vital competency in all areas of learning. As the world evolves rapidly with the rise of technology and innovation, the ability to think creatively has become a necessity for students to adapt, solve problems, and contribute meaningfully to society **(**Lucas, Claxton, & Spencer, 2013**)**. Traditional teaching methods, often focused on rote learning and passive absorption of knowledge, are insufficient in nurturing this essential skill. Active-participatory methods, which place students at the center of the learning process, have proven effective in stimulating creative thinking and encouraging active engagement.

Background

Creativity has long been associated with intrinsic motivation, emotional expression, and cognitive flexibility. Research shows that educational environments that support autonomy, offer challenges, and provide opportunities for exploration contribute significantly to creative development. Unfortunately, many traditional classrooms still emphasize standardized testing and factual recall over exploration and innovation. This disconnect highlights the need for instructional strategies that foster creativity rather than suppress it. Creativity plays a crucial role in students' intellectual and emotional development. In today's educational landscape, fostering creativity is more important than ever, as it encourages independent thinking, problem-solving skills, and adaptability. Active-participatory methods are widely recognized as effective tools in stimulating students' creative potential. This paper explores the significance of creativity in the learning process and examines how active-participatory teaching methods can contribute to its development (Sawyer, 2012; Beghetto, 2010).

In traditional educational environments, rigid structures and passive learning often limit creativity. However, methods that encourage participation such as debates, role-plays, group projects, and brainstorming sessions provide a more dynamic framework for expression and innovation. These approaches create an environment where students feel more engaged and motivated to think outside the box.

Active-participatory methods represent a shift in educational philosophy–from teacher-led instruction to learner-centered interaction. These methods include collaborative learning, debates, simulations, role-plays, project-based learning, and open discussions, all of which engage students in the co-construction of knowledge. Such strategies encourage risk-taking, self-expression, and the integration of diverse perspectives, all of which are critical to creative thinking (Robinson, 2011*).*

Theoretical Frameworks

To further ground this study, several key educational theories provide valuable insight:

- *Constructivism (Piaget, Vygotsky)***:** Learning is an active process. Vygotsky's emphasis on social interaction and the Zone of Proximal Development aligns directly with collaborative and participatory learning.
- *Multiple Intelligences (Gardner):* Creativity can manifest across diverse intelligences such as musical, bodily-kinesthetic, interpersonal, and intrapersonal. Active methods give space for all types of learners to express their creativity.
- *Bloom's Revised Taxonomy:* Creativity sits atop the cognitive domain, encouraging students to synthesize knowledge into original ideas.

Purpose and Objectives

The main purpose of this study is to analyze the role of active-participatory methods in enhancing students' creativity and to promote their integration into regular classroom practice. The specific objectives are:

- ✓ To define creativity within the educational context.
- ✓ To explore various active-participatory methods and their theoretical foundations.
- ✓ To assess the impact of these methods on students' creative development.
- ✓ To provide practical recommendations for educators aiming to cultivate creativity in their classrooms.
- ✓ To highlight the benefits of active learning, promote interactive teaching techniques, and support educators in adopting methods that encourage student innovation and *critical thinking.*

Methodology

This research involved the analysis of theoretical literature on pedagogy, classroom observations, and interviews with teachers who apply participatory methods in their lessons. Additionally, student feedback and creative output were used to assess progress and engagement. This study employs a qualitative research design, focusing on the analysis of pedagogical literature, classroom observations, and interviews with teachers. A total of ten teachers from various disciplines and school levels were interviewed regarding their experiences with active-participatory methods. Additionally, creative output from students (such as projects, presentations, and written work) was analyzed to evaluate the outcomes of such methods. The research was conducted over a three-month period in both primary and secondary schools (Mishra and Koehler (2006).

Findings and Discussion

The analysis of the data collected reveals several key findings:

1. *Enhanced Engagement and Motivation***:** Teachers reported that students were more engaged and motivated when they were actively involved in learning. Activities such as group projects and role-plays allowed students to explore topics in depth and express their personal viewpoints, increasing their investment in the learning process (Mishra & Koehler, 2006).
2. *Development of Critical and Divergent Thinking***:** Active-participatory methods encourage students to analyze problems from multiple perspectives and propose original solutions. Teachers noted a marked improvement in students' ability to think critically and creatively when compared to traditional lectures.
3. *Improved Collaboration and Communication Skills***:** Many of the methods employed required students to work in teams, negotiate roles, and present their ideas effectively. These interactions not only built social skills but also contributed to the refinement of creative ideas through collective brainstorming and feedback.
4. *Positive Classroom Climate***:** The use of participatory methods helped establish a supportive and dynamic classroom environment. Students felt more comfortable taking risks, sharing unconventional ideas, and learning from their mistakes–key elements in the creative process.
5. *Challenges and Limitations***:** Despite the many benefits, teachers also reported challenges such as time constraints, lack of resources, and resistance from students accustomed to passive learning. Additionally, the assessment of creativity remains a complex issue due to its subjective nature.

Examples of Active-Participatory Methods

Concrete strategies for fostering creativity include:

- ✓ Project-Based Learning (PBL): Encourages real-world problem-solving.
- ✓ Think-Pair-Share**:** Promotes verbal reasoning and peer feedback.

- ✓ Role-Playing and Storytelling**:** Enhances imagination and empathy.
- ✓ Learning Stations**:** Involve students in dynamic movement and peer instruction.
- ✓ Digital Tools**:** Platforms like Canva, Padlet, and Jamboard foster design thinking.

Assessment Techniques for Creativity*:* To assess creativity meaningfully, educators can use:

- ✓ Portfolios**:** Track student growth and originality.
- ✓ Rubrics**:** Evaluate based on originality, usefulness, and effort.
- ✓ Peer and Self-Evaluation**:** Encourage reflective learning.
- ✓ Narrative Feedback: Focus on growth and creative process.

Benefits Beyond Academics Active-participatory methods enhance not just academic achievement but also:

- ✓ Emotional Intelligence**:** Fosters empathy and resilience.
- ✓ Communication and Leadership Skills**:** Develop through group collaboration.
- ✓ Lifelong Learning Habits**:** Instill curiosity and intrinsic motivation.
- ✓ Reduced Anxiety**:** Create inclusive, supportive environments.

Implications for Teaching Practice

The findings suggest that integrating active-participatory methods into daily teaching can significantly enhance students' creative capacities. To implement these methods effectively, educators should consider the following recommendations:

- ✓ Create a Safe and Stimulating Environment**:** Encourage risk-taking and reward originality. Foster a classroom culture that values diverse perspectives and unconventional thinking.
- ✓ Incorporate Varied Learning Activities**:** Use a mix of debates, case studies, creative writing, and group work to cater to different learning styles and stimulate multiple intelligences.
- ✓ Provide Constructive Feedback**:** Offer specific, positive, and timely feedback that helps students refine their ideas without stifling their enthusiasm.
- ✓ Support Professional Development**:** Offer training for teachers to develop skills in designing and facilitating participatory learning experiences.
- ✓ Embrace Flexible Assessment: Use rubrics that evaluate creativity based on originality, relevance, and effort rather than fixed answers (Lucas et al. (2013).

Policy Implications and Future Research

Educational policymakers should support the inclusion of creativity-focused goals in curriculum standards. Teacher training programs must emphasize participatory methods and flexible assessment strategies. Future research should explore longitudinal impacts of creative teaching on academic performance and emotional intelligence, as well as investigate creative engagement in virtual learning environments *(*Runco & Acar, 2012*).*

Conclusion

Creativity is an essential component of modern education that equips students with the tools to navigate a complex and rapidly changing world. The application of active-participatory methods in the classroom has demonstrated considerable potential in fostering this vital skill. While challenges remain, the benefits to student engagement, cognitive development, and overall learning far outweigh the obstacles. By embracing a learner-centered approach, educators can unlock the

creative potential of their students and prepare them for future success. The implementation of active-participatory methods significantly enhances students' creativity by fostering a stimulating and inclusive educational setting. These strategies not only support academic growth but also contribute to the development of essential life skills. To cultivate creativity effectively, educators must adopt a flexible, student-centered approach that encourages exploration, dialogue, and collaboration.

References

Anderson, L. W., & Krathwohl, D. R. (2001). "A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives." Longman.

Beghetto, R. A. (2010). "Creativity in the classroom: Developing potential in all learners." Routledge.

Craft, A. (2005). "Creativity in schools: Tensions and dilemmas." Routledge.

Gardner, H. (2011). "Frames of Mind: The Theory of Multiple Intelligences." Basic Books.

Lucas, B., Claxton, G., & Spencer, E. (2013). Progression in Student Creativity in School. OECD Education Working Papers.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record.

Robinson, K. (2011). "Out of our minds: Learning to be creative." Capstone.

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. Creativity Research Journal.

Sawyer, R. K. (2012). "Explaining creativity: The science of human innovation." Oxford University Press.

Torrance, E. P. (2004). "The Torrance Tests of Creative Thinking-Norms-Technical Manual." Scholastic Testing Service.

Vygotsky, L. S. (1978). "Mind in society: The development of higher psychological processes." Harvard University Press.

Tiparul s-a realizat
la Tipografia Editurii Universităţii din Bucureşti