Portofoliu lucrări științifice

I. Articole publicate în reviste indexate în Web of Science (ISI)

1. Alecu, S., Onea, G. A., Badau, D., Badau, A., & **Nechita, F.** (2026). Influence of bilateral upper limb morphological asymmetry on grip strength related to gender in non-athlete university students. *Symmetry, 18(1),* 122. **IF – 2,2 in 2024** https://doi.org/10.3390/sym18010122 https://www.mdpi.com/2073-8994/18/1/122 WOS:001672649300001
2. Baba, D., Mijaica, R., **Nechita, F**., & Balint, L. (2024). Evaluating the effectiveness of the annual physical training plan for masters +45 women half marathon athletes: A guideline model for good practices for programming effort volume and intensity. *Sports, 12*(9), 256. **IF - 2.9 in 2024** https://doi.org/10.3390/sports12090256 https://www.mdpi.com/2075-4663/12/9/256 WOS:001326250400001
3. Buzescu, R., **Nechita, F.,** & Cioroiu, S. G. (2021). The relationship between neuromuscular control and physical activity in the formation of the visual-psychomotor schemes in preschools. *Sensors, 21(1)*, 224. **IF - 3,847 in 2021** https://doi.org/10.3390/s21010224 https://www.mdpi.com/1424-8220/21/1/224 WOS:000606291800001
4. Drugau, S., Badau, D., **Nechita, F**., Mijaica, R., Badau, A., Iordan, A. D., Stanciulescu, R., & Dina, G. (2025). Romanian physical education teachers' perception of formative feedback on their professional competencies. *Revista Romanească pentru Educație Multidimensională, 17*(1), 91–115. **IF – 0.4 in 2024** https://doi.org/10.18662/rrem/17.1/942 https://lumenpublishing.com/journals/index.php/rrem/article/view/7222 WOS:001462551200005
5. Mindrescu, V., Simion, G., Turcu, I., Catuna, C., Paun, D. G., & **Nechita, F**. (2022). The multiplicative effect interaction between outdoor education activities based on the sensory system. *Sustainability, 14(19)*, 11859. **IF – 3,9 in 2022** https://doi.org/10.3390/su141911859 https://www.mdpi.com/2071-1050/14/19/11859 WOS:000867234000001

II. Articole publicate în reviste indexate BDI

6. **Nechita, F.**, & Nechita, A. (2025). Contemporary fitness approaches to improve body composition in adults. *Bulletin of the Transilvania University of Brașov, 18*(2), 89–98. https://webbut.unitbv.ro/index.php/Series_IX/article/view/11044/6599
7. **Nechita, F.** (2025). Physical therapeutic intervention techniques in improving flat back syndrome in the school environment. *Bulletin of the Transilvania University of Braşov. Series IX: Sciences of Human Kinetics, 18*(1), 269–276. https://webbut.unitbv.ro/index.php/Series_IX/article/view/10375/6495

8. Samson, I., & **Nechita, F**. (2024). Study on the development of explosive force in athletic jumping through plyometric exercises at the level of junior athletes. *Bulletin of the Transilvania University of Brașov. Series IX: Sciences of Human Kinetics, 17*(2), 9–16. https://webbut.unitbv.ro/index.php/Series_IX/article/view/8413/6054
9. **Nechita, F. (2021).** The role of movement games in the education of speed indices in the pre-university system. *Bulletin of the Transilvania University of Brașov. Series IX: Sciences of Human Kinetics, 14*(1), 187–194. https://webbut.unitbv.ro/index.php/Series_IX/article/view/405/342

III. Proiect de cercetare

10. **Responsabil partener (manager proiect)** *"COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01*, proiect finantat de European Unión´s Horizon Europe Programme, durata contract: 03.11.2025 - 31.01.2028, proiectul include 38 organizatii din 12 tări. Partener Romania - Amistim Medical Equipment (AMI), buget total – 17 591 490.00 euro, buget Partener Romania - Amistim Medical Equipment 570.000 euro, contract nr. 17 din 29.10.2025**,** https://amistim.ro/research-and-development/

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Influence of Bilateral Upper Limb Morphological Asymmetry on Grip Strength Related to Gender in Non-Athlete University Students

Stefan Alecu [1], Gheorghe Adrian Onea [1,*], Dana Badau [2], Adela Badau [1] and Florentina Nechita [1]

[1] Department of Physical Education and Special Motricity, Transilvania University of Brașov, 500024 Brașov, Romania; alecu.stefan@unitbv.ro (S.A.); adela.badau@unitbv.ro (A.B.); florentina.nechita@unitbv.ro (F.N.)
[2] Department of Motor Performance, Transilvania University of Brașov, 500024 Brașov, Romania; dana.badau@unitbv.ro
* Correspondence: onea.gheorghe@unitbv.ro

Abstract

Bilateral morphological asymmetry of the upper limbs may influence grip strength even in semi-active young adults. Understanding this relationship is important for identifying early neuromuscular imbalances with implications for ergonomics and rehabilitation. This study aimed to examine associations between upper limb anthropometric characteristics and grip strength in non-athlete students, considering gender and manual dominance. The sample included 192 healthy university students (110 females, 82 males; mean age 19.92 ± 1.4 years) without prior sports training. Thirteen bilateral anthropometric parameters of the upper limbs were assessed, including hand and palm dimensions, segmental lengths, and arm and forearm circumferences, along with grip strength measured by dynamometry in two positions: arm extended and arm flexed at 90°. Statistical analysis revealed significant differences in forearm length, arm and forearm circumferences, and grip strength ($p < 0.001$). The dominant limb consistently demonstrated higher grip strength, with mean differences of approximately 2 kg. Male participants showed higher absolute values for all morphological and functional variables, whereas stronger correlations between distal upper-limb morphology and grip strength were observed in females. These findings indicate that, despite largely symmetric skeletal dimensions, moderate functional asymmetries exist and grip strength is influenced primarily by local muscular development rather than overall limb size.

Keywords: bilateral symmetry; upper limb morphology; grip strength; dynamometry; anthropometric analysis; functional asymmetry

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1. Introduction

Upper limb asymmetry is a phenomenon frequently observed even among apparently healthy young adults, such as students. These differences are influenced by factors such as manual dominance [1–3], daily habits of preferential hand use, and individual neuromuscular development. In students, who spend much time in sedentary or repetitive academic activities (writing, keyboard use), these asymmetries can become more pronounced, especially in the absence of functional balance generated through physical activity [4,5].

Over time, even minor differences can affect posture, movement ergonomics, or the distribution of muscular effort [6,7]. The evaluation of these discrepancies becomes essential not only for understanding general functional status, but also for preventing chronic imbalances, especially in the context of transition to active professional life. In this sense, analyzing morphological and functional symmetry offers a valuable perspective on body balance [8–10] and can support personalized interventions in physical education, rehabilitation, or even vocational selection.

This asymmetry can be morphological in nature: differences in length, width, circumference between the right and left limb; or functional: differences in grip strength [11,12], mobility, or motor coordination capacity.

Functional and morphological asymmetries [13–15] of the upper limbs [16,17] are frequently encountered among students, even in the absence of an active sports regimen. Differences in strength, length, or muscle mass differences between the right and left limbs can be explained both by manual dominance (right-handed vs. left-handed) and by disproportionate daily use of the dominant hand. These asymmetries can influence functional performance [18–20], posture, and risk of injury in daily life.

Studies have shown that even in the absence of sports practice, manual dominance [21] plays a significant role in the development of functional asymmetries [22], favoring the strength and muscle mass of the dominant limb [23]. Although the young adult population, especially students, is often perceived as functionally homogeneous, recent research suggests significant asymmetries in the upper limbs [24,25], even in the absence of sports training. These asymmetries can be explained by lateral dominance, but also by repetitive daily activities that involve preference for using a single hand.

A significant correlation was observed between grip strength and body segment size among young adults, with notable bilateral variations [26]. Additionally, Burdukiewicz et al. (2020) reported significant differences between athletes and sedentary students regarding the symmetry of grip strength and muscle mass [23]. This evidence suggests that asymmetry is a common characteristic among the university population and can serve as a useful indicator for functional assessments or corrective interventions. Moreover, differences in arm circumference, palm length, or grip strength [27] reflect not only natural anatomical variations, but also individual functional adaptations. Evaluating these asymmetries among non-athlete students [28–30] offers a valuable perspective on musculoskeletal balance status, with implications for prevention of imbalances, performance optimization, and early rehabilitation interventions. In this context, the present study aims to examine the relationship between bilateral morphological symmetry [31,32] and functional symmetry, offering a complete analysis of potential links between anthropometric parameters and force generation capacity at the upper limb level [33,34].

Based on an analysis of the specialized literature, we identified several gaps in research on morphological asymmetry and manual grip strength. Research on the influence of bilateral morphological asymmetry of the upper limbs on grip strength among non-athlete students has significant gaps that limit the validity and applicability of the results. From a methodological perspective, the current literature reflects a lack of standardization in measurement protocols, manifested through variability in criteria for defining significant morphological asymmetry and absence of consensus on relevant anthropometric parameters. Methods for evaluating grip strength vary in testing positions, number of attempts, and recovery intervals, compromising study comparability. Additionally, inadequate control of confounding variables such as lateral dominance, impact of sedentary behaviors, and occupational factors specific to the university population is observed. Aspects related to gender differences in the manifestation of asymmetry and the implications of different equipment and technology use on asymmetric development are insufficiently

explored. From a conceptual perspective, uncertainties persist regarding cause-and-effect relationships between morphological asymmetry and strength differences, and underlying neuromotor mechanisms remain unclear [35,36]. The lack of longitudinal studies prevents understanding of the dynamics of asymmetry development during the university period and the long-term implications for musculoskeletal health. The practical applicability of results is limited by the absence of reference values specific to the population and correlations with functional performance in daily activities [37,38]. These limitations highlight the necessity for standardized protocols, longitudinal studies, and a clear definition of the significance of morphological asymmetry in the context of the non-athletic university population. Research that integrates in a unified manner segmental measurements (lengths, circumferences, spans) with bilateral dynamometric evaluations among non-athlete students is relatively scarce and focuses especially on the assessment of motor components.

The present study makes an original contribution by investigating the relationship between morphological and functional symmetry of the upper limbs in a population of young adult students who are semi-active or moderately active and do not engage in competitive sports. Unlike the existing literature, which predominantly focuses on elite athletes or clinical populations with musculoskeletal pathologies, this research adopts an integrated approach, combining detailed segmental anthropometric assessments with bilateral dynamometric measurements performed in two distinct positions. The main innovative aspects consist of: characterization of asymmetries in an intermediate population, representative of the majority of young people in academic settings, thus providing reference values for healthy individuals with moderate physical activity; simultaneous and correlated analysis of morphological parameters (segmental measurements of arm, forearm, and hand) and functional parameters (bilateral grip strength), enabling the identification of direct structure–function relationships; dynamometric evaluation in two different biomechanical contexts, which allows the detection of position-dependent asymmetries and provides a more comprehensive picture of bilateral functional capacity; and comparative analysis between sexes, both for morphological and functional asymmetries, as well as for the correlations between them, aspects insufficiently investigated in previous studies on non-athletic populations. This multidimensional approach allows not only the identification of the degree of morphological and functional asymmetry at the upper limb level, but also testing the hypothesis that structural asymmetries correlate with functional ones and that these relationships may differ according to gender and the biomechanical context of the assessment.

The study aims to identify bilateral differences and correlations between segmental anthropometric dimensions of the upper limbs and grip strength (evaluated by dynamometry) in young adults, students, and non-athletes, by gender and manual dominance.

The study hypothesis was that asymmetry at the upper-limb level influences manual grip strength (dynamometry) in non-athlete students and that these effects differ by gender and manual prevalence.

2. Materials and Methods

2.1. Participants

The study included 192 participants, of which 110 were female and 82 were male, with ages ranging between 18 and 26 years (mean age: 19.92 years). The mean body mass and height of the total sample were 66.7 $\pm$ 13.8 kg and 170.9 $\pm$ 8.9 cm, respectively. In the female group, mean body mass was 60.1 $\pm$ 10.0 kg and mean height was 165.7 $\pm$ 6.6 cm, while in the male group, mean body mass was 75.5 $\pm$ 13.4 kg and mean height was 177.9 $\pm$ 6.2 cm. All subjects were volunteers recruited from students at a higher education institution, clinically healthy and fit for physical effort, without musculoskeletal conditions or other

contraindications that could influence anthropometric or functional measurements. Clinically healthy students who did not have musculoskeletal conditions or other medical contraindications were included in the study and provided informed consent for participation. An additional inclusion criterion was the subjects' declaration that they do not regularly practice physical exercise or are not registered with any sports club, to ensure the sample was representative of the non-athlete young adult population.

2.2. Study Design

This study took place from 27 March to 15 May 2025, with the objective of measuring anthropometric parameters and dynamometry of the subjects' upper limbs. The anthropometric measurement sessions were conducted under similar conditions and with the same measurement instruments for all participants. The order of performing anthropometric measurements was identical for all subjects. Anthropometric measurements of the upper limbs were performed bilaterally (both on the right side and on the left side). All measurements were performed in the faculty's physical education halls. Participants wore specific sports clothing and were instructed not to engage in intense physical exercise for at least 12 h before testing. Each measurement was performed with the same apparatus and equipment by the same evaluator to reduce inter-rater variability. Each parameter was recorded once, except for dynamometry, where the highest value from two attempts was taken into consideration. Data were centralized in digital format (Microsoft Excel 2021), processed, and statistically validated before final analysis. For measurements, the following were used: a stadiometer for height, a digital scale, a digital caliper, a flexible measuring tape, and a digital dynamometer.

The study was approved by the Ethical Board of the Faculty of Physical Education and Mountain Sports of Transilvania University of Brasov under the document no. 101/26.03.2025.

2.3. Measurements

For this study, 15 measurements were performed: 13 anthropometric and two motor. All anthropometric measurements were conducted according to standardized anthropometric procedures based on internationally accepted guidelines. Anatomical landmarks, participant positioning, and measurement techniques were defined in advance and applied consistently across all participants, following principles commonly used in anthropometric research and comparable to those described in the International Society for the Advancement of Kinanthropometry (ISAK) framework and were performed with standardized equipment as follows: for anthropometric evaluations of widths and lengths at the hand and palm levels, we used a Mitutoyo 500-196-30 digital caliper with a measurement range of 0–100 mm, a reading precision of 0.01 mm, and a tolerance of $\pm$0.01 mm. Segmental lengths (such as forearm length, arm length, and upper limb length) were measured with a flexible tape measure (150 cm), and circumferences were measured with an ergonomic tape measure featuring a self-tightening mechanism to ensure uniform application without tissue compression (Seca 201, Seca GmbH, Hamburg, Germany). For evaluations of hand grip strength, a GRIPX digital dynamometer was used, with a capacity of 90 kg, electronic. Although no formal validation study specific to this model has been published, digital hand dynamometers have been shown to provide reliable and valid measurements of grip strength in young adult populations when standardized testing protocols are applied. Similar digital dynamometry devices [39] have been widely used in previous studies investigating grip strength and its relationship with anthropometric parameters in students and healthy adults, supporting the methodological adequacy of this approach.

Anthropometric evaluations:

— Height—distance between the vertex (top of the head) and the sole level (support surface) in orthostatic position.
— Palm width—direct distance from the most lateral point of the second metacarpal head to the most medial point of the fifth metacarpal head.
— Palm width (thumb included)—direct distance from the most lateral point of the first metacarpal head to the most medial point of the fifth metacarpal head.
— Palm length—distance between the styloid line and the proximal phalanges between the middle and ring fingers.
— Hand length—distance between the styloid line and dactylion.
— Palm span—distance between the proximal phalanges of the little finger and the distal phalanges of the thumb, with fingers extended at maximum angles.
— Upper limb length—distance between the acromion and dactylion in orthostatic position, with the upper limb completely extended.
— Forearm length—distance between the lateral epicondyle of the humerus (olecranon) and the styloid process of the radius (styloid line where the prominence at the wrist is felt).
— Wrist circumference—on the styloid line, at the level of the styloid processes of the radius and ulna bones, i.e., at the two lateral bony prominences of the wrist. The measuring tape is placed exactly over these points, applied firmly but without compressing tissue, completely surrounding the joint.
— Relaxed forearm circumference—with the subject in orthostatic position and palm oriented anteriorly, half the distance between the lateral epicondyle and styloid process is determined, and the measuring tape is wrapped around the forearm.
— Flexed forearm circumference—with the subject in orthostatic position and palm oriented anteriorly, the subject is instructed to clench the fist and tense the forearm muscles in isometry, with the measuring tape wrapped around the forearm.
— Relaxed arm circumference—with the subject in orthostatic position and arm bent at the elbow at 90°, half the distance between the acromion and olecranon is determined and the measuring tape is wrapped at mid-distance, around the arm, without compressing tissues.
— Flexed arm circumference—with the subject in orthostatic position and arm bent at the elbow at 90°, in isometry, the subject is instructed to simultaneously clench the fist and flex the biceps, with the measuring tape wrapped around the arm.

Arm and forearm circumferences were analyzed as absolute anthropometric measures. Corrected circumferences adjusted for adipose tissue were not calculated, as skinfold thickness were not included in the study protocol. We aim to evaluate practical, field-based anthropometric indicators commonly used in educational and ergonomic settings, rather than estimates of isolated muscle cross-sectional area.

Motor evaluations:

— Dynamometry with extended arm—with the subject in orthostatic position with extended arm and palm oriented anteriorly, the subject is instructed to squeeze the dynamometer as hard as possible, without compensatory movements. Two attempts are performed with a 30 s pause between them. The highest value is recorded, expressed in kilograms (kg).
— Dynamometry with arm bent at 90°—with the subject in orthostatic position, with arm bent at the elbow joint at 90°, the subject is instructed to squeeze the dynamometer as hard as possible, without compensatory movements. Two attempts are performed with a 30 s pause between them. The highest value is recorded, expressed in kilograms (kg).

2.4. Statistical Analysis

Analyses were performed in IBM SPSS Statistics for Windows Version 26; IBM Corp., Armonk, NY, USA, with significance threshold $\alpha = 0.05$ (bilateral). The statistical power of the sample was calculated with G*Power 3.1.9.4. a priori/post hoc, indicating that for the main functional effects ($d^z \approx 0.46$–0.53), a sample of ~28–37 participants would ensure power ≥ 0.80 ($\alpha = 0.05$), while for smaller morphological effects, ~102 participants would be necessary. Our study included $n = 192$ subjects; the achieved power for key results was ≈ 1.00 (functional) and ~0.97 (e.g., forearm length), confirming sample adequacy for detecting effects of interest. For each bilateral variable, descriptive indicators (mean, standard deviation, minimum, maximum, skewness, kurtosis, CV%) and 95% confidence intervals (95% CI) were calculated. Left–right differences were evaluated using paired Student's *t*-tests; comparisons between genders were evaluated using independent Student's *t*-tests; and bivariate Pearson correlations were calculated between manual anthropometric measurements and dynamometric strength measurements. The coefficient of variation (CV) was calculated to highlight group homogeneity. We also calculated Cohen's d effect size. For paired tests, effect size was expressed through the statistical parameter Cohen's (d^z). The Pearson correlation coefficient was used to identify correlations between anthropometric indicators and grip strength; analyses were performed separately by gender (M/F), laterality (left/right), and posture (extension/flexion at 90°), with 12 anthropometric indicators per set. For identifying differences between the left and right upper segments. Before performing inferential analyses, the assumptions for parametric testing were examined. Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was evaluated using Levene's test. These analyses supported the use of parametric statistical procedures.

3. Results

In Table 1, the analysis of the fourteen bilaterally measured anthropometric parameters reveals consistent differences between genders, especially in linear dimensions and circumferences, as well as good body symmetry between the left and right sides. Regarding palm width, the mean values were 9.45 ± 0.61 cm in the female group and 10.63 ± 1.09 cm in the male group, with the difference confirmed by 95% confidence intervals. Hand length showed a similar trend, with means of 17.18 ± 0.94 cm in the female group and 18.89 ± 1.04 cm in the male group. For circumferences, values were significantly higher in the male group. At the wrist level, the mean was 15.6 cm in the female group and 17.4 cm in the male group. The difference was accentuated at the flexed arm, where the female group had a mean circumference of 27.9 ± 3.95 cm, while the male group had a mean circumference of 32.9 ± 4.24 cm.

Table 1. Descriptive statistics of the 14 parameters according to laterality and gender.

Parameters	Hand	Gender	Min.	Max.	X	SD	CI 95%		Kurtosis	CV%
							Lower	Upper		
Palm width with thumb (cm)	L	F	8.00	10.70	9.444	0.613	9.329	9.559	−0.509	6.496
		M	8.80	12.00	10.615	0.773	10.447	10.782	−0.564	7.283
	R	F	8.00	10.80	9.436	0.607	9.322	9.550	−0.276	6.438
		M	8.80	12.00	10.549	0.729	10.391	10.707	−0.219	6.912

Table 1. *Cont.*

Parameters	Hand	Gender	Min.	Max.	X	SD	CI 95%		Kurtosis	CV%
							Lower	Upper		
Palm width (cm)	L	F	7.00	9.00	7.869	0.456	7.783	7.954	−0.294	5.800
		M	6.50	10.00	8.743	0.592	8.615	8.871	1.644	6.773
	R	F	6.70	9.50	7.790	0.493	7.697	7.882	0.709	6.325
		M	7.30	10.00	8.650	0.548	8.531	8.769	−0.354	6.338
Palm length (cm)	L	F	8.50	11.30	9.768	0.615	9.653	9.883	−0.300	6.292
		M	8.50	12.00	10.556	0.675	10.410	10.702	0.751	6.394
	R	F	8.40	11.30	9.720	0.602	9.607	9.833	0.025	6.195
		M	8.80	12.00	10.513	0.682	10.366	10.661	0.495	6.489
Hand length (cm)	L	F	15.50	19.80	17.406	0.881	17.240	17.571	−0.244	5.060
		M	17.00	21.00	18.744	0.908	18.547	18.940	−0.637	4.846
	R	F	13.20	20.50	17.380	1.052	17.182	17.577	1.720	6.051
		M	16.80	20.50	18.635	0.928	18.435	18.836	−0.664	4.979
Hand span (cm)	L	F	16.50	22.50	18.986	1.306	18.741	19.231	−0.386	6.881
		M	18.20	24.60	21.240	1.415	20.934	21.547	−0.437	6.662
	R	F	13.30	22.00	18.882	1.452	18.609	19.154	0.989	7.692
		M	18.80	25.30	21.223	1.463	20.906	21.540	−0.223	6.894
Forearm length (cm)	L	F	20.00	28.00	24.112	1.604	23.811	24.413	−0.251	6.651
		M	22.70	28.50	25.941	1.299	25.660	26.223	−0.389	5.007
	R	F	20.00	29.00	24.369	1.801	24.031	24.707	−0.027	7.392
		M	22.50	29.50	26.328	1.518	26.000	26.657	0.064	5.765
Arm length (cm)	L	F	27.00	36.00	31.490	1.946	31.125	31.855	−0.369	6.180
		M	27.00	43.50	33.155	3.161	32.471	33.839	1.185	9.534
	R	F	26.00	36.50	31.453	2.021	31.074	31.833	−0.220	6.427
		M	26.00	43.00	32.939	3.463	32.189	33.689	0.374	10.514
Wrist circumference (cm)	L	F	13.40	19.00	15.649	1.293	15.406	15.891	−0.428	8.263
		M	15.50	19.00	17.068	0.936	16.866	17.271	−0.806	5.487
	R	F	13.40	19.50	15.645	1.280	15.405	15.885	0.004	8.179
		M	15.50	19.00	17.082	0.889	16.889	17.274	−0.738	5.207
Relaxed forearm circumference (cm)	L	F	17.80	30.00	23.507	2.312	23.073	23.941	0.594	9.835
		M	22.00	32.50	26.937	2.299	26.439	27.434	−0.192	8.534
	R	F	18.40	30.30	23.876	2.266	23.451	24.302	0.454	9.491
		M	22.40	33.50	27.279	2.336	26.774	27.785	0.027	8.564
Tense forearm circumference (cm)	L	F	18.70	31.00	24.099	2.276	23.672	24.526	0.687	9.445
		M	23.00	33.50	27.677	2.407	27.156	28.198	−0.057	8.696
	R	F	19.10	31.00	24.476	2.269	24.050	24.902	0.451	9.270
		M	23.20	34.50	28.059	2.368	27.546	28.571	0.191	8.438
Relaxed arm circumference (cm)	L	F	18.40	38.30	26.106	3.644	25.422	26.790	1.093	13.957
		M	21.50	42.00	29.882	3.894	29.039	30.724	0.367	13.030
	R	F	19.20	38.00	26.330	3.664	25.642	27.018	1.226	13.916
		M	21.50	43.00	29.987	3.767	29.171	30.802	1.368	12.563

Table 1. *Cont.*

Parameters	Hand	Gender	Min.	Max.	X	SD	CI 95%		Kurtosis	CV%
							Lower	Upper		
Tense arm circumference	L	F	21.00	41.00	27.760	3.702	27.065	28.455	1.492	13.335
		M	23.70	47.00	32.868	4.239	31.951	33.786	1.158	12.898
	R	F	21.60	41.00	28.008	3.626	27.328	28.689	1.284	12.946
		M	24.70	47.00	33.118	4.306	32.186	34.050	1.029	13.002
Extended arm dynamometry (kg)	L	F	13.50	36.80	23.865	5.019	22.923	24.807	−0.346	21.031
		M	20.00	64.50	36.450	10.606	34.154	38.746	−0.211	29.097
	R	F	12.50	44.50	25.862	6.232	24.692	27.032	−0.237	24.096
		M	19.90	69.30	38.728	11.707	36.194	41.262	−0.315	30.230
Bend arm dynamometry (kg)	L	F	9.90	39.90	23.098	5.515	22.063	24.134	0.201	23.877
		M	18.50	71.00	35.235	11.295	32.791	37.680	1.150	32.055
	R	F	10.70	36.80	25.004	6.059	23.866	26.141	−0.536	24.233
		M	19.50	62.90	37.505	11.122	35.097	39.912	−0.615	29.656

Min—minimum; Max—maximum; X—mean; SD—standard deviation; CI 95%—confidence interval 95%; CV—coefficient of variation; L—left; R—right; F—female; M—male.

Comparison of the left and right sides did not reveal significant differences. Means were almost identical across genders, and confidence intervals overlapped. For example, forearm length was 23.9 ± 1.46 cm (left) and 24.3 ± 1.54 cm (right) in the female group, and 26.3 ± 1.69 cm and 26.6 ± 1.75 cm in the male group, respectively. These results suggest stable structural symmetry between the two sides of the body.

The most evident differences between genders were observed in strength tests (dynamometry). In the extended arm test, the female group had a mean of 23.7 ± 7.6 kgf, while the male group had a mean of 36.1 ± 9.1 kgf. In the bent arm test, results were similar: 22.9 ± 8.2 kgf in the female group and 36.2 ± 8.5 kgf in the male group. Maximum values reached 55 kgf in the female group and over 70 kgf in the male group, illustrating not only the difference between means, but also greater variability in the male group.

The study results confirm that the male group presents significantly larger dimensions and strength than the female group, while bilateral symmetry is well preserved. These observations are relevant to both the sports and ergonomic domains, as well as to clinical applications, where assessment of body proportions and muscle strength can contribute to understanding functional performance and injury risk.

Descriptive characteristics of the sample showed clear differences between genders. Male participants presented higher mean body mass and height compared to female participants, while age distribution was comparable between groups.

The comparative analysis in Table 2 of upper limb anthropometric parameters revealed clear differences between genders, with consistently higher values in the male group across all linear dimensions and circumferences, as well as in muscle strength tests. At the same time, no notable differences were observed between the left and right sides, suggesting stable bilateral body symmetry. Regarding palm and hand dimensions, the male group showed superior values compared to the female group across width, length, and span. For example, hand length was approximately 2 cm greater in the male group, and palm span exceeded female group values by about 2.5 cm, with differences statistically confirmed ($p < 0.001$). At the level of proximal segments (forearm and arm), differences became even more evident. Mean forearm length was greater in the male group by approximately 2 cm, and arm length by 4–5 cm. These results confirm that gender differences are expressed more

markedly at the level of large bone and muscle structures. The most evident contrasts were observed in circumferences. Under conditions of muscle contraction, arm circumference in the male group exceeded that of the female group by nearly 5 cm, reflecting differences in muscle mass.

Table 2. Paired sample test analysis of the anthropometrics and dynamometric parameters according to handedness.

Parameters	Hand	ΔX	SD	95% CI		t	*p*	d
				LL	UL			
Palm width with thumb (cm)	L	9.945	0.895	9.818	10.073	1.392	0.166	0.100
	R	9.911	0.859	9.789	10.034			
Palm width (cm)	L	8.240	0.675	8.144	8.336	3.537	0.001	0.255
	R	8.156	0.669	8.060	8.251			
Palm length (cm)	L	10.098	0.756	9.990	10.206	1.857	0.065	0.134
	R	10.055	0.749	9.948	10.162			
Hand length (cm)	L	17.971	1.114	17.813	18.130	1.412	0.160	0.102
	R	17.913	1.176	17.745	18.080			
Hand span (cm)	L	19.942	1.757	19.692	20.192	1.049	0.296	0.076
	R	19.882	1.856	19.618	20.147			
Forearm length (cm)	L	24.880	1.746	24.631	25.128	−3.697	0.000	−0.267
	R	25.198	1.943	24.922	25.475			
Arm length (cm)	L	32.204	2.656	31.825	32.582	1.116	0.266	0.081
	R	32.091	2.817	31.690	32.492			
Wrist circumference (cm)	L	16.261	1.346	16.069	16.453	−0.357	0.721	−0.026
	R	16.270	1.334	16.080	16.460			
Relaxed forearm circumference (cm)	L	24.995	2.862	24.588	25.403	−9.482	0.000	−0.684
	R	25.355	2.848	24.949	25.760			
Tense forearm circumference (cm)	L	25.650	2.926	25.233	26.067	−10.007	0.000	−0.722
	R	26.030	2.911	25.615	26.444			
Relaxed arm circumference (cm)	L	27.749	4.186	27.154	28.345	−1.996	0.047	−0.144
	R	27.922	4.120	27.335	28.508			
Tense arm circumference (cm)	L	30.005	4.721	29.333	30.677	−2.506	0.013	−0.181
	R	30.258	4.722	29.586	30.931			
Straight arm dynamometry (kg)	L	29.232	10.050	27.801	30.662	−6.345	0.000	−0.458
	R	31.360	10.989	29.796	32.925			
Bended arm dynamometry (kg)	L	28.274	10.373	26.798	29.751	−7.315	0.000	−0.527
	R	30.346	10.565	28.842	31.850			

CI—interval of confidence; LL—lower limit; UL—upper limit; SD—standard deviation; d—effect size; L—left; R—right; t—Student's t; *p*—significance level; d = Cohen's effect size, statistical significance was set at $p < 0.01$.

In muscle strength tests, the contrast was clearly superior in favor of the male group. Dynamometry values showed differences of approximately 12–13 kg between genders in both the extended-arm and bent-arm tests ($p < 0.001$). Thus, the data support the idea of a pronounced gender difference at the upper-limb level, as evidenced by higher values in the male group across all anthropometric parameters and muscle strength. However, bilateral

symmetry between the left and right sides suggests that these differences are uniformly distributed and do not depend on laterality.

The results of the paired test in Table 3, analyzed separately for the female group and male group, show that bilateral asymmetry in anthropometric parameters is reduced for most measurements. For the forearm, both in the female and male groups, consistent differences were evident between the left and right sides. In the female group, right forearm circumference was approximately 0.33 cm greater at rest and 0.35 cm in contraction, both differences being highly significant ($p < 0.001$). The effect was of moderate magnitude ($d \approx -0.66$ and -0.72), suggesting clear muscular development of the dominant side. In the male group, values were similar: +0.40 cm at rest and +0.42 cm in contraction on the right side ($p < 0.001$, $d \approx -0.63$ and -0.74). The largest differences appeared in grip strength. The female group had on average 2.1 kg more strength in the right hand, both with extended arm and bent arm. Both results were extremely statistically significant ($p < 0.001$) and with moderate effects ($d \approx -0.5$). In the male group, differences were almost identical: −2.14 kg for extended arm and −2.09 kg for bent arm, confirming the same tendency of superior strength on the right side ($p < 0.001$).

Table 3. Paired Sample test analysis between left and right hands of the anthropometrics and dynamometric parameters according to gender.

Parameters	Gender	ΔX	SD	95% CI		t	*p*	d
				LL	UL			
Palm width with thumb (cm)	F	−0.010	0.286	−0.044	0.064	−0.367	0.714	0.035
	M	−0.066	0.395	−0.021	0.152	−1.509	0.135	−0.167
Palm width (cm)	F	−0.079	0.335	0.015	0.141	−2.452	0.016	−0.236
	M	0.927	0.327	0.020	0.164	−2.564	0.012	2.835
Palm length (cm)	F	−0.043	0.273	−0.009	0.094	1.641	0.104	−0.158
	M	0.042	0.372	−0.039	0.124	1.037	0.303	0.113
Hand length (cm)	F	0.022	0.700	−0.110	0.154	0.327	0.744	0.031
	M	0.109	0.350	0.031	0.185	2.808	0.006	0.311
Hand span (cm)	F	0.091	0.824	−0.065	0.246	1.156	0.250	0.110
	M	0.017	0.730	−0.143	0.177	0.212	0.833	0.023
Forearm length (cm)	F	−0.268	1.072	−0.471	0.065	−2.624	0.010	−0.250
	M	−0.387	1.345	−0.682	−0.090	−2.601	0.011	−0.288
Arm length (cm)	F	0.037	1.081	−0.168	0.240	0.353	0.725	0.034
	M	0.216	1.746	−0.167	0.599	1.119	0.266	0.124
Wrist circumference (cm)	F	−0.005	0.337	−0.069	0.058	−0.169	0.866	−0.015
	M	−0.014	0.352	−0.090	0.064	−0.344	0.731	−0.040
Relaxed forearm circumference (cm)	F	−0.371	0.477	−0.462	−0.281	−8.165	0.000	−0.778
	M	−0.342	0.585	−0.471	−0.214	−5.299	0.000	−0.585
Tense forearm circumference (cm)	F	−0.378	0.480	−0.469	−0.287	−8.254	0.000	−0.788
	M	−0.382	0.584	−0.510	−0.253	−5.919	0.000	−0.654
Relaxed arm circumference (cm)	F	−0.222	0.855	−0.384	−0.061	−2.732	0.007	−0.260
	M	−0.105	1.544	−0.444	0.234	−0.615	0.540	−0.068
Tense arm circumference (cm)	F	−0.255	0.745	−0.396	−0.114	−3.592	0.000	−0.342
	M	−0.250	1.967	−0.682	0.182	−1.151	0.253	−0.127

Table 3. *Cont.*

Parameters	Gender	ΔX	SD	95% CI		t	*p*	d
				LL	UL			
Straight arm dynamometry (kg)	F	−2.017	3.769	−2.729	−1.305	−5.613	0.000	−0.535
	M	−2.278	5.638	−3.517	−1.039	−3.660	0.000	−0.404
Bended arm dynamometry (kg)	F	−1.923	3.147	−2.518	−1.328	−6.409	0.000	−0.611
	M	−2.270	4.784	−3.320	−1.218	−4.295	0.000	−0.475

CI—interval of confidence; LL—lower limit; UL—upper limit; SD—standard deviation; M—male; F—female; d—effect size; t—Student's t; *p*—significance level; statistical significance was set at $p < 0.01$.

Analysis of effect size (Cohen's d) revealed important differences between structural and functional parameters of the upper limbs. For most linear measurements (palm length and width, hand or arm length, wrist circumference), d values were very small (below 0.2), indicating small effects and little practical relevance. This result suggests bilateral structural symmetry, with minimal differences between the left and right sides. In contrast, for muscular and functional parameters, effects of moderate to large magnitude were identified. Forearm circumference showed effects ranging from d = −0.63 to d = −0.74, in both the female and male groups, in the relaxed state and during contraction. These values indicate consistent differences in favor of the right side, reflecting more pronounced muscular development in the dominant forearm. Additionally, grip strength presented moderate effects (Cohen's d ≈ −0.5 to −0.6), confirming a clear functional difference between the literalities. The approximately 2 kg difference in favor of the right hand, observed in both the female and male groups, demonstrates the practical relevance of these effects. Thus, Cohen's d values suggest that while bone and articular dimensions remain largely symmetric, bilateral asymmetry with practical effect manifests especially at the muscular and functional level, being closely linked to manual dominance.

Mean grip strength values for dominant and non-dominant upper limbs in female and male participants, measured with the arm extended and with the arm flexed at 90°. Dominant limbs correspond to the right side for the majority of participants.

Table 4, Figure 1, reveals distinct association patterns, with relative structural symmetry and asymmetric, gender-dependent functionality. Among female participants, Pearson correlation analysis reveals significant associations between forearm and wrist circumference variables and grip strength. For example, flexed forearm circumference (right) correlates strongly with grip strength in extended position (r = 0.262, $p = 0.006$) and bent position (r = 0.305, $p = 0.001$). In contrast, wrist and relaxed forearm circumference show significant bilateral correlations, with r values ranging between 0.256 and 0.350 ($p < 0.01$). These results suggest that distal segmental muscular development is an efficient predictor of functional strength in the female population. Notably, palm width also correlates significantly with right-sided grip strength (r = 0.436, $p < 0.001$), suggesting a possible structural influence of the support base on force transmission.

In male subjects, relationships are less pronounced. Still, significant correlations are observed between relaxed forearm circumference (left) and grip strength in both positions (r ≈ 0.29, $p < 0.01$), as well as between flexed arm circumference and grip strength (r = 0.264, $p = 0.016$). This functional asymmetry in the expression of correlations suggests a different biomechanical model between genders. In the female group, grip strength appears more dependent on distal parameters (forearm, wrist). In contrast, in the male group, strength is distributed more diffusely and influenced by additional neuromuscular factors not directly reflected in segmental morphology. Additionally, the consistency of significant

relationships on the right side in both the male group and female group confirms functional lateral dominance, with associated morphological adaptations.

Table 4. Pearson correlations between dynamometric measurements and anthropometric parameters in relation to gender and handedness.

Parameters	Gender	Side	Straight Arm Dynamometry		Bended Arm Dynamometry	
			r	*p*	r	*p*
Palm width with thumb (cm)	M	L	−0.125	0.262	−0.014	0.902
		R	0.025	0.821	0.092	0.409
	F	L	0.144	0.134	0.157	0.104
		R	0.281 **	0.003	0.256 **	0.007
Palm width (without thumb) (cm)	M	L	0.121	0.279	0.133	0.235
		R	0.130	0.245	0.143	0.200
	F	L	0.274 **	0.004	0.327 **	0.001
		R	0.437 **	0.000	0.422 **	0.000
Palm length (cm)	M	L	0.198	0.076	0.192	0.085
		R	0.210	0.064	0.205	0.071
	F	L	0.175	0.069	0.153	0.113
		R	0.205 *	0.033	0.152	0.115
Hand length (cm)	M	L	0.112	0.317	0.104	0.350
		R	0.033	0.766	0.027	0.810
	F	L	0.223 *	0.020	0.193 *	0.044
		R	0.275 **	0.004	0.270 **	0.005
Hand span (cm)	M	L	0.181	0.104	0.150	0.180
		R	0.191	0.087	0.161	0.147
	F	L	0.093	0.337	0.162	0.092
		R	0.068	0.482	0.104	0.281
Forearm length (cm)	M	L	0.236 *	0.032	0.211	0.063
		R	0.253 *	0.021	0.225 *	0.049
	F	L	0.212 *	0.027	0.218 *	0.023
		R	0.085	0.378	0.100	0.303
Arm length (cm)	M	L	0.298 **	0.006	0.266 *	0.015
		R	0.303 **	0.005	0.270 *	0.014
	F	L	0.008	0.930	0.007	0.944
		R	0.106	0.272	0.065	0.501
Wrist circumference (cm)	M	L	0.195	0.080	0.176	0.113
		R	0.210	0.064	0.201	0.070
	F	L	0.326 **	0.001	0.354 **	0.000
		R	0.265 **	0.005	0.326 **	0.001

Table 4. *Cont.*

Parameters	Gender	Side	Straight Arm Dynamometry		Bended Arm Dynamometry	
			r	*p*	r	*p*
Relaxed forearm circumference (cm)	M	L	0.317 **	0.004	0.309 **	0.005
		R	0.328 **	0.003	0.315 **	0.004
	F	L	0.319 **	0.001	0.285 **	0.003
		R	0.259 **	0.007	0.307 **	0.001
Tense forearm circumference (cm)	M	L	0.333 **	0.002	0.322 **	0.003
		R	0.342 **	0.002	0.328 **	0.003
	F	L	0.342 **	0.000	0.275 **	0.004
		R	0.265 **	0.005	0.308 **	0.001
Relaxed arm circumference (cm)	M	L	0.355 **	0.001	0.349 **	0.001
		R	0.365 **	0.001	0.358 **	0.001
	F	L	0.265 **	0.005	0.238 *	0.013
		R	0.157	0.103	0.260 **	0.006
Tense arm circumference (cm)	M	L	0.384 **	0.000	0.378 **	0.000
		R	0.395 **	0.000	0.389 **	0.000
	F	L	0.254 *	0.008	0.228 *	0.017
		R	0.174	0.070	0.251 *	0.008

* M—group of male; F—group of female; L—left; R—right; r = Pearson correlation coefficient. ** Statistical significance was set at $p < 0.01$. ** Correlation magnitude was interpreted as follows: trivial (r < 0.10), small (r = 0.10–0.29), moderate (r = 0.30–0.49), and large (r ≥ 0.50).

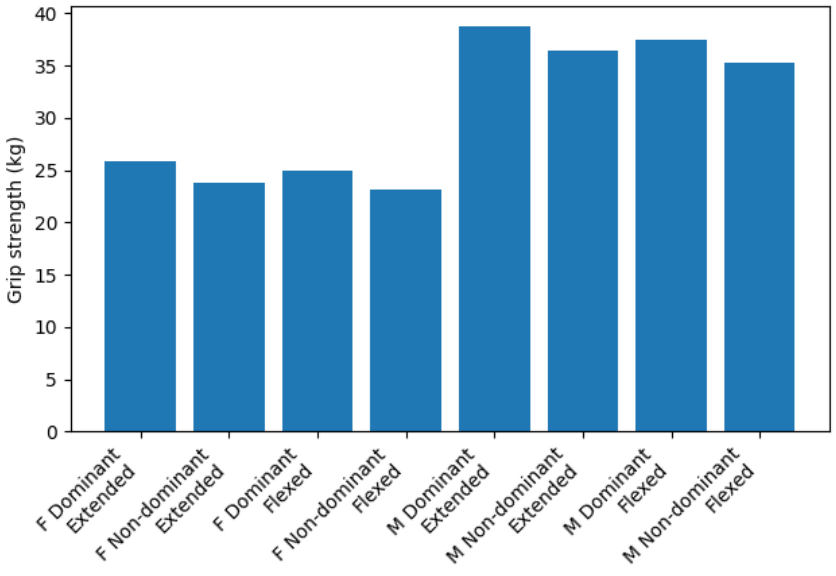

Figure 1. Grip strength differences between dominant and non-dominant upper limbs by sex and testing position.

4. Discussion

The main purpose of this study was to investigate the relationship between segmental morphological dimensions of the upper limbs and grip strength in the context of bilateral asymmetry in young non-athletes. By analyzing differences in the upper limbs and between genders, the study aimed to highlight possible functional or structural imbalances. The

obtained results contribute to understanding how the preferential use of one upper limb and anthropometric characteristics influence functional performance, even in the absence of organized sports training.

Statistical analysis revealed significant differences between the dominant and non-dominant limbs in functional parameters, especially grip strength, which showed clear superiority of the dominant limb across testing positions. This functional asymmetry appears as a systematic and recurrent phenomenon, reflecting neuromuscular adaptations induced by predominant unilateral use. At the morphological level, although most parameters showed relatively well-preserved symmetry, significant discrepancies were observed in forearm and arm length and circumference, suggesting localized structural adaptation, most likely due to daily activity. Gender differences were also evident: the male group showed higher values across all segmental dimensions and grip strength, whereas in the female group, stronger correlations were observed between morphological characteristics and functional performance.

Interestingly, although subjects in the male group had significantly greater strength, subjects in the female group demonstrated more consistent and significant correlations between segmental dimensions (forearm circumference, palm width) and grip strength. This aspect suggests a more predictable functional model in the female group, where morphological development is more closely linked to functional performance. In contrast, in the male group, strength appears influenced by additional factors, possibly neurophysiological or hormonal, that are not directly reflected in anthropometric dimensions.

The study results validate the research hypothesis regarding the link between morphological characteristics and functional performance, offering an essential scientific foundation for using anthropometric evaluations in predicting grip strength. Therefore, Table 4 not only supports the inclusion of gender and laterality differences in predictive models of neuromuscular function but also highlights an essential functional asymmetry that must be considered in ergonomics, sports medicine, and rehabilitation.

The results of this study offer a detailed perspective on bilateral asymmetries [40,41] of the upper limbs among university students not involved in organized sports activity. Although specialized literature tends to emphasize symmetry as a functional and morphological ideal in healthy populations [42,43], our data indicate statistically significant discrepancies, especially in functional parameters (grip strength) and, to a lesser extent, in some morphological parameters, such as forearm and arm circumferences.

The most prominent form of asymmetry observed was functional, reflected in grip strength differences between upper limbs [34,44,45]. This observation is in accordance with specialized literature, which emphasizes that manual dominance leads to preferential use of one limb, inducing functional hypertrophy and, consequently, greater strength in the dominant limb [1,46–48]. Thus, differences of approximately 2 kg on average in dynamometry tests between left and right limbs support the hypothesis of systematic and constant functional asymmetry among non-athlete subjects. It is noteworthy that these differences are not significantly influenced by the biomechanical testing position (extended arm vs. bent arm), suggesting that the determining factors are neuromuscular rather than strictly biomechanical.

In contrast to functional parameters, most morphological parameters did not show significant bilateral differences. Notable exceptions were forearm length and forearm and arm circumferences (both relaxed and flexed), where differences of up to 0.5–0.8 cm were observed between limbs. These discrepancies, although relatively small in absolute terms, are statistically significant and indicate differentiated muscular adaptation in the dominant limb, likely associated with repetitive, sustained use in daily activities.

These results are consistent with those reported by [23], who observed a similar pattern of lateralized functional hypertrophy in athletes and the general population. However, unlike studies focused on performance athletes, where morphological differences are much more pronounced [49,50], the population studied in this case presents relatively well-preserved structural symmetry, indicating a moderate influence of daily behavior on segmental morphology.

Gender analysis revealed clear differentiation regarding both morphological and functional parameters. The male group recorded significantly superior values for all strength indicators and for most segmental dimensions (forearm, arm, palm). This result aligns with recent meta-analyses that confirm physiological and hormonal gender differences in muscle mass and strength performance [26,34].

A central aspect emerging from current literature is the influence of asymmetric use on neuromuscular and morphological development of the upper limbs. Even in untrained populations, such as those investigated in this study, manual dominance determines differential stimulation of the musculature, with measurable effects on local strength and tone. It has been demonstrated that laterality significantly influences grip performance and that this difference directly correlates with segmental circumferences, especially at the forearm level, in healthy young people. This finding supports our results regarding the localized character of functional adaptations [26].

Additionally, the analysis of sex differences in the present study is in accordance with the literature, suggesting a differentiated distribution of muscle mass and gender-specific neuromuscular recruitment. Studies also emphasize that female and male group use different strategies during muscular effort, even within upper-limb muscle groups [51]. Thus, our results, which indicate a more predictable relationship between morphology and strength in the female group, can be explained by more linear neuromuscular control and a more uniform distribution of muscle mass involved in gripping actions. In contrast, in the male group, factors such as neural impulse, joint stiffness, or anabolic hormones may play a more important role in force generation, independent of morphology.

Beyond the explanatory dimension, these findings also have applicative implications in the field of ergonomics and rehabilitation. Grip strength, as an easily evaluated parameter, can serve as an early indicator of neuromuscular imbalances or risk of dysfunctions associated with excessive unilateral use. A specialized study highlights the need to assess strength by position and by professional activity, showing that position differences can have a reduced impact in the presence of marked functional dominance, as our data indicate [52]. We consider that dynamometric and segmental anthropometric evaluations can constitute a valuable tool for evaluating correlations between anthropometric and motor parameters, as predictive elements of body symmetries and harmonious physical development in young people [53–57].

4.1. Practical Implications of the Study

The identification and quantification of these functional and morphological asymmetries has major practical importance. In the context of physical education and the prevention of postural imbalances, these results can guide personalized interventions to balance functional loads on the upper limbs. Additionally, in ergonomics and occupational medicine, these data can serve as a basis for adapting repetitive tasks (e.g., typing, lifting objects, desk work) to be evenly distributed between limbs, thereby reducing the risk of unilateral overload and musculoskeletal dysfunctions. At the same time, in neuromuscular rehabilitation and sports medicine, evaluating these asymmetries can inform the development of differentiated training or recovery protocols that account for laterality, gender-related morphological variation, and segmental muscular adaptations.

4.2. Limitations and Future Directions

The study has several limitations that must be considered. First, the investigated population consisted exclusively of young, healthy students, limiting the generalizability of the results to other age groups or clinical populations. Second, electromyographic or imaging measurements were not included to highlight differences in muscle activation or tissue composition. In the future, integrating these methods could provide a more detailed picture of the mechanisms underlying the identified functional asymmetries. Additionally, the direct influence of daily activities or a history of physical exercise on symmetry was not analyzed, an aspect that could be explored in future longitudinal research. Evaluation of other body segments is also necessary to understand whether the asymmetry pattern is localized or generalized.

5. Conclusions

The research results partially confirmed the initial hypothesis: general morphological asymmetry is reduced and does not significantly influence functional parameters, but specific muscle segments and local circumferences clearly correlate with grip strength. Paired analyses showed constant functional asymmetry in favor of the right side, where grip strength was approximately 2 kg greater, both in the female group and male group. In parallel, forearm circumference (at rest and in contraction) presented significant differences between left and right, with moderate effects. Pearson correlations revealed positive links between forearm and arm circumference and grip strength, especially in the female group. Regarding gender differences, the male group recorded higher values for all segmental dimensions and grip strength, confirming evident functional and morphological differences between genders. However, in the female group, correlations between morphological and functional parameters were more consistent, indicating a closer relationship between structure and performance.

The study confirms that bilateral structural asymmetry (lengths and widths) does not significantly affect functional performance, whereas muscular asymmetry, especially at the forearm level, directly influences grip strength. These findings validate the research hypothesis and support the proposed title, highlighting that the influence of morphology on strength is localized and functional rather than global. The results can contribute to better understanding of the relationship between morphology and function in young semi-active populations. They can support preventive or rehabilitation programs oriented toward functional balancing of the upper limbs. Additionally, the study contributes to filling the scientific gap regarding the relationship between the bilateral morphology of the upper limbs and their functionality among the semi-active student population. These results can form the basis for preventive or corrective interventions that address functional and structural imbalances from the early stages of adult life.

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Article

Evaluating the Effectiveness of the Annual Physical Training Plan for Masters +45 Women Half Marathon Athletes: A Guideline Model for Good Practices for Programming Effort Volume and Intensity

Daniela Baba [1,2], Raluca Mijaica [2,*], Florentina Nechita [2] and Lorand Balint [2]

[1] Sports Science and Physical Education, IOSUD—Transilvania University of Brasov, 500036 Brasov, Romania; daniela.baba@unitbv.ro
[2] Department of Physical Education and Special Motricity, Faculty of Physical Education and Mountain Sports, Transilvania University of Brasov, 500036 Brasov, Romania; florentina.nechita@unitbv.ro (F.N.); lbalint@unitbv.ro (L.B.)
* Correspondence: raluca_mijaica@unitbv.ro; Tel.: +40-735844294

Abstract: This study presents the implementation and results of the Annual Physical Training Program for Masters +45 Half Marathoners (PASm-12), focused on optimizing athletic performance through rigorous planning of training volume and intensity. PASm-12, structured over 12 mesocycles and 52 microcycles, was applied to 6 female runners with over 10 years of experience. The results indicate that the total running volume achieved (2347 km) was 90.2% of the volume proposed by PASm-12 (2603.2 km), with statistically significant differences in most mesocycles (Cohen's $f^2 = 6.24$, $t = -5.997$, $p = 0.002$, indicating a large effect size). The training intensity was achieved at an average of 94.8% of what was proposed by PASm-12, with significant differences in several mesocycles (Cohen's $f^2 = 0.45$, $t = -1.972$ to -3.984, $p < 0.05$, indicating a moderate to large effect size). The female runners' performances in field tests generally showed faster times than the maximum and average values proposed in PASm-12, with the exception of the final competition, where performance was slightly lower due to external competitive factors (Cohen's $d = -0.53$, $t = -1.192$, $p = 0.3$). This plan, demonstrating good practice, could serve as a guideline model for amateur runners who do not have specialist counseling. PASm-12 can reduce the risk of injury, prevent excessive fatigue, and support ongoing participation in sports activities. Additionally, the implementation of this plan could provide amateur runners with a safe and effective training structure, contributing to improved health and athletic performance.

Keywords: annual physical training program; half marathon; master +45; women; training volume planning; training intensity; athletic performance

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1. Introduction

A half marathon is an athletic event involving a 21.0975 km race, half the distance of a marathon [1]. In sports terms, a half marathon is a road race, also called non-stadia. Non-stadia events are sports events organized outside the stadium, including mountain, road, or sand races [2].

Two categories of participants compete in half marathons: amateur runners and performance runners. Amateurs are passionate runners who become competitive over time. Competitors are classified into age groups—18–34, 35–44, 45–54, 55–64, 65+ [3]—while master runners compete in the following categories, regardless of gender identity (men, women, non-binary): 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 years [4]. Participation rates and performance vary by age group.

Although not currently included in the Olympic Games, the half marathon has become popular among amateur runners in recent decades [5]. Its current popularity is driven by

the large number of amateur runners, with an increasing number of women participating in such sports events [6]. A few studies shows that the number of women and men participating in half marathons and marathons increased significantly between 1999 and 2014, more so in half marathons and especially among women (123 times more women participate in half marathons than in marathons, and 75 times more men register for half marathons than for marathons) [5,6]. Similarly, in the USA, in 2019, the proportion of women (60%) surpassed that of men (40%) in half marathons, with more significant increases among master runners compared to younger runners [6]. Other studies also show that participation in competitions is relatively higher among women than men, especially in the 50+ age groups, with higher performance frequencies achieved at older ages [7–10].

In Romania, trends align with global ones, but the number of female participants in such races is still lower compared to other countries. The Romanian Athletics Federation (FRA) website indicates that the number of participants in the Bucharest Half Marathon has progressively increased since 2016, with a simultaneous increase in the number of female participants. Most women finished the race at the Cluj-Napoca Half Marathon from 2016–2022, with their numbers constantly growing, representing 29.06% of the total participants in 2022 [11].

Romanian master runners are registered with sports clubs affiliated with the FRA, also known as "veterans" [12] or senior runners [13]. As worldwide, in Romania, the scale and popularity of the half marathon are driven by amateurs, with fewer performance runners.

The increase in the number of endurance race participants and the diversification of participant groups (age, gender, profession, etc.) pose challenges in training design, monitoring, and execution, requiring adaptation to the specific needs of amateur runners. For women, training is conducted amidst numerous professional and family responsibilities [14]. Running many kilometers almost daily and weekly can interfere with their professional or family obligations or specific age-related needs. Additionally, women are more susceptible to injuries compared to men [15]. Training programs for master amateur runners should focus not only on physical performance but also on reducing physiological and relational stress. On the other hand, the heterogeneous profile of amateur half marathoners has led to diverse training models to adapt to the anatomical, physiological, or psychosocial factors influencing endurance runners' performance and well-being, whether amateur or professional [10]. Unlike professional athletes, amateur half marathon runners—although they often have some prior running experience, most of them are not coached by a trainer—tend to exceed their upper physical capacity limits, frequently experiencing overtraining syndrome [16], lack of physiological adaptation [17], or deterioration of physical fitness [18,19]. The disadvantage of amateur runners is highlighted in other studies, showing that many performance-related factors and finish time predictions are under-researched [20,21]. Additionally, another drawback is the fact that systematic analyses of training plans primarily focus on professional runners [22], while those intended for amateur athletes are much rarer, though not entirely absent [10,20]. Under these conditions, although the half marathon as an event for amateurs has impressively developed, there is no consensus on the best training practices that would allow for the optimization of physical performance in a healthy manner [23]. However, there is a lot of empirical data that is not necessarily based on scientific studies [24]. As a result, controversies among specialists regarding the effectiveness of various training models and the need to adapt them to amateur runners' particularities complicate the choice of optimal training type for a category or individual practitioners [25].

Sports training is a long-term activity carried out through a laborious process of planning and programming [26]. Training planning is a predictive process, based on experience and scientific knowledge, aimed at the rational, systematic, and sequential organization of training tasks and the recovery process to achieve performance objectives at specific times [27]. This involves paying special attention to the volume and intensity of effort, as these two variables are closely linked to the effectiveness and safety of training, directly influencing the capacity for adaptation and athletic progress [28]. The objective of

training is to improve the athlete's athletic skills and, ultimately, their performance level. The correct use of knowledge, experience, and principles of sports training leads to the design of effective training programs.

As revealed by a previous study that we conducted [29], many Romanian amateur athletes are interested in achieving faster race times and gaining social recognition for their efforts. In this context, they are concerned with optimizing their training efficiency. The importance of properly scheduling volume and intensity in this context is crucial, as it allows for the adjustment of training sessions to maximize performance without compromising the athletes' health [27]. The same study showed that 55.9% of runners become injured during training or competitions or engage in demanding training exceeding 100 km per week, often followed by excessive fatigue, making it difficult to maintain motivation and diminishing running satisfaction. This further emphasizes the need to carefully regulate the volume and intensity of training to prevent overtraining and ensure proper recovery, which are essential for maintaining long-term physical and mental well-being [30]. Amateur female athletes have varied perceptions of effective training, lacking consensus on the optimal patterns of training methods, as well as on the volume and intensity of effort applied during each training phase at any given time [29]. In other words, it is important to consider that both the volume and intensity of effort are essential components of planning the sports training process, being fundamental to structuring an effective training program. Numerous training programs highlight various solutions for achieving performance. These training programs aim to develop economical training strategies for half marathoners, maintaining sports efficiency within optimal limits and positive effects on physical and mental health [31–33]. The impact of the strategies used is controversial, with evidence suggesting that moderate-intensity training enhances athletic performance similarly to high-intensity training. However, high-intensity training shows more significant differences in the physiological adaptation of the body to exertion [34,35].

Regarding the timing and scheduling of training programs, from the study of various sources, we have found that the time intervals for which these training plans are developed vary: 12/15/32 weeks [32,36], 12 weeks [37,38], 20 weeks [23], or 4–6 months [39]. Some believe that a one-year training program is essential [17]. However, verifying these training programs' efficiency through experiments or quasi-experiments is rare or limited to elite runners [40].

As mentioned earlier, most training plan models target professional athletes, with far fewer tailored for amateur athletes. Generally, the traditional endurance training programming model is linear, featuring progressively structured training intervals in a predetermined sequence, including sessions, microcycles, and mesocycles that culminate in a macrocycle. Training periodization requires different training objectives, with its sequencing occurring during preparatory phases (focused on general and specific physical preparation, pre-competition, and competition preparation), concluding with a transition and recovery phase [28]. In the same context, another source emphasizes that scientifically approached training design and management should focus on key aspects of the training process, such as periodization, which require strategic adjustments to the volume and intensity of effort to optimize performance and physiological adaptation, along with training methods and monitoring, performance prediction, running technique, and the prevention and remediation of health issues associated with endurance running [23]. However, in practice, some half marathon runners employ a non-periodized strategy characterized by a fixed number of kilometers predetermined by repetitions throughout a training cycle [41]. This approach, while simplifying planning, may overlook critical aspects such as adjusting the volume and intensity of effort based on the athlete's physical condition and specific goals, which can limit the optimization of performance and proper physiological adaptation.

In this complex context of planning and training practice for amateur female runners, our study aims to develop, apply, and confirm the efficiency of a staggered physical training program over one year (macrocycle) for female Master (+45) half marathoners, aiming to generalize the experience and good practices of nationally and internationally recognized

runners adaptively. We believe their common training strategy can serve as a medium-term training model for amateur runners without a coach's counseling benefits. The emphasis placed on volume and intensity in this plan highlights our belief that precise management of these dimensions is essential for achieving the desired sports performance, without compromising the health and well-being of the female athletes.

Based on these considerations, for the application of our annual physical training plan, we have formulated three research questions, each associated with a specific research direction. Question 1 (Q1): To what extent does the volume of effort performed by athletes align with the planned volume of effort in the annual physical training plan? The research direction for this question is to assess the congruence between planning and execution of training volume, evaluating the effectiveness of the programming. Question 2 (Q2): How does the intensity of effort performed by athletes compare with the proposed intensity of effort in the training plan for each mesocycle? This research direction aims to determine if the intensity of the training is appropriately adjusted to promote physiological adaptations without inducing risks of overtraining. Question 3 (Q3): Do the performances achieved in field tests meet the expectations established by the proposed average times in the training plan? The research direction for this question explores the relationship between scheduled preparation and actual performances, highlighting the importance of calibrating time goals according to the athletes' real capabilities.

2. Materials and Methods

2.1. Study Design

The approach we implemented is ameliorative/formative in nature, as it aims to shape behavior [42], with the goal of improving or at least maintaining athletic performance in the half marathon event for master women (45+). Additionally, given that this is a physical training plan spread over the course of a year and considering that we have not found any macrocycle-type planning in the specialized literature, we consider our study to be a pilot one.

2.2. Study Subjects and Research Team

Within the study, female master athletes aged 45 and over were selected because, as mentioned earlier, several studies indicate that their participation in competitions has increased significantly globally over the past three decades [43–45]. From an age perspective, different age categories are considered to ensure some heterogeneity of the sample and, consequently, greater internal validity of research [42].

The subject group includes six female amateur runners (S1–S6) who practice long-distance running both indoor and outdoor, road and mountain running, and fall into the 45–49 and 50+ age categories. They are Master runners registered with Romanian sports clubs affiliated with the FRA, and at the study's outset, they had over 10 years of endurance running experience (Table 1). Being amateur runners, they do not have personal coaches. All participants live in urban areas and have different professions. The profession of the participants includes three physical education teachers, one doctor, one marketing specialist, and one museum curator. These characteristics were inclusion criteria, while health status and injuries were exclusion criteria.

Table 1. Socio-demographic characteristics of the runners who followed PASm-12 (October 2021).

Athlete	Age (Years)	Residence	Sports Club	Running Experience
S1	50	Brașov	Brasov University Sports Club	13
S2	44	Bucharest	Bucharest Railway Sports Club	10
S3	48	Mediaș	Star Athletics Club Mediaș	30
S4	55	Bucharest	Locomotiva Sports Club Bucharest	12
S5	57	Bistrița Năsăud	Municipal Sports Club Bistrița	38
S6	47	Sibiu	Sibiu Community Club	10

For this study, the Romanian female runners (S1–S6) were recruited at the World Masters Mountain Running Championships (Telfes, Austria 2021), where the Romanian team, including these female runners, placed third after Italy and Germany. In 2021, all six female runners were active, participating in national and international competitions, with one (S5) also participating in two virtual competitions.

To assess the health status of the six female runners, they underwent an initial laboratory diagnosis (in the first part of mesocycle 1; 4–31 October 2021) at the SZJA Sportlab Center in Cârța, Harghita County [46]. The specialized anamnesis showed no cardiorespiratory pathologies or injury history in the last six months. To determine the female runners' maximum heart rate (MHR) for establishing the training intensity and training zones, an effort test was conducted using a professional treadmill (HP Cosmos—pulsar®3p, h/p/cosmos sports & medical gmbh/Nußdorf, Germany) following the Brucea protocol at the same location [47]. The HP Cosmos treadmill is equipped with a chest strap connected to an external monitoring system, which displays the data on the screen in real time.

As study coordinators (the research team), five faculty members from the Faculty of Physical Education and Mountain Sports, Transilvania University of Brașov, participated in designing PASm-12, approving and adjusting its content as needed and monitoring the training process of the six female runners. Our research approach was approved by the Department of Physical Education and Special Motricity of the faculty (no. 332/1/23.09.2021, approved on 23 September 2021) and was based on the Helsinki Declaration regarding research ethics, ensuring the rights, safety, and well-being of the participants. Informed consent of the participants was obtained. Additionally, during the implementation of PASm-12, periodic consultation was sought from a sports nutrition specialist (Superfit Center in Bucharest) [48].

2.3. Procedure

Throughout the training program, periodic non-specific and specific tests were applied to the six female runners for more rigorous control and regulation of the staggered physical training process over one year.

The independent variable consists of the content of the annual physical training program for Masters +45 half marathoners (PASm-12) and was largely followed independently (self-training) by each study participant through a personalized training program derived from PASm-12, monitored, and staggered over 12 training mesocycles. Since PASm-12 is applied in the runners' natural environment, the control of the independent variable is not very strict, but the research has the advantage of being an ecological intervention, making its results and conclusions more suitable for practical problem-solving compared to laboratory experiments [49].

Dependent variables include the participants' performances in applying the dependent variable, i.e., running distances achieved, the intensities at which they were performed, with both effort indicators reported to the corresponding values proposed by PASm-12. Additionally, partial or complete test times in five field tests conducted in non-competitive and competitive environments, where the runners gathered at predetermined locations during PASm-12 design, also represented elements of the dependent variable.

After selecting the subject group, participants were informed about the study's general objectives and the annual physical training program's structure and content—as well as the competition calendar (2021–2022)—were agreed upon, with potential adjustments depending on the evaluations/results obtained from the scheduled/designed tests.

2.3.1. The Presentation of the Annual Physical Training Plan for the Half Marathon (PASm-12)

Considering various training models and debates regarding the advantages or disadvantages of certain periodization methods, as well as the consequences of different training volumes (kilometers covered) and intensities (execution times/tempo, expressed as a percentage of maximum effort capacity per subject) on performance and maintaining

female runners' health, we opted for a traditional linear hierarchical training model in our study. We chose this training–planning strategy given the selected female runners' already-developed motor skills (technical), appropriate physical preparation level, and well-defined training routines.

As structured, PASm-12 spans 12 mesocycle comprising 52 microcycles, each microcycle consisting of 4 or 5 training sessions per week, depending on the training period. The methodology for planning the annual physical training plan for women Master 45+ runners, covering the period 4 October 2021–30 September 2022, proposes a progressive, cross-sectional arrangement of cycles/periods/phases of training [27,28,30]. Structurally, PASm-12 features a preparatory period (PP 4 October 2021–30 January 2022) developed into two phases: general physical preparation (GPP, 4–31 October 2021) and specific physical preparation (SPP, 1 November 2021–30 January 2022). This is followed by a pre-competition period (PCP, 31 January–3 April 2022), a competition period (CP, 4 April–18 September 2022), and concludes with a transition period (TP, 19–30 September 2022). In our planning model, training volume and intensity increase gradually in GPP, while in SPP and PCP, volume decreases to medium, and intensity increases to an optimal level according to event-specific demands. In CP, intensity fluctuates from high (submaximal) to optimal for the half marathon event, while volume fluctuates from high to medium, depending on runners' performance objectives related to the significance of tests/competitions in the pre-set calendar. PASm-12 is structured to allow the runners' functional recovery in a permanent and controlled manner as they progress toward the main period (CP) and the major objective competition [30,50].

The plan initially proposes moderate training intensity (about 70% of the maximum heart rate per athlete) and relatively small training volume (about 40 km/week), with indicators progressively increasing during the training process. Training sessions were planned to allow physiological recovery for participants and facilitate the body's functional adaptation to effort.

For the agreed-upon preparation period, a unanimously agreed competition calendar was developed, correlated with PASm-12's quantitative and qualitative indicators (volume/intensity). The collaborative development of the competition calendar is justified by the need to harmonize runners' professional, family, and financial activities. Thus, the competition calendar included five field tests (Table 2), with the final one representing an official competition, termed the major objective.

Table 2. Common competition calendar for the annual physical training program for the half marathon (PASm-12) 2021–2022.

No.	Month	Competition Name—Field Test	Test Type	Location
1	January	Road running—10 km	Non-specific test	Zărnești (Romania)
2	February	Road running—21 km	Specific test	Cluj-Napoca (Romania)
3	March	Road running—21 km	Specific test	Oradea (Romania)
4	April	Road running—21 km	Specific test	Brașov (Romania)
5	May	European Masters Athletics Championships Non-Stadia—21 km	Specific test	Grosseto (Italy)

For each of these tests, the PASm-12 pre-established the race time (referred to by us as the "proposed running time") with a tempo/km range set between a minimum and maximum limit, aiming to achieve an average reference value. These times were fixed as an anticipated consequence of the training plan's content periods. Thus, for the Zărnești test, scheduled in mesocycle IV/microcycle 17 (3–30 January 2022), a running tempo for the 10 km distance was set at 5′10″/km (maximum limit, slower time)–4′50″/km (minimum limit, faster time), equating to 3100 s/10 km and 2900 s/10 km respectively, with an average between the two values of 3000 s/10 km (50 min). For the other 4 tests—scheduled in Cluj-Napoca—mesocycle V/microcycle 19 (7–13 February 2022), Oradea—mesocycle VI/microcycle 24 (14–20 March 2022), Brașov—mesocycle VII/microcycle 28

(11–17 April 2022)—a running tempo for the regulation distance of the half marathon was projected between 5′40″/km (maximum) and 5′30″/km (minimum), resulting in 7140 s maximum/21 km and 6930 s minimum/21 km, with an average test time of 7035 s/21 km (117 min and 15 s). For EMACNS—Grosseto—mesocycle VIII/microcycle 32 (9–15 May 2022), a running tempo of 5′10″/km (maximum) and 4′50″/km (minimum) was established, with a maximum time for completing the full race distance of 6510 s/21 km and a minimum of 6090 s/21 km. The proposed finishing average time (finish time) for the race was 6300 s/21 km (105 min).

Macroindicators for PASm-12 (training days, mesocycles, microcycles, number of field tests, laboratory tests) are presented in Table 3. In terms of content and training means, it should be noted that some microcycles in the plan are identical, while others vary based on the training objectives assigned to each mesocycle.

Table 3. Quantitative macro-indicators of PASm-12.

No.	Indicator	Model—Women +45
1	Training days (no.)	235
2	Training sessions (no.)	235
3	Macrocycles (no.)	1
4	Mesocycles (no.)	12
5	Microcycles (no.)	52
6	Field tests—allocated to the study (no.) *	5
7	Laboratory test (no.)	1

** In addition to the tests scheduled in PASm-12, following the official test in Grosseto (specific test 5), each athlete also underwent additional unaccounted tests through participation in various competitions—this option for participating in the verification process was driven by the athletes' familial, professional, and financial constraints.*

For an overview of the programmed means in PASm-12 and the volume indicators (distance covered/km, execution duration), as well as the intensity of effort (average percentage intensity of effort/mesocycles) predetermined for the plan, we summarize some relevant characteristics in Table 4 and the dynamics of the proposed volume and intensity distribution in Figure 1.

Table 4. Training means and effort indicators proposed for PASm-12.

Training Means	Mesocycles/Quantitative Effort Indicators												Total Proposed Volume (km)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Long-duration run with pre-set tempo (5′10″–4′50″/km)		40	50	30		10	10		10				150
Run with elevation difference (km)			60	56	11		10		10				147
Interval run (km)				24	32	18.6	37.8	6.6	24.2	47.8	55.2		246.2
Long-duration run with pre-set tempo (5′40″–5′10″/km)					25				52	18	20	5	120
Long-duration run with pre-set tempo (5′40″–5′30″/km)		40	70	40	68	115	116	16	90	160	187	11	913
Moderate tempo long-duration run (km)	160	48	50	24	43	69	24	41	88	68	72	13	700
Fartlek run (km)		40			31	13	25	10	38	52	24		233

Table 4. *Cont.*

Training Means	Mesocycles/Quantitative Effort Indicators												Total Proposed Volume (km)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Test run (km)				10	21	21	21	21					94
Total proposed running volume (km/mesocycle)	160	168	230	184	231	246.6	244	94.6	312.2	346	358.2	29	2603.2
Proposed intensity averages (% MHR)	70.0	75.0	70.0	76.3	77.6	72.8	80.8	71.0	76.2	80.5	80.5	78.3	-

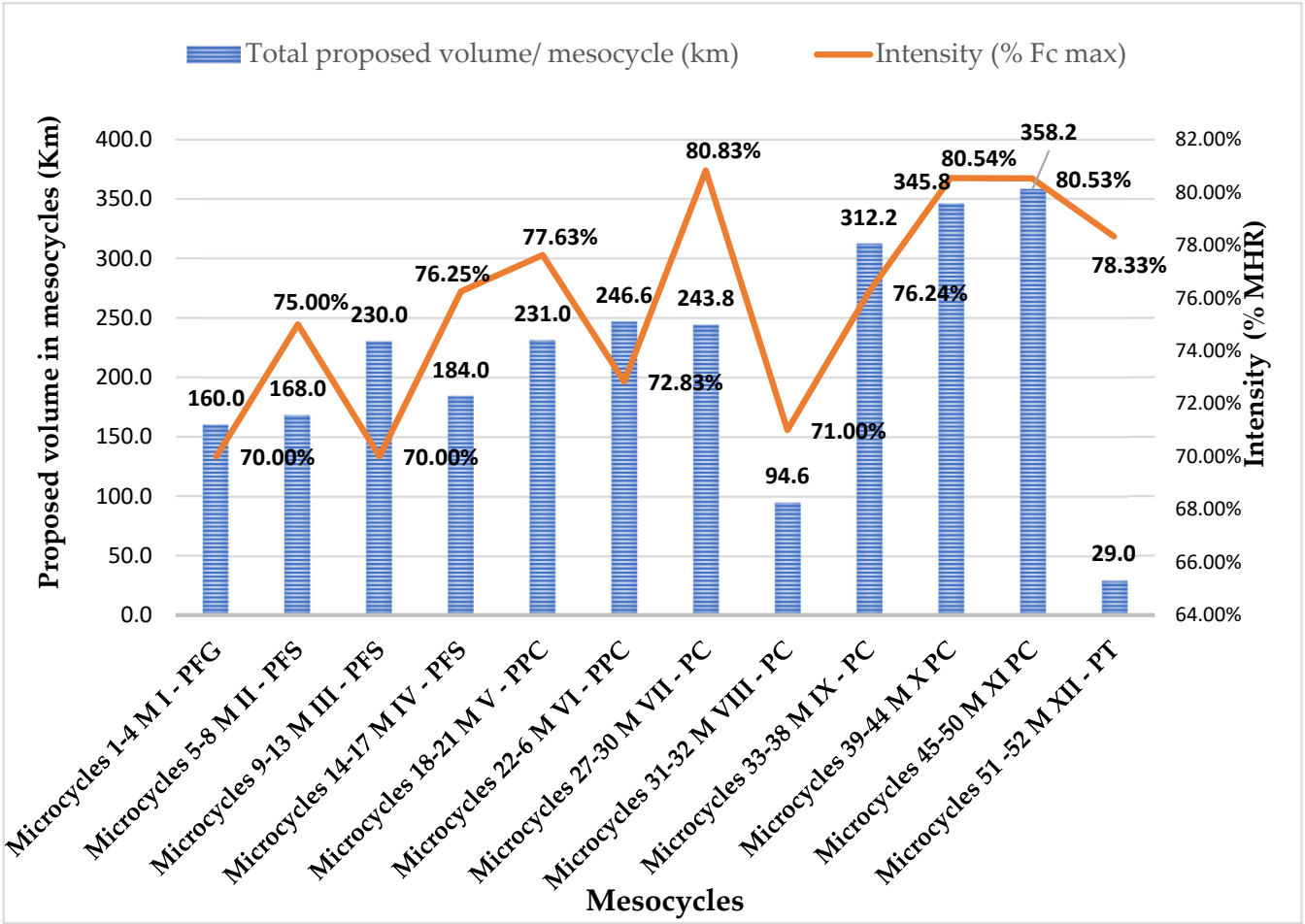


Figure 1. Dynamics of proposed training volume and intensity—average values/mesocycle in PASm-12.

2.3.2. Remote Monitoring Equipment for Runners' Activity

A necessary step in conducting our study, which was largely monitored remotely, involved the acquisition of six Garmin Fenix 6S PRO watches (Garmin Ltd., Olathe, KS, USA) with GPS technology. Currently, a growing number of running enthusiasts use technology for self-monitoring. An online study with a sample of 3723 participants analyzed how endurance runners use technology for training monitoring [51]. The results indicate that approximately 6 out of 10 respondents (59.5%) used a sports watch, 28.4% used a running app, and only 12.1% did not use either a watch or a running app. The watches were used to monitor distance (96.20%), time (90.0%), speed (85.5%), and calories (8.8%). Another study indicates that, although Garmin Fenix 6 watches may have a tendency

to underestimate HR at low intensities and overestimate it at high intensities, they still provide useful and relevant data, especially in contexts where continuous monitoring and portability are essential [52]. In our study, throughout the entire application period of PASm-12, all training indicators considered relevant—training days and hours, distance covered, volume parameters per athlete (distances, effort durations), and effort intensity per athlete (pace, heart rate, etc.)—were continuously monitored and centralized weekly via Bluetooth by the research team for each athlete through the data provided by the Garmin Connect (Version 5.5) app. The watches were acquired through the "Life Quality and Human Performance" Research Laboratory of the Faculty of Physical Education and Mountain Sports in Brașov.

2.4. Statistical Analyses

The collected data were analyzed using SPSS v.23 for Windows. The significance level was set at $p \leq 0.05$. Descriptive data are reported as mean and standard deviation (SD) and sometimes as percentages (%). Differences in continuous variables (volume, intensity, tempo, test execution times) were analyzed using the paired *t*-test. Given the small sample size, we used bootstrapping, where the statistical software creates simulated samples similar to the analyzed one, increasing result accuracy and stability. The ideal is to use 1000 samples, which we applied in our data processing [42].

In addition, we calculated the effect size using two distinct methods, tailored to the specific context of each indicator, with the aim of ensuring a rigorous and appropriate evaluation of the obtained data. Thus, for the indicators of effort volume and intensity, we chose to apply Cohen's f^2, as this method allows for a comprehensive assessment of the variance explained by our training model in relation to the proposed volume and intensity. For the comparison between the proposed and achieved times in the five tests, we opted for the Cohen's d formula, which is suitable for measuring the differences between two means, taking into account the standard deviation, thereby ensuring an accurate evaluation of individual performances against the expected values. The effect size serves to evaluate the impact of the intervention and to facilitate the justification of the necessary number of participants in future studies as well as to estimate the magnitude of the differences that other researchers might expect [42].

3. Results

3.1. The Level of Fulfillment of the Annual Physical Training Plan for Half Marathon Runners Aged 45+—PASm-12

Compared to what was proposed in PASm-12, the six research subjects reported the volume and intensity indicators they actually achieved in varying proportions. The following results will be presented accordingly: effort volume, determination of maximum heart rate (MHR) and establishment of training zones, as well as effort intensity and the testing times obtained.

3.1.1. Comparison of Proposed and Realized Training Volume through PASm-12 (Q1)

In Table 5, the data show that athlete S3 achieved the highest training volume (2478 km) while athlete S1 achieved the lowest (2232 km). These data allow us to assert that PASm-12 was not fully applied, only at 90.2%.

If the significance of the comparison test is greater than $p = 0.05$, we accept that the data do not provide sufficient evidence to conclude that the volume of effort performed by the athletes aligns with the planned volume of effort in the annual physical training plan. On the other hand, if $p \leq 0.05$, we reject the null hypothesis, suggesting that there is sufficient evidence to conclude that the volume of effort performed by the athletes is congruent with the planned volume, indicating the effectiveness of the scheduling.

Table 5. Effort volume realized by runners and proposed by PASm-12.

Mesocycles	Effort Volume Realized per Athlete (S)/km						Proposed Training Volume/km
	S1	S2	S3	S4	S5	S6	
I	132	156	160	130	148	142	160.00
II	146	150	162	142	160	136	168.00
III	162	162	178	158	170	172	230.00
IV	172	178	180	168	176	168	184.00
V	178	202	220	185	206	201	231.00
VI	212	230	236	228	232	240	246.60
VII	228	227	230	228	230	235	243.80
VIII	90	150	95	90	93	95	94.60
IX	302	320	332	308	280	310	312.20
X	310	320	340	300	298	345	345.80
XI	270	308	315	290	265	310	358.20
XII	30 *	50 *	30 *	20 *	40 *	20 *	29.00 *
Total effort volume achieved per athlete (km)	2232	2453	2478	2247	2298	2374	2603.2 / 2347
Effort volume achieved per athlete from the proposed effort volume (%)	8.7	94.2	95.2	86.3	88.3	91.2	90.2

* Note: In the proposed volume value, the athletes also accounted for mountain hiking activities to a greater or lesser extent. To verify if the proposed training volume in each mesocycle is statistically equivalent to the training volume performed (Q1), we used the paired *t*-test to compare the means of the two training volumes (proposed/realized) across the sample/12 mesocycle, employing the bootstrapping method for small samples (Table 6).

Table 6. Differences between realized and proposed training volume through PASm-12.

Pair	Volume Indicator Variable Compared/Mesocycle/Realized-Proposed	Mean S1–S6 (km)	Difference	t	*p*
1	Realized training volume mesocycle I Proposed training volume mesocycle I	144.7 160.00	−15.33	−3.052	0.028
2	Realized training volume mesocycle II Proposed training volume mesocycle II	149.33 168.0	−18.67	−4.495	0.006
3	Realized training volume mesocycle III Proposed training volume mesocycle III	167.00 230.00	−63.00	−20.40	0.001
4	Realized training volume mesocycle IV Proposed training volume mesocycle IV	173.67 184.00	−10.33	−4.939	0.004
5	Realized training volume mesocycle V Proposed training volume mesocycle V	198.67 231.00	−32.33	−5.247	0.003
6	Realized training volume mesocycle VI Proposed training volume mesocycle VI	229.67 246.60	−16.93	−4.290	0.008
7	Realized training volume mesocycle VII Proposed training volume mesocycle VII	229.67 243.08	−14.13	−12.041	0.001
8	Realized training volume mesocycle VIII Proposed training volume mesocycle VIII	102.17 94.60	7.57	0.787	0.467
9	Realized training volume mesocycle IX Proposed training volume mesocycle IX	308.67 312.20	−3.53	−0.493	0.643
10	Realized training volume mesocycle X Proposed training volume mesocycle X	318.83 345.80	−26.97	−3.302	0.021

Table 6. *Cont.*

Pair	Volume Indicator Variable Compared/Mesocycle/Realized-Proposed	Mean S1–S6 (km)	Difference	t	*p*
11	Realized training volume mesocycle XI Proposed training volume mesocycle XI	293.00 358.20	−65.20	−7.414	0.001
12	Realized training volume mesocycle XII Proposed training volume mesocycle XII	31.67 29.00	2.67	0.559	0.600
Total effort volume achieved (macrocycles) Total proposed effort volume (macrocycles)		2347.00 2603.20	−256.2	−5.997	0.002

Regarding the effect size, the calculated R^2 value is 0.8619, indicating that 86.19% of the variation in the realized training volume can be explained by the proposed training volume through PASm-12. This shows a strong correlation between the two sets of data. Additionally, the Cohen's f^2 value for the mean difference in training volume is approximately 6.24, indicating a large effect size. This suggests that the difference between the proposed and realized training volume is not only statistically significant but also has a substantial practical impact.

3.1.2. Determination of Maximum Heart Rate (MHR) and Establishment of Training Zones for the Research Subjects

Based on the laboratory tests presented in the procedure section, individual training zones were established for each athlete, including maximum heart rate (MHR), which are essential for monitoring and adjusting the intensity of effort during the application of PASm-12 (Table 7).

Table 7. Training zones and maximum heart rate determined through the Bruce test for female runners S1–S6.

Athlete	Training Zone	Heart Rate (bpm)	Tempo/Speed (min/km)
S1	RL/LDL	125	slower than 6:32
	MDL	126–144	6:32–5:30
	TDL	145–155	5:30–5:01
	ETL	156–162	5:01–4:41
	ITL	163–168	4:41–4:24
	SB	**169–max.**	faster than 4:24
S2	RL/LDL	162	slower than 5:33
	MDL	163–169	5:33–4:55
	TDL	170–175	4:55–4:24
	ETL	176–178	4:24–4:06
	ITL	179–181	4:06–3:58
	SB	**182–max.**	faster than 3:58
S3	RL/LDL	134	slower than 5:40
	MDL	135–148	5:40–4:48
	TDL	149–158	4:48–4:20
	ETL	159–166	4:20–4:01
	ITL	167–173	4:01–3:39
	SB	**174–max.**	faster than 3:39
S4	RL/LDL	90	slower than 9:39
	MDL	91–115	9:39–7:03
	TDL	116–126	7:03–6:30
	ETL	127–145	6:30–5:07
	ITL	146–151	5:07–4:48
	SB	**152–max.**	faster than 4:48

Table 7. *Cont.*

Athlete	Training Zone	Heart Rate (bpm)	Tempo/Speed (min/km)
S5	RL/LDL	147	slower than 7:19
	MDL	148–153	7:19–6:31
	TDL	154–164	6:31–5:14
	ETL	165–167	5:14–4:52
	ITL	168–170	4:52–4:39
	SB	**171–max.**	faster than 4:39
S6	RL/LDL	133	slower than 6:20
	MDL	134–144	6:20–5:36
	TDL	145–154	5:36–5:13
	ETL	155–168	5:13–4:20
	ITL	169–174	4:20–4:04
	SB	**175–max.**	faster than 4:04

RL/LDL: Low-intensity distance (low-intensity running, recovery pace); MDL: medium-intensity distance (medium-intensity running, base pace); TDL: threshold distance (threshold running, anaerobic threshold pace); ETL: endurance tempo (endurance pace, tempo running); ITL: interval training (interval training, high-intensity pace); SB: speed burst (speed bursts, sprints). The bold value represents the maximum heart rate for each athlete. These values serve as benchmarks for calculating individual percentage values in the case of the scheduled effort intensity.

Based on initial laboratory data, we proposed and then monitored PASm-12's training intensity for each athlete. Each mesocycle and microcycle had pre-set training intensity values (proposed values) applied in practice (realized values) through PASm-12.

3.1.3. Comparison of Proposed and Realized Training Intensity through PASm-12 (Q2)

The intensity indicator considered was based on the physiological response of the body to the strength of the stimulus/the physical exercise performed, specifically reflected by the heart rate (HR), expressed as the average percentage per mesocycle per athlete. This percentage value is related to the maximum heart rate (MHR) of each athlete (Table 8).

Table 8. Effort intensity realized by runners and proposed by PASm-12.

Mesocycles	Effort Intensity (Average %) Realized/ Athlete (S)						Realized Training Intensity Average S1–S6/Proposed (%)	
	S1	S2	S3	S4	S5	S6	Realized	Proposed
I	65%	75%	75%	60%	67%	70%	69%	70.0%
II	66%	76%	77%	62%	67%	70%	70%	75.0%
III	65%	67%	68%	63%	71%	72%	68%	70.0%
IV	69%	70%	70%	65%	70%	71%	69%	76.3%
V	68%	78%	74%	70%	72%	77%	73%	77.6%
VI	75%	65%	65%	70%	67%	70%	69%	72.8%
VII	75%	78%	75%	80%	76%	70%	76%	80.8%
VIII	75%	65%	65%	70%	67%	70%	69%	71.0%
IX	80%	75%	70%	76%	71%	70%	74%	76.2%
X	77%	72%	77%	81%	79%	75%	77%	80.5%
XI	79%	75%	72%	80%	78%	72%	76%	80.5%
XII	75%	66%	65%	70%	78%	70%	71%	78.3%

These values, taken as the average percentage values of realized training intensity by S1–S6/mesocycle (relative to MHR/S), were compared with the proposed percentage values of mesocycle averages by PASm-12 (Table 9, Figure 1). Data analysis shows that training intensity was realized at 94.8%, indicating almost complete plan application.

Table 9. Differences between realized and proposed training intensity through PASm-12.

Pair	Effort Intensity Variable Compared/Mesocycle/Realized-Proposed	Mean S1–S6 (%)	Difference	t	*p*
1	Realized training intensity mesocycle I Proposed training intensity mesocycle I	69 70.0	−1.0	−1.283	0.128
2	Realized training intensity mesocycle II Proposed training intensity mesocycle II	70 75.0	−5.0	−0.867	0.213
3	Realized training intensity mesocycle III Proposed training intensity mesocycle III	68 70.0	−2.0	−2.904	0.017
4	Realized training intensity mesocycle IV Proposed training intensity mesocycle IV	69 76.3	−7.3	−2.961	0.016
5	Realized training intensity mesocycle V Proposed training intensity mesocycle V	73 77.6	−4.6	0.885	0.208
6	Realized training intensity mesocycle VI Proposed training intensity mesocycle VI	69 72.8	−3.8	−1.972	0.053
7	Realized training intensity mesocycle VII Proposed training intensity mesocycle VII	76 80.8	−4.8	2.833	0.018
8	Realized training intensity mesocycle VIII Proposed training intensity mesocycle VIII	69 71.0	−2.0	−1.972	0.053
9	Realized training intensity mesocycle IX Proposed training intensity mesocycle IX	74 76.2	−2.2	1.164	0.148
10	Realized training intensity mesocycle X Proposed training intensity mesocycle X	77 80.5	−3.5	3.984	0.005
11	Realized training intensity mesocycle XI Proposed training intensity mesocycle XI	76 80.5	−4.5	2.956	0.016
12	Realized training intensity mesocycle XII Proposed training intensity mesocycle XII	71 78.3	−7.3	−0.526	0.311

To verify if the proposed training intensity/mesocycle is statistically equivalent to the realized training intensity (Q2), we used the same statistical comparison procedure of the two effort intensities' means (realized/proposed) for the entire sample S1–S6/12 mesocycle, using the paired *t*-test and the bootstrapping method (1000 samples) (Table 9).

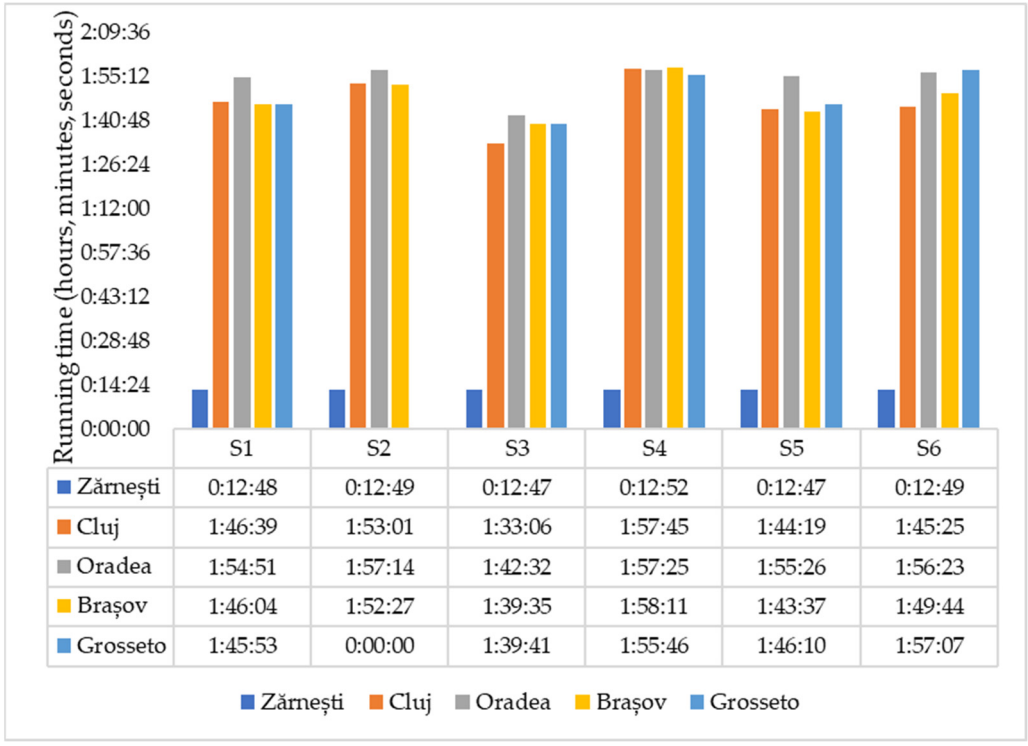
We observe that, similar to the training volume, the realized training intensity by runners (average value S1–S6/mesocycle) is generally lower than the proposed intensity, with mostly negative differences. However, there are some exceptions where the realized intensity is close to or even higher than the proposed (mesocycle V, IX, and XII). The significance of differences is statistically significant for most mesocycle, except for mesocycle I, II, V, VIII, IX, and XII, where differences are not statistically significant. We conclude that the statistical differences were insignificant in most mesocycle, indicating good conformity with the initial plan (PASm-12).

By calculating the effect size, the R^2 value is 0.314, indicating that 31.4% of the variation in the dependent variable (realized effort intensity) can be explained by the independent variable, namely the proposed effort intensity through PASm-12. This is a relatively moderate coefficient, indicating a significant, but not very strong, relationship between the variables. However, the Cohen's f^2 value is 0.45, which indicates a large effect, and the independent variable (PASm-12) has a substantial impact on the dependent variable (average intensities per mesocycle/S1–S6). This suggests that the plan was robust enough to guide the athletes towards achieving most of the proposed objectives, also demonstrating that, even with deviations from the initial plan, PASm-12 managed to maintain a coherent direction in our female athletes' training.

3.1.4. Comparison of Realized Test Times with Proposed Execution Times in PASm-12 (Q3)

To answer the question: How are runners' performances influenced by the partial application (90.2% of the proposed training volume and 94.8% of the requested intensity) of PASm-12?. We chose to compare the realized test times of runners in the five tests with the proposed times in the microcycle within the mesocycle corresponding to the testing moments in PASm-12. We started from the premise that if these compared time values do not indicate significant statistical differences, and the test execution times and those proposed by PASm-12 are statistically equivalent, we can affirm that the training volume and intensity realized by runners are sufficient to achieve the planned performance goals for the major objective competition (EMACNS Grosseto).

Results expressed in race times in the five tests conducted by the six female runners are presented in Figure 2. The female runners participated in all tests (except S2 in test 5), namely the non-specific 10 km test and four specific 21 km tests. In PASm-12, for the non-specific test (Zărnești 10 km), the proposed and initially accepted tempo by runners was 5′10–4′50″/km, with an average of 5 min/km, converting to 3000 s/10 km for the entire test. For the specific tests in Cluj-Napoca, Oradea, and Brașov (21 Km), the proposed tempo by PASm-12 for the entire half marathon was 5′40″–5′30″/km, with an average tempo of 5′35″/km, equivalent to 7035 s/21 km. For the European Masters Athletics Championships Non-Stadia (EMACNS Grosseto—Italy), the proposed training program tempo was 5′10″–4′50″/km, with an average of 5′/km—thus, 6300 s/21 km.



	S1	S2	S3	S4	S5	S6
Zărnești	0:12:48	0:12:49	0:12:47	0:12:52	0:12:47	0:12:49
Cluj	1:46:39	1:53:01	1:33:06	1:57:45	1:44:19	1:45:25
Oradea	1:54:51	1:57:14	1:42:32	1:57:25	1:55:26	1:56:23
Brașov	1:46:04	1:52:27	1:39:35	1:58:11	1:43:37	1:49:44
Grosseto	1:45:53	0:00:00	1:39:41	1:55:46	1:46:10	1:57:07

Figure 2. Results of the five tests in the 2020–2021 competition year.

To verify Q3, we used the paired *t*-test to compare the realized test times (average value/test S1–S6) with the proposed average times per km (running tempo/km) at the five testing moments included in PASm-12. Calculations show that these times, except for the Grosseto test, are shorter, thus better, compared to the projected average test times in PASm-12 in the corresponding mesocycle/microcycle. Four differences between the two series of times are positive, and the time obtained at EMACNS—Grosseto (Italy) is longer than the proposed time, with a negative but statistically insignificant difference (Table 10).

Table 10. Differences between the average realized test times by runners S1–S6 and the proposed average times in PASm-12 (H3.b).

Test No.	Sports Event/Test km/Location	Proposed PASm-12 Average Time s (I)	Realized Average Time S1–S6 s (J)	Difference I–J	SD	t	*p*
1	Zărnești 10 km test	3000	2951.6	48.40	110.97	0.975	0.39
2	Cluj-Napoca 21 km test	7035	6458	576.20	344.297	3.742	0.02
3	Oradea 21 km	7035	6858	177.00	433.06	0.914	0.41
4	Brașov 21 km	7035	6446.8	588.20	422.96	3.110	0.04
5	Grosseto 21 km	6300	6535.2	−235.20	441.19	−1.192	0.3

Note: N = 6, bootstrapping—1000; execution time averages are described in seconds; SD—standard deviation.

In the case of proposed average times (s/km/test) as a performance benchmark in executing the tests, analysis of these differences indicates varied results in testing: for three tests (Zărnești, Oradea, and Grosseto), the average differences are not significant ($p > 0.05$), meaning the runners achieved the overall "finish time" indicator at the projected average value set by PASm-12. For the tests in Cluj-Napoca and Brașov, the average differences are statistically significant, with p being less than 0.05; in these tests, the runners had weaker overall performance (S1–S6) than proposed by PASm-12. Therefore, it cannot be concluded with certainty regarding achieving the "average test times/km" proposed in PASm-12 and the actual test times, taken as an average value for the six runners in executing the tests.

The effect size for each test, specifically the differences between the planned times and the actual times achieved, is as follows: for the 10 km test in Zărnești, Cohen's d was 0.44, indicating a small to moderate difference; for the 21 km test in Cluj-Napoca, Cohen's d was 1.68, indicating a large difference, favorable to the actual times achieved; for the 21 km test in Oradea, Cohen's d was 0.41, indicating a small difference, with actual times close to those planned; for the 21 km test in Brașov, Cohen's d was 1.39, showing a large difference, favorable to the actual times achieved, which were shorter; and for the 21 km test in Grosseto, Cohen's d was −0.53, suggesting a moderate difference, with the actual times being longer than those planned.

After executing the main test—the objective (EMACNS—Grosseto), the entire group agreed to continue monitoring the training process through PASm-12 until its full completion without participating in common competitions imposed by PASm-12. This request was largely due to family and professional responsibilities and financial constraints. However, all runners agreed to participate in the study until the full execution of PASm-12 contents and to report continuously via smartwatches both the requested training parameters and competition participation within the competition period defined by PASm-12, even if these were not always exclusively related to the half marathon event. Data collected from S1–S6 show that female runners continued competitive activity (except S1—due to professional and academic reasons), participating in both national and international competitions (Table 11).

Table 11. Number of competitions conducted by female runners S1–S6 during the competition period not included in PASm-12.

Competition Level	Subjects						Total
	S1	S2	S3	S4	S5	S6	
National competitions	0	9	9	3	1	6	28
International competitions	0	0	1	3	1	1	6
Total	0	9	10	6	2	7	34

From these quantitative data, it is observed that the participation of each subject varies in number (between 0–10), with the predominant ones being at nationally scheduled competitions.

4. Discussion

The purpose of this study was to design and implement an annual physical training plan for master athletes aged 45 and above, specifically focusing on the half marathon (PASm-12) event. This age category generally includes amateur practitioners who often lack a scientifically grounded training program, at least as a guiding framework, to meet the multiple demands associated with this event. Moreover, they often do not benefit from the counseling of a specialized coach to coordinate the complex aspects of sports training and continuously adapt training methods and means to the efficiency and safety requirements necessary for the event. To apply and validate such a medium-term (over one calendar year) plan, we involved six Master amateur runners (+45 years), each with at least 10 years of competitive experience. We considered their experience and competition results prior to the study as a guarantee for both good practice of the specialized training process within our approach and future confidence from other amateur runners regarding the sustainability of the sports training model followed by our athletes.

4.1. Discussions on the Structure, Content, and Effort Indicators of PASm-12 Compared to Other Planning Documents Presented in the Specialized Literature

Compared to what is mentioned in Section 2.3.1, other studies applying endurance event (half marathon, marathon) training programming based on the same linear planning model present somewhat simplified periodization strategies compared to PASm-12. For example, planning sequences include four stages with a preparatory period (November to February), a pre-competition period (March to the end of April), and a competition period (May to September) [22] or a single 20-week competition macrocycle ("evolutionary periodization") following a 3-month preparatory period. In this case, the competition macrocycle is divided into two mesocycles, each of 10 weeks, with the training process applied to a single performance athlete aged 50 [53]. Another planning method on a relatively short term involves a three-phase plan—base phase, training phase, and recovery phase [54]—or recommends 4–6 months of preparation until competition day [39]. Another study suggests a 12-week preparation plan for an experienced athlete [37]. In planning PASm-12, we considered a one-year training program to provide a comprehensive strategy for training and allow the practitioner to form a continuous anticipatory behavior focused on the provided methodology.

From the perspective of the number of training sessions, in PASm-12 we proposed that the amateur athletes undertake four or five training sessions per week. In other training models—for example, for the marathon distance—11–13 training sessions have been scheduled for high-performance athletes [22]. For the half marathon distance, other sources suggest either 5–6 training sessions per week for a 50-year-old performance athlete [53], 6 training sessions per week for advanced half marathoners [39], or 5 weekly training sessions with 2 rest days [54].

The means/exercises most commonly used by half marathon runners, according to studies focused on this direction, include easy running, alternating walking and easy running, acceleration runs, repeated sprint training, aerobic–anaerobic threshold running, progressive reduction in distance running, aerobic threshold long runs, Fartlek, steady-tempo running, interval running, strength endurance training—circuit type, jumps, etc. [32,35,36,39,53–56]. In PASm-12, similar means/exercises were largely utilized. In summary, we applied steady-tempo running at a pace of 5′40″–5′30″/km (the most frequently used specific method in PASm-12, representing 35.1% of total means used), moderate-paced long-distance running (making up 26.9% of the total), interval running (9.5%), Fartlek running (9% of total training means), steady-tempo running at 5′10″–4′50″/km (programmed at 5.8%), whereas hill running and steady-tempo running at 5′40″–5′10″/km were the least

used exercises in PASm-12, representing 5.6% and 4.6% of the total means programmed, respectively. Additionally, competitive races conducted as tests in PASm-12 account for 3.6%. In contrast to PASm-12, another study recommends replacing 25–30% of running volume with other training options [54], which is agreed upon in our case.

The Dynamics of Volume and Intensity Indicators in PASm-12

The most important training indicators targeted by PASm-12 were the volume and intensity of effort. Quantitative parameters—volume indicators such as running distance and duration (when applicable)—were considered, while execution times, related with the predetermined tempo and the athlete's functional demand (heart rate relative to maximum heart rate—MHR), provided data on the qualitative component of effort, i.e., its intensity (the functional demand of the body in response to effort). In PASm-12, during the preparatory period (PP, October–January/mesocycle I–IV), we proposed a volume of 160 km in GPP and 194.00 ± 32.18 km in SPP, with runners running an average of 40–46 km per week, 4 times per week, at an average intensity of up to 70% (72.8%) of MHR/athlete (monitored via Garmin watches). In the pre-competitive period (PPC, February–March/mesocycle V–VI), a larger running volume of 238.8 ± 11.03 km was proposed, to be completed over 5 training sessions per week, with weekly volumes ranging from 36 km to 64.8 km and intensities between 65% and 82% of each athlete's capabilities (with an average of 75.2%/PPC mesocycle). During the competitive period (CP, April to mid-September/mesocycle VII–XI), the proposed training volume was 270.92 ± 108.11 km, with runners running 42–67 km per week at intensity levels ranging from 68% to 85% of MHR/athlete (average of 77.8%). In the transition period (TP, mid-September, mesocycle XII), a volume of 29 km was proposed, with weekly training intensity ranging from 70% to 77% of MHR/athlete, averaging 78.2% per mesocycle. Our effort parameter phasing strategy in PASm-12 is similarly noted in other studies. For example, for an experienced half marathoner, weekly running volumes of 32, 48, or 64 km are recommended [37], and for training intensity, combining moderate- and high-intensity sessions is considered an effective approach [40]. In another study on endurance runners, combining volume and intensity of effort showed no consensus on the most effective practices for maintaining or developing health and performance in amateur runners: either increase intensity by 10% per week or run 70 km per week [53]. In PASm-12, we aimed to facilitate progressive biological adaptation to effort by scheduling shorter distances and times at the beginning of the training period to prevent early dropouts, often justified by amateur runners due to lack of time, injuries, or dissatisfaction with training due to fatigue [29]. Running more than 65 km per week for men and between 48–63 km per week for women is associated with higher health risks for amateur runners [57–59], and preventing these risks involves reducing training volume [60]. Excessive training volume can be detrimental, leading to fatigue, reduced training efficiency, uneconomic muscle effort, and increased injury risk [17]. Some authors, however, find current research results inconclusive in this regard [61].

4.2. Discussions on Comparison of Effort Volume and Intensity Indicators Proposed by PASm-12 and Those Achieved by S1–S6

4.2.1. Comparison of Proposed and Achieved Volume—The Response to Q

To analyze the implementation of PASm-12 in terms of volume, we compared the total running volume completed by the six runners (2347 km) with the volume proposed by the annual plan (2603.2 km). The comparison shows a difference of 256.2 km between the proposed and achieved volumes over the macrocycle, corresponding to a 90.2% implementation rate of PASm-12 (Table 5). Generally, the female runners ran less than the proposed volume, with differences mostly negative and only twice positive in mesocycle VIII and XII. The differences are statistically significant at $p = 0.05$ for most mesocycle, except for VIII, IX, and XII (Table 6). Thus, we accept that for mesocycles VIII, IX, and XII, the differences between the proposed and the actual volume of effort are not statistically significant. In other words, in these three mesocycles, the athletes ran, on average, dis-

tances statistically equivalent to those proposed in PASm-12. Conversely, we reject that the differences between the proposed and actual volume are not statistically significant for the other mesocycles, where the proposed volume is greater than what was actually achieved. Therefore, we can state that the annual training plan (PASm-12), from the perspective of running volume, was implemented, but not fully. Periodic reports show that the overall training volume was achieved by the runners as follows: 85.7% by S1; 94.2% by S2; 95.2% by S3; 86.3% by S4; 88.3% by S5; and 91.2% by S6.

The analysis of the effect size for the observed differences in the training volume achieved compared to the proposed one highlighted a significant effect size (Cohen's $f^2 = 6.24$). The large effect size indicates that variations in training volume are sufficiently pronounced to have observable consequences on performance and athletes' adaptation. This finding emphasizes not only the statistical significance and substantial practical impact of the differences but also their relevance in the context of training planning for female master 45+ amateur athletes. Furthermore, the importance of this effect size extends beyond the validation of the PASm-12 training program, serving as a guiding tool for researchers planning similar studies and contributing to the improvement of reliability and validity in future research on this area.

4.2.2. Comparison of the Intensity Percentage Value Proposed in PASm-12 and That Achieved by S1–S6—The Response to Q2

The training intensity achieved by the runners was implemented on average (S1–S6) at 94.79% of the proposed PASm-12 intensity. This high percentage indicates that although the achieved intensity (mesocycle I–XII/S1–S6: 69%; 70%; 68%; 69%; 73%; 69%; 76%; 69%; 74%; 77%; 76%; 71%) was slightly lower than the proposed intensity (70.0%; 75.0%; 70.0%; 76.3%; 77.6%; 72.8%; 80.8%; 71.0%; 76.2%; 80.5%; 80.5%; 78.3%) in most mesocycles, the annual training program implementation was very close to the established objectives. Thus, we accept that for mesocycles I, II, V, VIII, IX, and XII, the actual intensity of effort is statistically equivalent to the proposed intensity of effort. Conversely, we reject that the actual intensity of effort is equivalent to the proposed intensity for the other mesocycles, where the proposed intensity is significantly higher than what was actually achieved. Therefore, while PASm-12 was largely followed in terms of training intensity, it was not fully implemented (94.8%), indicating the need for some adjustments in future applications to ensure that the proposed intensity is met in all mesocycle.

The results of the effect size calculation and the coefficient of determination (R^2) highlight several important aspects in evaluating the effectiveness of the PASm-12 plan, especially in the context of self-managed training and athletes' self-reporting of data. With an R^2 of 0.314 and Cohen's f^2 of 0.45, it can be said that the independent variable (the training intensity proposed by PASm-12) explains a moderate portion of the variation in the achieved training intensity and has a large effect on this variable. This means that the proposed training intensity plays a significant role in determining the achieved training intensity. Although the R^2 coefficient, calculated at 0.314, indicates a discrepancy between the proposed and achieved values, it should be emphasized that this does not necessarily represent a limitation of the PASm-12 plan itself but rather reflects the inherent variability in a long-term training program involving athletes who self-manage their training. This variability actually demonstrates the flexibility of the PASm-12 plan, which allowed for personalized adaptation of the training to the needs and capabilities of each athlete without compromising the overall objectives of the plan.

In principle, for both indicators of effort analyzed, we agree with studies that claim that a high training volume and a high training pace (intensity) are predictors of a better race finish time [57,59,62,63].

4.2.3. Comparison of Test Results and Proposed Times in PASm-12 (The Response to Q3)

We aimed to assess the efficiency of PASm-12, considering that it was not fully implemented (as expected for an intervention conducted under natural conditions over a relatively long period). We compared the average times per km from the field tests of the six athletes to the average time per test proposed by PASm-12. If these comparisons show no significant statistical differences, indicating the times achieved and proposed are statistically equivalent, we can affirm that the achieved volume and intensity of effort are sufficient to meet the planned performance. Following data analysis, we consider the results satisfactory, as they indicate that most of the times achieved in the field are lower than the average times proposed by PASm-12 (Table 9). Corroborating the results obtained from the responses to Q3, it can be asserted that PASm-12 is suitable for training for the half marathon, as the athletes' performances in the five tests were either better than or equivalent to the proposed times. Compared to the average proposed time per test, which is between the maximum and minimum (Table 9), the times obtained per test (average value S1–S6) are as follows: four of the recorded times are lower than the proposed time (with two differences being statistically significantly smaller), and the time recorded in Grosseto is weaker, but the difference is statistically insignificant. Thus, we consider the times to be equivalent.

From the perspective of effect sizes for the times achieved compared to those proposed across the five tests, a valuable insight into the actual effectiveness of the PASm-12 plan can be drawn. The variation in effect sizes among the five tests reflects the direct impact of the plan on performance, highlighting the athletes' ability to adapt and respond to the specific demands of competitions. For most tests, except Grosseto, effect sizes (Cohen's d) indicate improved performance, where athletes achieved better times than those proposed. This demonstrates the effectiveness of PASm-12 in preparing athletes for competitions, validating its scientific and tailored approach to master athletes. A notable exception was the Grosseto test, where the negative effect size (−0.53) suggests that performance was below expectations. This finding indicates that competition performance is often influenced by a range of external factors related to the competitive environment. Factors such as course conditions, psychological pressure, and competition dynamics can affect results, causing them to differ from those obtained in non-competitive tests. This variation necessitates a deeper analysis of the factors that might be responsible for this deviation.

As such, although the indicators of training volume and intensity were adhered to only 90.2% and 94.8% throughout the entire macrocycle/year of preparation as outlined in PASm-12, the female athletes managed to perform unequivocally at the average level accepted by consensus and projected by PASm-12. Therefore, following PASm-12 to a large extent results in positive outcomes for the performance of the female athletes in our subject group, even under conditions of international competition. This fact is also demonstrated by the placements achieved at the target competition set by PASm-12 (European Masters Athletics Championships Non Stadia, held in Grosseto, Italy, from 12–15 May 2022), where our female athletes achieved the following rankings: S1 finished 6th (W50), recording her personal best time of 01:45:52 (PB) during the study period; S2 did not participate in the EMACNS—Grosseto due to family issues; S3 recorded a time of 01:39:41, placing 3rd (W45); S4 completed the race with a time of 01:55:46, placing 8th (W55); S5 achieved a time of 01:46:10, finishing 12th (W50); and S6 obtained a time of 01:57:07, placing 17th (W45).

In conclusion, we believe that the study results underscore the potential of the PASm-12 plan to serve as an effective model for preparing master female athletes for half marathon events, encouraging continuous adaptation and adjustment of training plans based on real feedback obtained through testing. This approach not only enhances performance but also improves athletes' motivation and satisfaction, which are essential for sustaining long-term commitment to the sport.

4.3. Limitations

Despite these positive results supporting the practical viability of PASm-12, our study has limitations. The primary limitation is the small sample size, resulting from the difficulty of finding participants willing to follow a common training program over a year through self-instruction. This small sample size may affect the generalizability of the results. It is possible that the use of a control group may have contributed to the reporting of more relevant data. We attempted to mitigate this by using the statistical bootstrapping method, as is done in case studies [42,49]. Another limitation is the use of self-reported data by the athletes, which can negatively affect objectivity and, consequently, the quality of the research. However, this method of data transfer was the only feasible way to explore the training indicators of interest. Additionally, there are opinions suggesting that the accuracy of measurements performed by smartwatches, a procedure we also adopted, is influenced by errors, varying in magnitude depending on the measured variable and the device used [52]. However, the validation of several such devices, including those from Garmin's range, has been conducted in various sports activities, and clinical study results have highlighted those wearable devices are important for improving athlete performance and preventing adverse cardiovascular events [64]. Additionally, it seems that at least distance measurement—one of the data directions we also adopted—appears to be the most reliable [65]. The use of heart rate belts might provide more accurate data for HR measurement, but the device we used, the Garmin Fenix 6S PRO, offers additional data that a chest belt cannot directly provide, such as: running route, altitude and terrain variation monitoring, training time and environmental conditions, pace and running speed monitoring, recovery monitoring function, etc. These features were useful to us in monitoring (adjusting) the training process.

In this context of limitations, as a subjective evaluation of intensity, we could have also used the rate of perceived exertion (RPE) as an alternative mechanism for controlling effort pace. We believe that this method could have provided valuable information, especially in situations where GPS technology or heart rate monitoring might have been limited by external interference or individual variability.

Another limitation is that the runners participating in validating PASm-12 are not solely road runners but also engage in mountain running. The five tests conducted in PASm-12 were road runs, so the plan should be viewed as an indicative strategy for half marathon preparation and execution. On the other hand, we believe that explaining the performances of the six athletes in our group is not only attributed to the use of PASm-12 or the variety of training methods and tools it includes, but also to other factors that are difficult to control in a study with a single group. Among these, we mention a healthy lifestyle, manifested through appropriate nutritional strategies, suitable professional equipment, and academic education, all of which are often enhanced by domain-specific readings or the frequency of distances covered in hiking as alternative, complementary training. These aspects, interacting variably in the runners' daily routines, could be subjects of future studies. Last but not least, while PASm-12 was designed for women, it could also be adapted for use with other categories, including men and non-binary individuals.

Additionally, some experts might consider that establishing and following a common training plan, even if only indicative, with fixed indicators of physical preparation such as volume and intensity of effort, would not only be difficult but also inefficient, as each athlete is unique in their own way.

5. Conclusions

The implementation of the annual physical training plan for master athletes aged 45+ (PASm-12), created with the hope of becoming a model of good practice for amateur half marathon runners who do not have the guidance of a specialist, has proven to be an effective action. Although the volume and intensity of effort were not fully achieved compared to what was proposed in PASm-12, the data from the *t*-test and the effect size analysis

indicated a substantial practical impact of the observed differences, demonstrating that the program successfully achieved results that are both statistically and practically significant.

From a methodological perspective, these indicators were progressively and judiciously scheduled, avoiding a chaotic self-training process. This facilitated the athletes' biological adaptation, reduced (practically eliminated) the risk of injury, and resulted in the maintenance or improvement of athletic performances, including competitive ones.

PASm-12 also demonstrated its ability to maintain or improve performances in real competitive conditions, even though the results in competitions, such as the Grosseto test, were influenced by external factors specific to the competitive environment, which is often difficult to replicate in non-competitive testing conditions. The success of PASm-12 underscores the complexity and comprehensiveness of this specialized sports training model, structured over a 12-month period, divided into distinct periods correlated with a competition calendar. This methodological approach provides an additional training framework compared to the short-term programming models cited in the referenced studies.

For future applications of PASm-12, it would be beneficial to include additional monitoring tools, such as more advanced wearable technologies and real-time feedback mechanisms, which could further optimize individual biological adaptations. This would allow for more personalized training adjustments, ensuring that each athlete's performance level is both challenging and achievable. Additionally, exploring the inclusion of motivational and psychosocial support within the program could enhance adherence and long-term success in this type of sports training.

By continuing to refine and adapt PASm-12, this program has the potential to become a benchmark for training master athletes, not only in the self-coaching of half marathon runners but also in various other endurance sports. It offers a solid framework for improving athletic performance while also maintaining the health and well-being of the athletes.

Additionally, researchers and practitioners who wish to replicate or test the PASm-12 model in the context of their own studies or training can receive access to all necessary supplementary information by contacting any of the authors of this study.

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Article

The Relationship between Neuromuscular Control and Physical Activity in the Formation of the Visual-Psychomotor Schemes in Preschools

Roxana Buzescu [1], Florentina Nechita [2,*] and Silviu Gabriel Cioroiu [2]

[1] The School for Moving Health, SANpitic from Brasov, 500035 Brasov, Romania; roxana.buzescu@gmail.com
[2] Department of Physical Education and Special Motricity, Faculty of Physical Education and Mountain Sports, Transilvania University of Brasov, 500068 Brasov, Romania; silviu.cioroiu@unitbv.ro
* Correspondence: florentina.nechita@unitbv.ro; Tel.: +40-722-416-423

Abstract: *Background:* This research has started from the empirical observation that preschoolers who practice systematic and continuous physical activities can solve the tasks they receive more accurately and in less time than those who do not do sports in an organized setting. *Methods:* The research was carried out in 2015 in the Laboratory of Physical Therapy and Special Motricity of the Faculty of Physical Education and Mountain Sports, Transilvania University of Brasov. The survey sample included 51 preschoolers (26 boys and 25 girls), and the study implemented "real experiment" type research with a post-test phase to find out to what extent cortical stability is dependent on practicing a form of systematic movement at the ages of 4–6 years by analyzing proprioceptive sense and neuromuscular control. Thus, we could see how a 4-to-6-year-old child's brain responds to a given stimulus by using the ERGOSIM condition simulator, which provides real-time feedback. *Results:* The results of the study show significant values for the visual control of the subjects by adjusting movement. *Conclusions:* The practice of physical activities benefits from learning through the visual scheme, having real-time feedback, and subjects being able to maintain indices closer to the required model, on the one hand, and on the other, to return with spherical correction stimuli during a wrong move much better than those in the control group. The results suggest that systematic practice of psychomotricity can improve general development and cognition in children, and that implementing this methodology could thus be useful in educative intervention.

Keywords: psychomotor development; neuromuscular control; physical education; preschoolers; health

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1. Introduction

The objectives of this research started from the following questions, which were born from empirical observations made during work with children aged 4 to 6 years:

1. Are there differences in the formation of a psychomotor scheme in children aged 4–6 years who participate in physical exercises systematically and continuously compared to those who participate occasionally? How fast can a child aged 4 to 6 years manage to change movement parameters according to visual stimulus?

2. How long can children keep their attention focused after learning how much force to apply in motion and how much amplitude to give it? Are there differences in maintaining attention between those who exercise systematically and those who do so occasionally or not at all?

3. Does age and, therefore, the degree of psychomotor development influence neuromuscular control and the speed of adaptation of the motor act depending on the visual stimulus?

4. Is the conscious and concentrated performance of a motor act superior to a motor act that has become reflexive?

From these objectives, the following research hypotheses were outlined:

-The first hypothesis is to discover to what extent cortical stability is dependent, at the age of 4–6 years, on the practice of a systematic form of movement, by analyzing the proprioceptive sense and neuromuscular control.

-The psychomotor learning process, with real-time feedback, is superior to the time and quality of information processing in children aged 4 to 6 years who practice systematic exercise compared to those who do so occasionally.

-Maintaining attention in a system of information retrieval, i.e., learning, is different in children aged 4 to 6 years who practice systematic exercise compared to those who do it occasionally.

Psychomotor intervention is an activity that is performed in order to enhance an individual's potential development through the use of the body, in action and in motion [1].

This is a complex function that integrates and unites the motor and mental elements determining the regulation of the individual's behavior. It includes the participation of various mental processes, thus ensuring adequate performance of response to different situations/stimuli [2], as well as adequate psychomotricity [3]. Being a basic function with processes and phenomena of mental nature, psychomotor intervention is generated and expressed by involuntary movements of the body, influencing their application in actions [4].

Psychomotricity theories play an important role in the development of preschool children and are necessary for the educational process at this age, highlighting the possible combinations of conditioning and coordination of skills that characterize the motor-coordination component of human kinesthetic potential [5].

The selection of the most effective methods of physical activity defined not only by their contribution to the education of the main components of psychomotricity, but also by their structure and their degree of accessibility for the ages being researched represents a key step in the didactic strategy for the development of psychomotricity in children aged 4–6 years [6].

Psychomotor education is the beginning of the process of early childhood education. The learning disabilities detected in a child may cause psychomotor development delay [7].

In psychomotor activity, the movements and basic elements of gross and fine motricity are formed. Psychomotor education aims for the optimal development of psychomotricity components in children through the organized use of means, materials and methods corresponding to children's particularities and their level of training. Thus, the ability of the locomotor apparatus to manipulate various objects or to perform certain movements in relation to space and time relations bears the name of coordination [8].

Coordination–neuromuscular control is the ability of the human brain to engage in voluntary activities that engage one or more skeletal muscles. Optimal neuromuscular control requires increased involvement and attention, as well as awareness of the movements that are required to be performed [9]. Thus, the development of visual perception is achieved by identifying the presence and the degree of visual–perceptual deficit and visual integration in children aged between 4 and 12 [10].

The effects that occur in this process are:

- The child becomes aware of the gestural space through various sedentary positions, executed in diverse postures (horizontal and vertical positions of the arms in the straight position, the position of the legs);
- The child gets to know his body through manual contact (a priceless source of exteroceptive sensations) and through personal actions on their own body; the individualization of the body through manual contact personal actions on the child's own body, with left–right discrimination, executed by a child who has already gone through and passed the previous stages [11].

The essence of the research is to use the "hand–eye coordination" component of motor–eye coordination, which is defined as the ability of the vision system to analyze

and guide the information captured by the eyes to the upper limbs that are tasked with carrying out ordered actions, such as catching or throwing an object.

Recent studies have confirmed that hand–eye coordination is based on the ability of eye perception to aid the performance of a task by the hand [12–17]. For this to happen, the ability to perceive details, good control of the hand–eye coordination process and unaffected motor independence of the eyeball are necessary, because the hand movements must be as effective as possible. Weakness, instability, muscle tension or hypertonia are also causes that cannot be overlooked, as thanks to them the fine movements are transformed into interrupted or incorrectly performed movements along the amplitude trajectory [18].

Ages of 4 to 6 can be a degeneration factor in the neuromuscular coordination process, but physical activity performed with moderation tends to use both gross and fine motor skills and can successfully combat the effects of possible delays, aiming at optimal development of the neuromuscular system [19]. Controlling the action of the body and the hands is possible due to the level of intelligence, managing to give rise to the coordination process. This intelligence time concerns the actions performed by both the gross and the fine movements in which the body engages [20].

Cognitive therapy is the modification of the cognitive schemes of the subject [21]. The cognitive system's stimulus processing is made from physical characteristics (contour, color, dimensions, displacement, etc.) and semantic or functional characteristics (meaning, function, category to which it belongs, etc.). This characteristic of the cognitive system is called the ascending analysis of the stimulus. It contains both the properties of peripheral cognitive modules and the characteristics of the stimulus. The processing of this system, from the subject's knowledge to the physical properties of the stimulus, is called downstream analysis.

The computational level refers to the processing required for input-to-output transformations or the input–output function. It shows the exhaustive determination of the processes to which the data of the problem (input) for obtaining the solution (output) are subjected.

The primary processing of visual information is based on computational theory, which has an abstract, formal–mathematical character, and which logically and mathematically reflects the function by which a cognitive system makes an input to correspond to a specific output. This theory explains the reception of contours and three-dimensionality. Primary processing involves prenatal processing that represents the physical characteristics of the stimulus in the cognitive system. Processing at this level localizes the stimulus but does not characterize it.

Secondary visual perception contains mechanisms for recognizing figures and objects (their result is three-dimensionality and stimulus identification). Color processing is based on chemical and physical phenomena and mechanisms. Secondary processing in visual information (object recognition) has as input the intermediate sketch, and as output three-dimensional representations.

Recognition is the superposition of perceived object over its representation in memory; it is characterized by speed and flexibility. An important role in this is played by ascending analysis, but also downstream analysis. The relationship between intermediate representations and representations of objects is facilitated by spatial details or "non-incidental properties": the straight line, the curve, parallelism and symmetry.

The novelty of the study is to correlate the level of neuromuscular control with physical activity in the formation of visual–psychomotor schemes at this age.

The purpose is to determine whether the degree of psychomotor development with real-time feedback is superior in terms of the time and quality of information processing as an adaptation of the motor act according to the visual stimulus.

2. Materials and Methods

2.1. Study Lot

The participants were children aged between 4 and 6 years from private kindergartens in Brasov with teaching and activities in German and English at "Heidi Kindergarten and Maya and Montessori Kindergarten". The children came from a medium-to-high socio-economic environment, representing a homogeneous sample in terms of quality of life.

The research includes a cohort of 51 (26 boys and 25 girls) preschool children divided into two groups: The experimental group (LE) comprised 29 subjects who practiced systematized and continuous physical exercise for at least 1 year at least 2 times a week, and the other group 22 (the control group—LC) who practiced organized physical activities sporadically or not at all.

The sample consisted of: LE: 18 (62.07%) females and 11 (37.93%) males; LC: 7 (31.82%) females and 15 (68.18%) males. The average age was 5.06; the minimum age was 4.2 and the maximum age was 6.02.

The research was based on informed consent, which aims to inform parents about the research and includes the purpose, objectives, methods and procedures used, and there were no negative incidents during the experiment.

2.2. Procedure

In order to observe how the 4-to-6-year-old child's brain responds to a given stimulus, an ERGOSIM condition simulator that offers real-time feedback was used. ERGOSIM is a highly successful program based on a computer-assisted simulator. It was designed by the National Research Institute for Sport, Bucharest, Romania.

The novelty and originality of the device, which also gives it its uniqueness value, is its ability to analyze the motion parameters at work at the desired speed on an acceleration motion achievable in all planes at a multitude of angles with ideal amplitude, no forced return, as happens with classical devices (arc, chain, ribbon, etc.).

The realization of the psychomotor–visual schemes included the following procedures on ERGOSIM:

a. Test 1 (T1): Non-visual execution, Figure 1.

Figure 1. Non-visual execution, ERGOSIM.

Initial position: seated at the same time as holding the cane with two hands, grasping from above at shoulder width, arms outstretched. Performing 10 tractions (lowering the cane forward to the abdomen).

Generally, cortical stability followed the same route without any explanation. For this test, only the lines coming out of the pattern, the eccentric ones, were counted, which led to the percentage of cortical instability.

b. Test 2 (T2): The execution with visual stimulus in imitation of the model rendered by the simulator, Figure 2.

Figure 2. Execution with visual stimulus, ERGOSIM.

When testing T2, the difference from T1 was that the subjects received the information that the executed movement must draw a line as close to the model (Figure 3—yellow graph) 10 times. They did not receive any explanation as to how the movement should be done (how hard or slow to pull or how to reach their arms).

Figure 3. The visual–psychomotor scheme made without visual stimulus, Subject L. M.

Thus, subjects achieved 20 tractions, helmet type, assisted by ERGOSIM, on a given model. From the number of executions, 10 of these were executed without looking at the screen, being the first part of the T1 test, and in the next 10 (T2), the children tried to draw a drawing on the screen as close as possible to the given pattern. For each traction on the screen, a graph appears based on the amplitude, velocity, and force of the movement. For each movement on the screen, a line of a certain color appears—see Figure 3. The first strokes were set to appear on the monitor in green, then gradually to red until the end.

The first 5 tractions are colored with green shades from closed to open and the next 5 from orange to red very dark, so they can be evaluated individually from a bundle of 10.

When testing T1 (Figure 3), we can see 3 "atypical" blows, which are offset from the order chart for the other tractions. We notice that all the other 7 tractions have a fast ascending route of force (up to about 0.05–0.06 m), and the 3 tractions highlighted do not fit in the pattern of most orders. The one marked by the blue arrow has a slow ascending path; a force of 2dN is recorded at a position of 0.1 m. The ascent is long delayed compared to the rest of the tractions.

The traction highlighted by the yellow arrow also bends because it reaches 2 dN very late, i.e., at about 0.25 m, compared to most of the tractions, which reach this threshold of the model before 0.07 m.

The traction marked with the white arrow does not reach the value of the model and does not have a fast-ascending and slow-descending path. The appearance is closer to some force–position function.

Thus, the graph of proprioceptive sense with eyes open but without real-time feedback, as noted with note 7, is appreciated; the three strokes described above that reduce from the general pattern of beginnings for the others are subtracted from the total of 10.

The T2 test noted at which traction subjects managed to approach the model (the first traction they learn). Afterwards, until as many tractions as possible, subjects were concentrated on trying to follow the pattern (the first traction they look at). The total number of successful tractions (the note obtained by seeing the model) and maintaining the focus of attention (the number of the tractions maintain learning) was calculated by the difference between "the first traction they look at" and "the first traction they learn".

We appreciate the number of reactions that the subject's brain has been able to transmit commands to move the motion parameters to the given pattern.

Thus, for example, the green line, shown in Figure 4 with a yellow arrow, is the second or third traction in which the subject manages to send the command to the effectors. It is important to know that the brake on which the subject pulls was set to 0, because we did not want to test the strength of the children, but only their ability of neuromuscular control. It is knowns that using a large brake, neuromuscular control is easier to achieve, and the model is easier to reach; thus, any movement can be performed much more easily.

Figure 4. Visual–psychomotor scheme with real-time model tracking, Subject L.M.

The ideal of motricity is to perform different movements with the same amplitude and direction on a predetermined volume and intensity with minimal energy consumption.

Another example, in the graph above, is the red coral line, shown by the purple arrow (one of the last tractions). This was counted as good traction, because up to 15 cm, the subject managed to stay on the model, then between 16 and 30 cm he could not control it, but from 33 until the end, he again tried to reach the model (Figure 4).

2.3. Data Analysis

The results were processed with IBM SPPS Statistics 20 (Armonk, NY, USA). The statistical indicators used were arithmetic average (X), standard deviation (SD) and Student's *t*-test (*t*), for $p < 0.05$.

3. Results

This section presents the most relevant results and descriptive information of the study on the procedure for the realization of the visual–psychomotor schemes by the preschoolers included in our study.

Following statistical processing, the values of the statistical indicators presented in Table 1 were extracted from the SPSS outputs.

Table 1. Statistical description of the research activity indexes.

Group		No.	X	SD	Student Test t	*p*
Note without visual stimulus	LE	29	6.86	0.86	1.89	0.06
	LC	22	6.00			
The first traction he learns	LE	29	2.69	1.08	−1.79	0.08
	LC	22	3.77			
The first traction he looks	LE	29	7.14	1.59	1.92	0.06
	LC	22	5.55			
Visual stimulus note	LE	29	5.97	3.46	6.61	0.01
	LC	22	2.50			
The number of the tractions maintain	LE	29	4.45	2.67	4.33	0.01
	LC	22	1.77			

No.—number of subjects; X—Arithmetic average; SD—standard deviation; *t*-test; $p < 0.05$; LE—The experimental group; LC—The control group.

According to our study using the ERGOSIM simulator, the most important index was "visual stimulus note", which has a value of $t = 6.61$ and a significance threshold of $p < 0.01$. There were significant differences when participants had visual control and could use visual input to adjust their movement.

Another significant difference (Table 1) is "the number of tractions in which learning is maintained", at which the difference was 2.67 with $t = 4.33$ at $p < 0.01$, which shows that practicing systematic and continuous sports helps in concentrating attention over a longer period of time or returning to the task of learning based on previous learning.

In terms of "first learning traction" and "first shot look", differences are 1.08 and 1.59 with $t = 1.79$ and $t = 1.92$, respectively, for $p < 0.5$. Thus, practicing physical exercise in preschool children does not bring improvements to the requirements and processing of information until the problem is solved (learning), as well as when the task is performed over a longer period of time.

There are no notable gender differences for the values with high significance, so for the number of blows with visual stimulus, the boys had an average of 4.42 and the girls 4.52. The same is true for the number of the tractions, where the average value for boys was maintained at 3.27, and for girls 3.32. The advantage that girls have is imperceptible and may be due only to the seriousness of the approach to that activity.

Regarding differences according to age, and neuromuscular control increasing as biological age increases, we did not find a higher share of it with growth. We have grades of 7 and 8 at the age of 4.2 years (with visual stimulus) which we do not find at all at 6 years, and for the number of tractions, at the average age of 5.06 years, 5 children had an average of 5.20 tractions (the maximum age being 6.02 years). Thus, neither gender difference nor age differences influence the processing of information until the problem is solved and the task is performed.

4. Discussion

Through our results, our study helped to discover to what extent cortical stability is dependent, at the ages of 4–6 years, on the practice of a systematic form of movement by analyzing proprioceptive sense and neuromuscular control. The results of the study are in correlation with previous studies. The study highlighted the correlation between cortical stability (defined by strength, balance and attention–concentration) and individuals who exercise and those who do not, at the age of 4–6 years.

Although many studies have highlighted the importance of "hand–eye" research, the computational mechanisms underpinning these coordinated movements remain elusive [22,23].

The results of these studies show that sustained exercise contributes to increased performance [24] when visual cues are allowed, which is closer to real-life situations in which children can use their eyesight.

The possibility of evaluation and real-time observation of behavior allows an optimal intervention in the direction of psychological aspects [25].

Based on the importance of practicing physical activities systematically and continuously [26], the focus of the attention has increased over a longer period of time. From the point of view of the number of tractions maintained, our research shows that preschoolers return to the execution of the task imposed on the basis of previous learning (LE). In the case of LC, physical exercise does not bring improvements to the requirements and the processing of information until the problem is solved (learning), as well as when carrying out the task for a longer period of time.

A study aimed at assessing knowledge about visual motor integration determined that this is a vital ability in childhood development, which is associated with the performance of many functional skills, and this research confirms our aspects and results [27].

After all, the analysis of the research is the consequence of stabilizing the relationship between physical activity and the neuro-motor coordination of the subject. It is certainly more important to place emphasis on movement at this age, whether practiced under the supervision of a non-specialized framework in the field of physical education and sports, or the exaggerated strain in modern learning algorithms [28]. Cognitive learning [29,30], with this neurobiological base formed, will have a solid foundation in our study.

Limitations: In this paper, there are still some limitations:

Our study employed a small number of subjects, and expanding research could target pre-university cycles.

Cognitive factors contribute significantly to loss of attention, so children at the age of 4–6 years master many physical abilities that must be well correlated with specific activities performed in their own environments.

Strengths: The strengths of the study were the evaluation of the two groups through the complex ERGOSIM [31,32] conditions simulator at this age and the relevance of the results obtained and the findings of the study.

5. Conclusions

The study highlighted the idea that preschoolers, when they do not have a visual schema as required learning information, can maintain effective neuromuscular control over movements, developing similar strength–function position reports between successive repetitions. The application of research within the educational process has highlighted the importance of practicing systematic and continuous physical activities.

The results of the research allow referrals to the fact that based on visual schemes, by internal representations of physical and mental actions, these children in the experimental group evolved through assimilation and accommodation to superior neuromuscular control in order to approach the given model.

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Romanian Physical Education Teachers' Perception of Formative Feedback on Their Professional Competencies

Sorin DRUGAU[1]
Dana BADAU[2*]
Florentina NECHITA[3]
Raluca MIJAICA[4]
Adela BADAU [5]
Andrei Daniel IORDAN [6]
Robert STĂNCIULESCU [7]
George DINA[8]

[1*] "Transilvania" University of Brasov, Romania, https://orcid.org/0000-0003-1774-3487; sorin.drugau@unitbv.ro
[2] "Transilvania" University of Brasov, Romania, https://orcid.org/0000-0002-1881-3531; dana.badau@unitbv.ro
[3] "Transilvania" University of Brasov, Romania, https://orcid.org/0000-0002-3638-3934; florentina.nechita@unitbv.ro
[4] "Transilvania" University of Brasov, Romania, https://orcid.org/0000-0002-1071-8003; raluca.mijaica@unitbv.ro
[5] "Transilvania" University of Brasov, Romania, https://orcid.org/0000-0002-1656-5060; adela.badau@unitbv.ro
[6] "Dunarea de Jos" University of Galati, Romania, https://orcid.org/0000-0001-6422-2030; daniel.iordan@ugal.ro
[7] "Nicolae Balcescu" Land Forces Academy of Sibiu, Romania, https://orcid.org/0009-0005-7296-889; stanciuleascu.robert60@gmail.com
[8] National University of Physical Education and Sports of Bucharest, Romania, https://orcid.org/0009-0009-3913-2506; george.dina@gmail.com
[*] corresponding author: dana.badau@unitbv.ro

Abstract: *The main purpose was to identify the formative perception of disciplines studied within the bachelor programs in Physical Education and Sports (PES) on the professional competence provided in the qualification sheets of the National Register of Qualifications in Higher Education (NRQHE) for the occupational qualification of Physical Education Teacher in primary and secondary education levels. Ranking the disciplines outlined in the Romanian Agency for Quality Assurance in Higher Education standards for the program in PES based on their impact on professional competencies (PC). 412 teachers: 284 junior teachers group (JTG) and 128 permanent teachers group (PTG). Online was filled out the Questionnaire (QAFISPES) for assessing the ranking of the disciplines provided in the Romanian Agency for Quality Assurance in Higher Education standards on PC in PES, structured on 3 subscales corresponding to the typology of the disciplines: fundamental, PE field, and specialized. For the Fundamental Disciplines subscale, the highest score per rank was recorded by PES Theory and Methodology at 6.66 points; Basic Gymnastics had 5.75 points. For the subscale PE field disciplines, the greatest impact for PC in PES: the Theory and Practice of Athletics 11.25 points, the Theory and Practice of Gymnastics 11.08 points. For the subscale Specialized Disciplines, the most relevant contributions were made by the Methodology of Teaching Athletics in Schools 12.16 points, and the Methodology of Teaching Gymnastics in Schools 11.83 points. Establishing a hierarchy of disciplines based on their formative significance facilitates the optimal allocation of instructional hours within the bachelor's program's Physical Education and Sports (PES) curriculum.*

Keywords: *professional competence; junior teachers; permanent teaching; fundamental disciplines; PE field disciplines; specialized disciplines.*

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Introduction

The development of the teaching career requires the extension of the fund of professional competencies and specific knowledge to optimize the human, social, and, especially, teaching actional potentialities at the current standards of the educational environment (Baumgartner, 2022; Kovalenko et al., 2021; Tul et al., 2019; Souza Neto et al., 2017). The current trends in professional training at the academic level focus on developing and extending specialized professional competencies for teaching careers (Jones-Jofré et al., 2022; Ruiz-Montero et al., 2022). A major concern of the educational system is improving the quality of the teaching act. The teaching activity is directly influenced by the professionalism of the teaching staff and by the national and international level of visibility and recognition of the scientific activity of active teachers. Teachers should permanently focus on continuous and upward professional training and development, which must be directed toward deepening and expanding professional competencies (Ferry, 2018; Molina García et al., 2024a; Molina-García et al., 2024b).

Through its content, specificity, and complexity, the discipline of Physical Education and Sports presents a series of particularities regarding the methods of transferring theoretical knowledge in developing motor skills, which requires the efficient involvement of specialized teachers (Maksimović et al., 2023; Heck et al., 2021). The teaching of Physical Education and Sports is influenced by the level of pedagogical competence and theoretical knowledge of teachers (Salcines Talledo et al., 2024; Nasrulloh et al., 2022). The role of Physical Education and Sports within the context of integrated and unified quality education is clear, focusing on maximizing human potential in response to the demands of modern society and the professionalization of the teaching career (Ivanii, 2014; Feuerman, 2014).

Experts believe that professionalizing the teaching career establishes the foundation for developing a training and lifelong learning system within an integrated European context (Kougioumtzis et al., 2011; Kårhus, 2010). The evolution and dynamics of career and professional development rely on the expansion of specialized skills that facilitate the transition from theory to practice in real educational contexts (Gordon et al., 2015; O'Sullivan, 2018). Research has shown that the professionalization of the teaching career involves a complex and dynamic process through which teachers become aware of their professional roles and responsibilities and maintain a continuous focus on their professional development to meet current educational challenges and requirements (O'Sullivan, 2018; Pozo, 2018; Tatto, 2021).

The efficiency of an educational process depends on the competence level of teachers. This process of developing specialized pedagogical competence (PC) must start from the initial professional training stage, including bachelor's and master's studies, and continue into the early years of teaching (Jones-Jofré et al., 2023; Nasrulloh et al., 2022). Junior teachers need guidance and mentorship from experienced educators, as the future effectiveness of their teaching depends significantly on the quality of this mentoring process (Baumgartner, 2022; Griban et al., 2022; Goodwin, 2021).

Current professional teaching standards emphasize professionalizing the teaching career, deepening and expanding knowledge, and continuously developing the pedagogical competencies specific to Physical Education and Sports teachers (Lohmann et al., 2023; Lohmann et al., 2021; Goodwin, 2021; Abdelkafi et al., 2020). The professional training of teachers is a major educational goal for education systems. Its development and implementation involve several aspects that require optimization, such as increasing the duration of specialized practice during university studies, enhancing the qualifications of mentor teachers, and implementing a permanent and efficient mentoring process aligned with current educational standards and the professional development requirements of teachers (Nasário et al., 2020; Cañadas et al., 2020; Demir, 2015).

Professional competencies (PC) are developed through the disciplines included in the curriculum of the bachelor's program in Physical Education and Sports. These curricula must comply with the standards set by the Romanian Agency for Quality Assurance in Higher Education (RAQAHE) for the respective specialized field (RAQAHE, 2023; Solà Santesmases, 2021). The National Register of Qualifications in Higher Education (NRQHE) outlines six specific professional competencies (PC) for Physical Education and Sports (PES) (NRQHE, 2024). The design of educational plans requires a direct correlation between these six competencies and the disciplines accredited by RAQAHE.

The program coordinator determines each discipline's course hours, seminars, and practical work allocation. Our study is the first to explore PES teachers' formative perceptions regarding the correlation between professional competencies and the significance of subjects in undergraduate university curricula. The weight distribution among these disciplines should be informed by their formative impact on professional competencies. The effectiveness of the Physical Education and Sports (PES) discipline is influenced by multiple factors, including specific infrastructure and logistics, geographical location, teachers' professional experience, the limited duration of study, and the level of professional training attained after completing

undergraduate studies. Each aspect plays a crucial role in enhancing the efficiency of physical education activities and shaping teachers' perceptions of the PES discipline. This study contributes to the existing body of research by addressing a critical knowledge gap regarding how PES teachers evaluate the competencies acquired across various academic disciplines during their studies.

An examination of the curricula within the Romanian academic system reveals notable disparities in the distribution of course hours, seminars, and practical lessons across various programs. Enhancing the awareness of both novice and experienced teachers regarding their roles and responsibilities is essential for improving the overall effectiveness of the teaching process. Furthermore, identifying the disciplines that exert the most significant formative impact on developing teachers' professional competence profiles will serve as a foundation for optimizing the pedagogical framework in Physical Education and Sports (Duclos Bastías et al., 2023; Kida, 2019; Baghurst, 2015).

Establishing this hierarchy will, we believe, lead to a more balanced and fair allocation of time and content for disciplines in bachelor's programs based on their formative impact on developing professional competencies specific to Physical Education and Sports.

The goals of this study are:

- O1. Identifying the formative perception of the disciplines studied within the bachelor programs in Physical Education and Sports (PES) on the PC provided in the qualification sheets of the National Register of Qualifications in Higher Education (NRQHE) for the occupational qualification of Physical Education Teacher in primary and secondary education levels;
- O2. Ranking the disciplines outlined in the RAQAHE standards for the specialization program in Physical Education and Sports based on their formative perception on professional competencies, to develop a comprehensive profile of professional competence in Physical Education and Sports.

Study hypotheses:

- H01. The disciplines provided in the RAQAHE standards and implicitly in the curricula of the bachelor study programs of Physical Education and Sports contribute differentially to the training of specific PC (PC1-6) provided in the NRQHE qualification sheets in primary and secondary education;

- H02. By evaluating the formative impact of the disciplines included in the curricula for bachelor's study programs and, implicitly, in the RAQAHE standards, we aim to establish an accurate hierarchy of the disciplines based on their importance and typology.

Materials and Methods

Study design

In our cross-sectional research design, a questionnaire was applied. It analyzed a Questionnaire for assessing the formative perception (QAFISPES) of the junior teachers and permanent teachers provided in RAQAHE standards on professional competencies according to NRQHE qualification sheets for the Physical Education and Sports teachers at the secondary education level. The distribution of the questionnaire and the collection of the data were made online. Only fully completed questionnaires were quantified for the present study. This study complied with the principles of the Helsinki Declaration; the study was approved under protocol no. 400/06.12.2023 by Ethical Board of Faculty of Physical Education and Mountain Sports, Transilvania University of Brasov. All authors have contributed equally to this article and have equal contributions with the first author.

Participants

412 teachers participated in the study. They were divided into 2 groups: the junior teacher's group (mentored) (JTG) with 284 beginning teachers (121 females, 163 males; average age 22.4 years) and the permanent teacher's group (mentors)(PTG) with 128 teachers (52 females, 76 males; mean age 42.7 years). Depending on the counties where they teach Physical Education and Sports, the study teachers came from: Brasov - 66 teachers; Constanta - 60 teachers; Galati - 28 teachers; Covasna - 38 teachers; Mures 34 - teachers, Cluj - 63 teachers; Prahova - 13 teachers; Arges - 21 teachers; Iasi - 47 teachers; Bucharest - 44 teachers. Study inclusion criteria for junior teachers' group (JTG) were: age over 21 years; undergraduate studies completed with a bachelor's degree, active teachers teaching in the primary or secondary education system; full completion of the questionnaire. Study inclusion criteria for the group of permanent teachers (PTG) were: age over 30 years; bachelor's and master's studies completed with bachelors and master's degrees, active teachers teaching in the primary or secondary education system; minimum didactic degree II, full completion of the questionnaire. The strategy of cluster sampling was chosen for this study.

Teachers who partially completed the questionnaire were excluded from the study. Initially, several 427 teachers participated in the study, but only 412 (96.5%) teachers were included in the study, the remaining 15 (3.5%) teachers were eliminated because they did not out the questionnaire.

The questionnaire was applied between September 2023 and May 2024. The use of the Google Form Platform to disseminate the questionnaire and collect results was based on the email addresses of the dedicated groups of education teachers per the inclusion criteria. The completion of the questionnaire was restricted so that only one questionnaire was completed from a single email address, excluding repetitive completion.

The assessment tools

In the study, we used the questionnaire-based survey method, and the collected data were statistically processed to highlight relevant aspects. The questionnaire was named Questionnaire for assessing the formative perception of the disciplines provided in RAQAHE standards on professional competencies in Physical Education and Sports (QAFISPES). The questionnaire was designed on the Google Form platform. The questionnaire was carried out ad hoc. QAFISPES included 6 subscales corresponding to the 6 specific professional competencies provided in the NRQHE qualification sheet for the teacher of Physical Education and Sports in secondary education:

Professional competencies (PC):

- PC1 Modular designing and planning of basic contents of the field with interdisciplinary orientation;
- PC2 Organizing of integrated curriculum and instructional and learning environment, with interdisciplinary focus;
- PC3 The evaluation of physical growth and development and motor quality according to PES-specific requirements and the attitude towards independent practice of physical exercises;
- PC4 The description and demonstration of the operational systems specific to Physical Education and Sports (PES), by age groups;
- PC5 The assessment of the training level of the PES practitioners;
- PC6 The use of the specific management and marketing elements in this field.

Questionnaire scores were evaluated for the six subscales related to Physical Education competency. Only the compulsory disciplines included in most bachelor's programs in Physical Education and Sports from profile

faculties in Romania were assessed. The disciplines were structured according to the distribution from the RAQAHE standards into: fundamental disciplines (7); PE field disciplines(12) and specialized disciplines (14). Each subject was evaluated according to the formative perception of PC according to the Likert scale with a score from 1 to 5 where: 1 point – not at all; 2 points - very little; 3 points – a little; 4 points – a lot; 5 points – very much. The ranking of the disciplines - To rank the disciplines, a rank will be granted in descending order depending on the arithmetic average recorded (for example: for fundamental disciplines, which are 7 disciplines, 7 ranks will be provided, where rank 7 will be granted to the subject with the greatest formative perception in the formation of PC of PES teachers and rank 1 will be granted for the least relevant subject in terms of PS). For fundamental disciplines 7 ranks will be granted, for PE field disciplines 12 ranks will be granted and for the specialized disciplines will be granted 14 ranks. The arithmetic mean between the rank evaluations of the two samples included in the study shall be calculated. The final average value will be the final benchmark value for ranking the disciplines according to the formative perception of the development of the professional competencies of the PES teachers.

The Statistical Analysis of Data

We used SPSS 24 software to calculate the following statistical parameters: arithmetic mean (X), difference in arithmetic means (ΔX), Cronbach's Alpha for internal consistency; Cronbach's Alpha value of over 0.8 was considered appropriate for the present study. To rigorously assess the validity and reliability of the questionnaire, Cronbach's Alpha was utilized as a metric of internal consistency. The analysis yielded a coefficient exceeding 0.8, signifying a high degree of reliability and demonstrating strong internal coherence among the measured constructs. This result substantiates the robustness of the instrument, ensuring its suitability for accurately capturing and evaluating the targeted dimensions within this study.

Results

The statistical indicator Cronbach's Alpha (α) ranged between 0.940 and 0.986 (Table 1) at all subscales of the Questionnaire for assessing the formative perception of the disciplines studied and included in the RAQAHE standards on professional competencies in PES provided in the NRQHE qualification sheet (QAPCPEST), the internal consistency was very

good. Cronbach's Alpha values reflected that the questionnaire results were statistically validated for both groups of the study (JTG and PTG).

Table 1. Internal consistency of the Questionnaire for assessing the formative perception of disciplines included in RAQAHE standards on specific professional competencies from the NRQHE qualification sheet in PES (QAFISPES).

PES professional competencies	JTG	PTG
	Cronbach's alpha	Cronbach's alpha
PC1 Modular designing and planning of basic contents of the field with an interdisciplinary orientation	.940	.956
PC2 Organising of integrated curriculum and instructional and learning environment, with an interdisciplinary focus	.953	.957
PC3 The evaluation of physical growth and development and motor quality according to PES-specific requirements and the attitude towards independent practice of physical exercises	.959	.969
PC4 The description and demonstration of the operational systems specific to Physical Education and Sports (PES), by age groups	.964	.976
PC5 The assessment of the training level of the PES practitioners	.963	.975
PC6 The use of the specific management and marketing elements in this field	.970	.985

JTG –junior teachers group; PTG –teachers group; PC – professional competence

In Table 2 we highlighted the arithmetic averages (x) and the ranks of the main disciplines from RAQAHE standards for all 6 professional competencies specific to the Physical Education and Sports teacher from secondary education. For JTG, the subject PES Theory and Methodology scored highest for all professional competencies PC1-6, rank 7. For PTG, PES Theory and Methodology has a major formative role for PC1-3. Respectively for PC4-6 the Basic Gymnastics subject was considered the most important (rank 7). The Kinesiology discipline had the lowest score for JTG; for all PCs, it ranked 1. For PTG, the lowest score was Kinesiology, rank 1 at PC1,2,3,6, and Health Education and First Aid subject at PC4,5.

Table 2. Descriptive statistics - Questionnaire for assessing the formative perception of the main disciplines from RAQAHE standards on professional competencies (PC) in PES

Main disciplines		PC1		PC2		PC3		PC4		PC5		PC6	
		X	R	X	R	X	R	X	R	X	R	X	R
Kinesiology	JTG	2.74	1	3.06	1	3.13	1	2.97	1	2.95	1	2.94	1
	PTG	2.57	1	2.53	1	2.74	1	2.87	2	2.81	2	2.76	1
Psychopedagogy	JTG	2.94	2	3.65	3	3.33	2	3.20	3	3.15	3	3.12	3
	PTG	3.12	3	3.14	3	2.87	3	2.94	3	2.95	3	2.88	3
PES Theory and Methodology	JTG	4.19	7	3.77	7	3.85	7	3.76	7	3.73	7	3.71	7
	PTG	4.28	7	3.66	7	3.27	7	3.34	5	3.35	6	3.27	7
Health Education and First Aid	JTG	3.30	3	3.46	2	3.18	3	3.05	2	2.99	2	2.98	2
	PTG	3.11	2	2.98	2	2.80	2	2.83	1	2.80	1	2.79	2
General Basics of Athletics	JTG	3.59	4	3.66	4	3.72	4	3.54	5	3.54	4	3.50	4
	PTG	3.95	5	3.36	5	3.35	5	3.37	6	3.34	5	3.19	5
Basic Gymnastics	JTG	4.17	5	3.76	6	3.72	5	3.54	4	3.56	5	3.51	5
	PTG	3.98	6	3.38	6	3.41	6	3.49	7	3.48	7	3.30	6
Scientific Foundations of Sports Games: Basketball, handball, volleyball, football	JTG	4.18	6	3.76	5	3.76	6	3.63	6	3.62	6	3.58	6
	PTG	3.61	4	3.14	4	2.98	4	3.07	4	3.06	4	3.02	4

JTG –junior teachers group; PTG –teachers group; R- rank of disciplines; X- arithmetic mean.

For field disciplines, we found that JTG considered the Theory and Practice of Gymnastics' Branches subject as having the greatest formative perception on PC1, (x=3.66; rank 12); and the Theory and Practice of Athletics subject had a major formative perception on PC2-6. The PTG considered that the Theory and Practice of Athletics subject (rank 12) contributed most to the formation of all PC of the PES teachers in secondary education (Table 3). The lowest arithmetic averages, respectively rank 1, were recorded by JTG for: PC1,2,4 in the Theory and practice in combat sports subject, respectively in the Functional Anatomy subject for PC3,5,6. In the case of PTG, the most irrelevant disciplines (rank 1) with a formative role in the formation of PC were: the Theory and Practice of Combat Sports subject for PC1,2,3,5, the Functional Anatomy subject for PC4, respectively the Theory and Practice in Water Sports subject for PC6 (Table 3). We consider that the disciplines that have a low formative perception of the professional competencies of the PES teacher are because they are not provided in the national curriculum at PES for primary and secondary school and, in this context, the disciplines of the study consider them to have a low formative contribution.

Table 3. Descriptive statistics - Questionnaire for assessing the formative perception of the disciplines from RAQAHE standards on PC in PES

PE field disciplines		PC1		PC2		PC3		PC4		PC5		PC6	
		X	R	X	R	X	R	X	R	X	R	X	R
Motor and Somato-Functional Assessment	JTG	3.64	10	3.46	8	3.50	8	3.40	7	3.41	8	3.37	8
	PTG	3.11	8	3.03	8	2.76	5	2.95	10	2.98	10	2.91	2
Functional Anatomy	JTG	3.28	8	3.46	9	3.17	1	3.09	2	3.11	1	3.09	1
	PTG	3.20	11	3.14	10	2.88	7	2.85	1	2.84	5	2.80	6
Physiology	JTG	3.26	4	3.27	3	3.44	6	3.39	10	3.37	7	3.36	7
	PTG	3.20	10	3.13	9	2.99	10	2.98	2	2.95	9	2.90	11
Theory and Practice of Athletics	JTG	4.16	11	3.86	12	3.91	12	3.75	12	3.75	12	3.70	12
	PTG	3.89	12	3.34	12	3.15	12	3.16	12	3.16	12	3.03	12
Theory and Practice of Gymnastics Branches	JTG	3.76	12	3.86	11	3.82	11	3.73	11	3.73	11	3.69	11
	PTG	3.13	9	3.20	11	3.10	11	3.13	11	3.13	11	3.04	5
Theory and Practice of Winter Sports	JTG	3.16	3	3.28	6	3.53	9	3.44	9	3.43	9	3.42	9
	PTG	2.70	4	2.72	4	2.73	4	2.84	4	2.82	4	2.88	9
Theory and Practice of Water Sports	JTG	3.27	5	3.38	7	3.46	7	3.37	4	3.36	5	3.35	5
	PTG	2.92	7	2.91	6	2.80	6	2.95	9	2.91	7	2.93	1
Theory and Practice of Combat Sports	JTG	2.76	1	3.08	1	3.26	2	3.17	1	3.17	2	3.17	2
	PTG	2.20	1	2.23	1	2.40	1	2.52	5	2.48	1	2.59	3
Theory and Practice of Expressive Sports	JTG	3.28	7	3.28	5	3.40	5	3.38	3	3.36	6	3.36	6
	PTG	2.70	3	2.66	2	2.59	2	2.79	6	2.74	2	2.80	8
Practical Lessons in Winter Sports	JTG	3.16	2	3.18	2	3.38	4	3.32	5	3.31	4	3.31	4
	PTG	2.64	2	2.67	3	2.91	8	2.95	7	2.93	8	2.92	10
Practical Lessons in Water Sports	JTG	3.27	6	3.28	4	3.26	3	3.29	6	3.27	3	3.27	3
	PTG	2.86	5	2.88	5	2.91	9	2.94	3	2.91	6	2.96	4
Theory and Practice of Other Sports	JTG	3.38	9	3.58	10	3.64	10	3.59	8	3.57	10	3.55	10
	PTG	2.91	6	2.95	7	2.73	3	2.76	8	2.77	3	2.82	2

JTG –junior teachers group; PTG –permanent teachers group; R- rank of disciplines; X- arithmetic mean.

According to Table 4, we found that the specialized subject with the greatest formative role for PTG was the Internship in Educational Units subject for PC1-6 (rank 14) because it is the subject in which theoretical concepts are applied in concrete conditions of teaching PES in school to different classes of primary or secondary school students. In the case of JTG, the situation is

different compared to PTG, They considered that for PC1 and PC6 the most important formative role was played by the Methodology of Teaching Gymnastics in Schools subject (rank 14); for PC2 by the Methodology of Teaching Basketball in Schools subject (x=4.28; rank 14); for PC3 and PC5 by the Methodology of Teaching Athletics in Schools subject (rank 14); for PC4 by the Fitness subject (X=3.74, rank 14). The differences between PTG and JTG regarding the disciplines with the greatest formative role of PC were due to practical experience in schools. PTG appreciated the experience gained during specialized practice. JTG appreciated various disciplines (Athletics, gymnastics, sports games, and fitness), which they considered to have increased applicability in school based on their experience during undergraduate studies and reduced teaching experience in school. For both groups of the study, the lowest formative input regarding the PC specific to the PES teacher had the disciplines (rank 1): Fitness for PC1 and Leisure Motor Activities for PC4,5,6. For PC2, JTG considered that the Body Expression and Eurythmy subject is the most irrelevant from the point of view of training PC, and for PTG, the Internship in Tourism Activities subject was the most irrelevant. We noticed that both groups rated almost the same the disciplines with the lowest formative perception of professional competencies, with one exception for PC2.

Table 4. Descriptive statistics - Questionnaire for assessing the formative perception of specialized disciplines from RAQAHE standards on PC in PES

Specialized disciplines		PC1		PC2		PC3		PC4		PC5		PC6	
		X	R	X	R	XD	R	X	R	X	R	X	R
Adapted motor activities	JTG	3.48	3	3.58	6	3.62	10	3.61	10	3.60	9	3.57	9
	PTG	3.25	6	3.20	6	3.09	8	3.17	6	3.19	6	3.15	9
Leisure Motor Activities	JTG	3.50	4	3.38	2	3.35	1	3.37	1	3.35	1	3.33	1
	PTG	2.83	3	2.80	4	2.63	1	2.75	1	2.73	1	2.79	1
Body Expression and Eurythmy	JTG	3.59	6	3.35	1	3.44	2	3.70	12	3.44	3	3.50	11
	PTG	3.03	5	3.06	5	3.04	5	3.00	5	3.01	5	2.97	3
Fitness	JTG	3.38	1	3.56	5	3.53	4	3.74	14	3.54	4	3.42	3
	PTG	2.77	1	2.78	2	2.90	4	2.77	2	2.80	2	2.82	2
Methodology of Teaching Athletics in Schools	JTG	4.38	13	3.77	10	3.82	14	3.56	6	4.22	14	3.67	13
	PTG	4.02	13	3.45	12	3.21	12	3.42	13	3.38	13	3.20	13
Methodology of Teaching Basketball in Schools	JTG	3.77	12	4.28	14	3.64	8	3.56	5	3.55	5	3.52	7
	PTG	3.34	10	3.31	10	3.06	6	3.23	7	3.20	7	3.10	7
Methodology of Teaching Football in Schools	JTG	3.66	9	3.78	13	3.46	3	3.45	2	3.44	2	3.41	2
	PTG	3.25	8	3.23	8	3.13	9	3.30	10	3.26	9	3.14	8
Methodology of Teaching Gymnastics in	JTG	4.39	14	3.78	12	3.82	13	3.46	3	3.71	13	3.68	14
	PTG	3.52	12	3.46	13	3.22	13	3.34	12	3.30	12	3.17	11

Schools													
Methodology of Teaching Handball in Schools	JTG	3.69	11	3.67	8	3.55	6	3.58	9	3.56	8	3.52	6
	PTG	3.33	9	3.30	9	3.16	10	3.31	11	3.27	10	3.17	10
Methodology of Teaching Volleyball in Schools	JTG	3.68	10	3.68	9	3.55	5	3.58	8	3.56	7	3.51	5
	PTG	3.25	7	3.23	7	3.09	7	3.23	8	3.20	8	3.10	6
Practice and Methodology of Motor Activities by Age Groups	JTG	3.61	7	3.78	11	3.73	11	3.73	13	3.71	12	3.66	12
	PTG	3.50	11	3.42	11	3.18	11	3.29	9	3.29	11	3.20	12
Internship in Tourism Activities	JTG	3.48	2	3.49	4	3.62	9	3.57	7	3.55	6	3.55	8
	PTG	2.80	2	2.78	1	2.82	2	2.84	4	2.81	4	3.03	5
Internship in Leisure Facilities	JTG	3.59	5	3.49	3	3.64	7	3.55	4	3.63	11	3.62	4
	PTG	2.89	4	2.88	4	2.87	3	2.82	3	2.80	3	3.01	4
Internship in Educational Units	JTG	3.66	8	3.67	7	3.73	12	3.64	11	3.62	10	3.61	10
	PTG	4.28	14	4.15	14	4.01	14	4.09	14	4.09	14	3.97	14

JTG –junior teachers group; PTG –permanent teachers group; R- rank of disciplines; X- arithmetic mean.

According to Table 5, analyzing the results for PC1-6, we found that the arithmetic means of JTG were higher than those recorded by PTG at all subscales corresponding to the disciplines' typology. For PC1, the most significant differences between JTG and PTG occurred at subscales of the PE field and specialized disciplines with 0.41 points. The most considerable average difference was for subscales PE Field disciplines at PC2 with 0.50 points, PC3 with 0.57 points, PC4 with 0.50 points, PC4 with 0.51 points, and PC6 with 0.50 points. Analyzing Cronbach's alpha values, we found that at all the subscales of the questionnaire, for all the professional competencies (PC1-6), the values ranged between 0.802 and 0.979, which reflects a very good internal consistency. Cronbach's Alpha values reflected that the questionnaire results were statistically validated for both groups of the study (JTG and PTG).

Table 5. The statistical analysis of PC about the disciplines' typology

PC	Disciplines' typology	Group	X	ΔX (JTG-PTG)	Cronbach's alpha
PC1	Fundamental disciplines	JTG	3.47	0.23	.803
		PTG	3.24		.802
	PE Field disciplines	JTG	3.32	0.41	.933
		PTG	2.91		.952
	Specialized disciplines	JTG	3.63	0.41	.911
		PTG	3.21		.922
PC2	Fundamental disciplines	JTG	3.58	0.41	.880
		PTG	3.17		.804
	PE Field disciplines	JTG	3.41	0.50	.894
		PTG	2.90		.950
	Specialized disciplines	JTG	3.62	0.44	.894
		PTG	3.18		.923
PC3	Fundamental disciplines	JTG	3.52	0.46	.802
		PTG	3.05		.814
	PE Field disciplines	JTG	3.40	0.57	.943
		PTG	2.82		.948
	Specialized disciplines	JTG	3.60	0.54	.909
		PTG	3.06		.946
PC4	Fundamental disciplines	JTG	3.38	0.25	.844
		PTG	2.12		.820
	PE Field disciplines	JTG	3.40	0.50	.954
		PTG	2.90		.963
	Specialized disciplines	JTG	3.57	0.39	.961
		PTG	3.14		.952
PC5	Fundamental disciplines	JTG	3.36	0.25	.838
		PTG	3.11		.811
	PE Field disciplines	JTG	3.40	0.51	.949
		PTG	2.88		.959
	Specialized disciplines	JTG	3.56	0.43	.961
		PTG	3.13		.959
PC6	Fundamental disciplines	JTG	3.33	0.30	.867
		PTG	3.02		.925
	PE Field disciplines	JTG	3.38	0.50	.961
		PTG	2.88		.979
	Specialized disciplines	JTG	3.54	0.44	.966
		PTG	3.09		.967

PC – professional competence, X- arithmetic mean, ΔX – difference of arithmetic means between groups, JTG – junior teachers group, PTG – permanent teachers group.

Based on the ranks assigned to the disciplines included in each subscale about the arithmetic means, we made a hierarchy of disciplines on subscales to highlight the importance of these disciplines in terms of the

formative aspect of the professional competencies of the PES teacher in the secondary education cycle. We found that for the Fundamental Disciplines' subscale, the highest score per rank 7 was recorded by PES Theory and Methodology with 6.66 points, followed by Basic Gymnastics with 5.75 points and by Scientific Fundamentals of Sports Games: basketball, handball, volleyball, and football with 4.91 points. In the opinion of the study disciplines, for the subscale Fundamental Disciplines, Health Education and First Aid with 2 points and Kinesiology with 1.16 points (Table 6) had the lowest impact in PC training. For the subscale PE field disciplines, we found that the Theory and Practice of Athletics, with 11.25 points, the Theory and Practice in Branches of Gymnastics, with 11.08 points, and the Motor and Somato-Functional Evaluation, with 7.91 points, had the greatest formative role for the PC in PES. The following undergraduate disciplines contributed the least to the training of PC: the Theory and Practice in Expression Sports with 5.50 points, and the Theory and Practice in Combat Sports with 1.66 points.

In Table 6, for the subscale, Specialized disciplines were recorded as the highest ranks, reflecting a major formative perception on PC at the Methodology of Teaching Athletics in School with 12.16 points, the Methodology of Teaching Gymnastics in Schools, and Internship in Educational Units with 11.83 points. Fitness recorded the lowest formative role in the subscale Specialized Disciplines with 3.67 points and Leisure Motor Activities with 1.75 points. This hierarchy of disciplines corresponding to the three subscales will facilitate understanding the formative perception. It will implicitly contribute to rethinking the content and the number of hours assigned for courses, seminars, and practical lessons for all disciplines. The better ranking of some disciplines is related to the formative role in the perception of PES teachers. The ranking of the disciplines will have to determine the allocation of a more significant number of course hours or practical work in the curricula for the bachelor's program. Increasing the workload of the disciplines will ensure the training of the specific professional skills necessary for teaching PES in the school.

Table 6. The ranking of the disciplines according to X – ranks in the Questionnaire for assessing the formative perception of the disciplines from RAQAHE standards on professional competencies (PC) training in PES in both groups of the study (PTG and JTG)

Professional competence	PC1	PC2	PC3	PC4	PC5	PC6	XPC
Disciplines	Rank of disciplines						
Fundamental disciplines							
Theory and Methodology of PES	7	7	7	6	6.5	6.5	6.66
Basic Gymnastics	5.5	6	5.5	5.5	6	6	5.75
Scientific Foundations of Sports Games: Basketball, handball, volleyball, football	5	4.5	5	5	5	5	4.91
General Basics of Athletics	4.5	4.5	4.5	5.5	4.5	4.5	4.66
Psychopedagogy	2.5	3	2.5	3	3	3	2.83
Health Education and First Aid	2.5	2	2.5	1.5	1.5	2	2.00
Kinesiology	1	1	1	1.5	1.5	1	1.16
PE Field disciplines							
Theory and Practice of Athletics	11.5	12	12	12	12	8	11.25
Theory and Practice of Gymnastics Branches	10.5	11	11	11	11	12	11.08
Motor and Somato-Functional Assessment	9	8	6.5	8	9	7	7.91
Physiology	7	6	8	8.5	8	5	7.08
Theory and Practice of Other Sports	7.5	8.5	6.5	6	6.5	5.5	6.75
Theory and Practice of Winter Sports	3.5	5	6.5	6.5	6.5	12	6.66
Functional Anatomy	9.5	9.5	4	3	3	9	6.33
Theory and Practice of Water Sports	6	6.5	6.5	6	6	6.5	6.25
Practical Lessons in Winter Sports	2	2.5	6	6.5	6	12	5.83
Practical Lessons in Water Sports	5.5	4.5	6	4.5	4.5	8	5.50
Theory and Practice of Expressive Sports	5	3.5	3.5	4.5	4	12.5	5.50
Theory and Practice of Combat Sports	1	1	1	1.5	1.5	4	1.66
Specialized disciplines							
Methodology of Teaching Athletics in Schools	13	11	13	9.5	13.5	13	12.16
Methodology of Teaching Gymnastics in Schools	13	12.5	13	7.5	12.5	12.5	11.83
Internship in Educational Units	11	10.5	13	12.5	12	12	11.83
Practice and Methodology of Motor Activities by Age Groups	9	11	11	11	11.5	12	10.92
Methodology of Teaching Handball in Schools	10	8.5	8	10	9	8	8.91
Methodology of Teaching Basketball in Schools	11	12	7	6	6	7	8.16
Adapted motor activities	4.5	6	9	8	7.5	9	7.33
Methodology of Teaching Volleyball in Schools	8.5	8	6	8	7.5	5.5	7.25
Methodology of Teaching Football in Schools	8.5	10.5	6	6	5.5	5	6.91
Body Expression and Eurythmy	5,5	3	3,5	8,5	4	7	5.25

Internship in Leisure Facilities	4.5	3.5	5	3.5	7	4	4.58
Internship in Tourism Activities	2	2.5	5.5	5.5	5	6.5	4.50
Fitness	1	3.5	4	8	3	2.5	3.67
Leisure Motor Activities	3.5	3	1	1	1	1	1.75

PC – professional competence.

Discussion and limit

The first purpose of the study was to identify the formative perception of the disciplines studied within the bachelor programs in Physical Education and Sports (PES) on the PC provided in the qualification sheets of the National Register of Qualifications in Higher Education (NRQHE) for the occupational qualification of Physical Education Teacher in primary and secondary education levels. The results show that the disciplines from the RAQAHE standards contribute to different PC training for PES teachers. Also, there were differences of opinion in assessing the formative perception of PC depending on the typology of disciplines between study groups (PTG and JTG). Thus, PTG emphasizes disciplines that make the transfer between theory and current practice specific to PES teaching in schools. At the same time, JTG values more disciplines with a higher degree of attractiveness, based on experience in undergraduate studies and their little teaching experience in school.

The secondary purpose of our study is to rank the disciplines outlined in the RAQAHE standards for the specialization program in Physical Education and Sports based on their formative perception of professional competencies to develop a comprehensive profile of professional competence in PES. This ranking aimed to create a profile of professional competencies in PES. Using the study results, we categorized the disciplines into the three groups provided in the RAQAHE standards (fundamental, PE field, and specialized disciplines). We ranked them according to their formative role in developing the professional competencies of PES teachers. This hierarchy supports revising and optimizing curriculum content and its distribution for university-level PES specialization programs.

The study complements previous research highlighting the importance and necessity of updating the process of training professional competencies to align with current school contexts (Quilindo, 2023; Asún et al., 2020; Ward et al., 2016; Ennis, 2013). In the Romanian school system, Athletics, Gymnastics, and Sports Games (handball, basketball, volleyball, and football) are the main activities (Murathan, 2017; Kovač et al., 2008). Various studies have explored integrating holistic approaches in teaching physical exercises, enabling students to adapt effectively to new practice contexts (Yildiz et al., 2021; Murathan, 2017;

Kovač et al., 2008; Richardson et al., 2018). The traditional approach to training professional competencies in PES must continuously evolve to meet modern educational requirements and adapt to emerging practice forms, such as fitness (Huhtiniemi et al., 2022; Davis, 2020).

We believe that the curricula specific to bachelor programs in PES should be updated periodically to align with societal needs (Protsenko et al., 2024; Ponciano Nuñez et al., 2023, Shivoro et al., 2017; Marinho et al., 2017) and modernize teaching and exercise activities (Protsenko et al., 2024; Gheorghe et al., 2023; Harju et al., 2016). Studies conducted in various European countries have examined the correlation between the professional competencies of PES teachers and different professional training factors, including training volume, the compactness of specific content, and the typology of disciplines (Hurtado Almonacid et al., 2024; Protsenko et al., 2024; Ahmed et al., 2017; Litoi, 2016). These studies have highlighted differences in competencies among PES teachers based on curriculum content and experience level, consistent with our study's findings on the importance of aligning professional competencies with the number of hours allocated to PES degree program disciplines (Hurtado Almonacid et al., 2024; Protsenko et al., 2024; Cañadas et al., 2019; Ahmed et al., 2017).

Study limits

The limitations of the study: active students in the I-III years of their Field' in PES and future teachers were not included in the study; the analysis of transversally specific competencies was not targeted; the geographic location where the disciplines of the study came from (urban or rural) was not taken into account, the school infrastructure where the disciplines teach was not taken into account; the material base influences the way of organizing the teaching process and the typology of physical activities; the optional disciplines were not included in the evaluation due to their diversity in the curricula; the urban or rural environment of the schools where the teachers come from was not analyzed in the study; the reasons why there are differences in the ranking of PES disciplines according to PC between JTG and PTG have not been analyzed.

Practical implication

The allocation of hours to courses, seminars, and practical lessons should be aligned with the formative perception of professional competencies (PC) among Physical Education and Sports (PES) teachers in the gymnasium education cycle. This original contribution aims to facilitate the reassessment of curricular content and enable the restructuring of time

and resource allocation for each subject within the curricula of specialized faculties. Such adjustments will enhance their impact on the development of specialized professional competencies, thereby optimizing teacher preparation and instructional effectiveness.This study addresses an important issue in the training of PES teachers because depending on the formative perception of the subjects studied, the weight of the subjects in the curriculum should be restructured; the practical experience of teachers in schools should be the main criterion for allocating the number of hours for each specific discipline of the PED program: until now, no study has been carried out to rank the disciplines according to their formative role for teachers, the distribution of hours for each the discipline being at the discretion of the study program coordinator; the study results should be taken into account for the modernization of the PES curriculum.

Conclusions

The site study's results reveal differences of opinion in assessing the formative perception of PC depending on the typology of the disciplines between study groups (PTG and JTG). Thus, PTG emphasizes the disciplines that make the transfer between theory and current practice specific to PES teaching in schools. At the same time, JTG values the disciplines with a higher degree of attractiveness based on their experience in undergraduate studies and the reduced teaching experience in schools. Based on the relevant results, we identified the formative perception of the compulsory disciplines provided in the RAQAHE standards for the specialization of Physical Education and Sports about the specialized PC provided in the NRQHE qualification sheets for the teacher of Physical Education – secondary education.

The Disciplines were structured as in RAQAHE standards into fundamental disciplines, PE field disciplines, and specialized disciplines, and the granting of the ranks according to the arithmetic average recorded in the study allowed us to rank these disciplines from the perspective of their formative perception on the development of PC of PES teachers. The results of the study reveal that the disciplines with the greatest formative role on the PC of PES teachers were the fundamental disciplines: the PES Theory and Methodology, Basic Gymnastics, the Scientific Foundations of Sports Games Basketball, Handball, Volleyball, Football the PE field disciplines: the Theory and Practice of Athletics, the Theory and Practice of Gymnastics' Branches, the Motor and Somato-Functional Evaluation; among the specialized disciplines: the Methodology of Teaching Athletics in Schools, the Methodology of Teaching Gymnastics in Schools and the

Internship in Educational Units. The lowest formative role on PC, on subscales, has the disciplines Kinesiology, Theory, and Practice in Combat Sports, respectively, the Motor Leisure Activities.

Currently, the distribution of hours by subjects in the bachelor's programs in Physical Education and Sport (EPS) curricula is determined not by their formative significance but by the administrative preferences of the department heads when they constitute the didactic norms. This approach may negatively affect professional skills development in future PES teachers, as the training volume does not align with current teaching requirements in schools. The ranking of the disciplines according to their formative role will be able to determine the improvement of allocating the weight of hours (the number of course hours and seminars/practical work) for each discipline in the PES curriculum for the bachelor's program.

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Article

The Multiplicative Effect Interaction between Outdoor Education Activities Based on the Sensory System

Veronica Mindrescu [1], Gabriel Simion [1,*], Ioan Turcu [1,*], Cristian Catuna [2], Dan Gheorghe Paun [2] and Florentina Nechita [1,*]

[1] Faculty of Physical Education and Mountain Sports, Transylvania University Brasov, 500036 Brasov, Romania
[2] Faculty of Physical Education and Sports, Spiru Haret University, 030045 Bucharest, Romania
* Correspondence: gabriel.simion@unitbv.ro (G.S.); ioan.turcu@unitbv.ro (I.T.); florentina.nechita@unitbv.ro (F.N.); Tel.: +40-722-416-423 (G.S. & I.T.)

Abstract: *Background:* The present paper initiates the introduction of physical education activities within the Transylvania University of Brașov, aiming at a new strategy. The purpose is identifying the level of knowledge and the level of perception regarding the extent to which outdoor activities are viewed and implemented, and the effects that the latter has on them by tracking certain variables of a sensory nature, comprised of visual, auditory, kinesthetic and digital areas. *Methods:* This research aims to analyze if the type of sensory channel is influenced by the type of sport and the environment (urban/rural) of that practiced sport. We also analyzed the benefits offered by different sports and if these benefits influence the type of activity. Data were collected using an online survey, a questionnaire, using a Likert scale, with subjects having to choose between multiple answers. In addition, data were allocated and reviewed based on a sample of 100 students who have the habit of practicing outdoor activities. *Results:* The results of the study significantly show that the objectives were met and as such it can be concluded that outdoor activities, from the point of view of perception systems, can be classified according to the method of ordering the rank of activities by the dominant kinesthetic sensory channel.

Keywords: multiplicative effects; interaction; outdoor education; sensory systems

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1. Introduction

Outdoor education as a form of education comprises, alongside the learning factor, its experiential aspect and its setting, because it is primarily conducted outside, as well as the concept of senses and how they are perceived and used in all their characteristics and domains [1]. Education effectuated outside, in a natural environment, has started to put quite a lot of emphasis on the perception of the senses, whereas this perception is made based on different feelings experienced outside or based on factual observation and the dualistic aspect of the cause-effect relationships arisen within the undertaking of different outdoor activities [2].

Referring to outdoor education activities, it is necessary to point out that the major objective, almost unique, is acknowledging and surpassing one's limits; victory, as an objective that comes from the accomplishment of each individual, is also pointed out [3]. This need represents an energizing part of the outdoor education activity, leading to obtaining a certain high level of self-esteem. The benefits of this accomplishment are first of all the ideal and then the material. If the programs of outdoor education have an organized, specific structure that the educators can provide, then the outdoor learning notion becomes not only a point of challenge for the students when undertaking different activities but also builds changes in oneself, leading to growth, personal development, and self-confidence [4]. The outdoor activities and sports are mostly practiced gaining a high level of fitness and good health. Another important motivation is having fun near

family, friends, and colleagues [1]. They love the experience of feeling excitement and adventure due to the adrenaline release. People that practice outdoor activities have the benefit of observing the scenic beauty and being close to nature. Talking about outdoor sports, the most important gain is developing specific skills, abilities and gaining a sense of self-confidence [2–4].

The need to wisely use open, free spaces is a product of the culture and education, life evolution, and contemporaneous civilizations. Today, when work becomes less and less physical and more and more intellectual, free time spent in different ways and forms, as a necessary complementarity to the routine and stressful activities from closed spaces, becomes the most valuable time asset outside productive work [5].

In the course of the contemporary development of life, within the last couple of years with the unfolding of the COVID-19 pandemic and the lockdowns, parents have started to work more from home, thus leading to children staying at home and performing activities inside. This sedentariness has meant fewer and fewer trips outside, losing the connection with nature for a while, becoming more engaged in things primarily effectuated in confined spaces, and experiencing a high level of stress for both parents and children [6–8].

The delusion of modern technological methods, such as the television or the computer, has led to a sedentary life among children and adults. Lately, a worrying increase in the number of overweight or anemic people has been registered both among adults and children who are attracted to video games and movies and forget, with their parents' consent, about outdoor games and walks in nature [9–11].

Though these are useful for the individual's intellectual development, they do not always offer everything necessary to develop a balanced and harmonious life. The specialized knowledge and situations where one refers to multi-disciplinary cooperation all can prove that a major part is played by outdoor activities, and one presumes that their effectuation makes it possible to highlight a superior age branch of the student's main sensory system. The need to develop the human personality through outdoor activities is believed to represent the broad field of human experiences dedicated to forming healthy characters; in this way, they can build, keep and transmit further along with a much cleaner, more beautiful, and healthier world [12–15].

Outdoor education activities are interactive activities that simulate real situations and involve resolving certain tasks. "An experiential way of learning that involves using all senses" takes place generally, but not exclusively, through exposure to the natural environment through outdoor education activities. They involve all three fields: physical, psychological, and emotional. Consequently, the participants assimilate a series of abilities and skills that contribute to improving personal performances; furthermore, when team members become aware of the obstacles that harden the teamwork, all of this contributes to improving the team's performance both within the exercise and in "real life" [16].

The main objective of outdoor activities is to encourage the development of certain personality traits with broad social acceptance: initiative, perseverance, optimism, willingness, organizing skills, courage, and special organizing skills. These characteristics arise from spending time performing outdoor activities and are constantly developing when they are constantly effectuated. Playing outside or engaging in different outdoor activities creates relationships, develops the social connections between peers, and develops motor skills, while also generating more learning possibilities in the natural environment and encapsulating a healthier mindset in all the upcoming challenges society might bring [17–20].

Moreover, in analyzing the personality traits, one must bear in mind the dynamics that characterize them and the sudden or gradual transformations that have taken place at their level. The dynamic character of free time activities also determines differentiated attitudes towards the effectuated activity and differentiated relationships between the group members. In other words, an individual does not manifest the same behavior or attitude in connection to the effectuated activity of each member of that respective group [21].

2. Review Research of Web of Science—Articles 2018–2020

The research design was defined by the following topics: "outdoor education and sports" (Topic) and 2018–2020 (Year Published) and Articles or Review Articles (Document Types) and all categories from (Web of Science Categories). As a result, only 360 papers were returned. We selected only 40 papers. The rest of the 320 was in another language than English, or do not offer the full text, or analyses collateral to the outdoors sports theme. Figure 1 shows the authors' high visibility of most respective papers and the link between themes, and publication year.

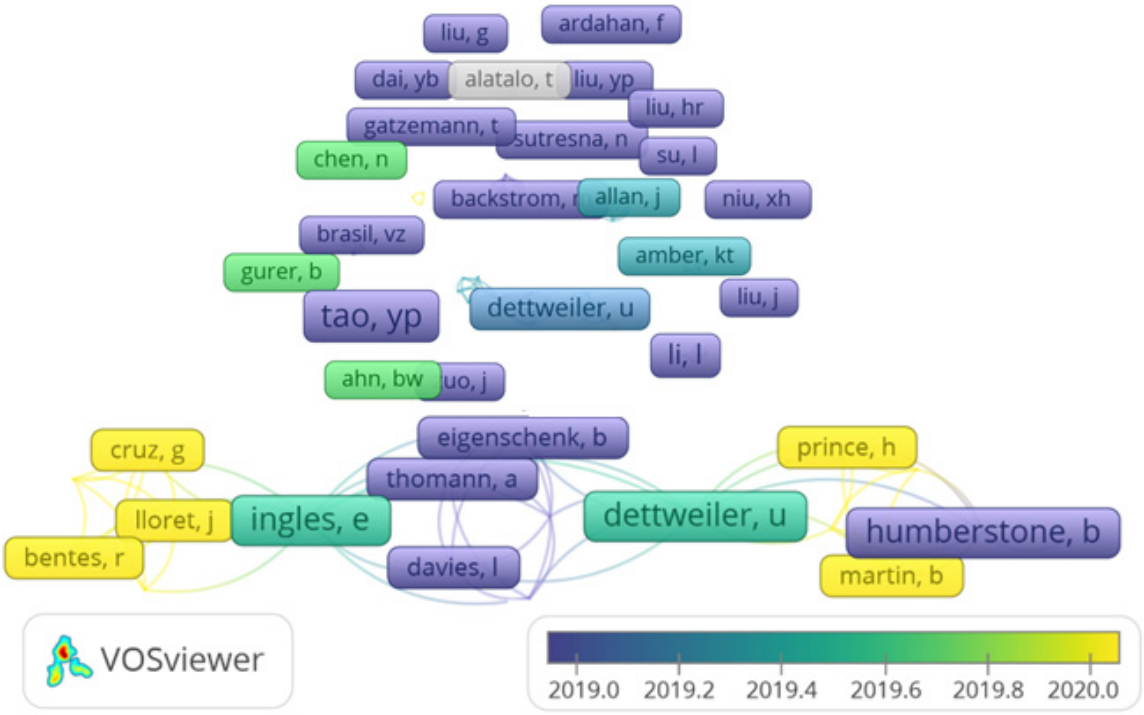

Figure 1. Clusters of papers published from 2018 to 2020 (Source: VOSviwer version 1.6.18 (May 2022).

We decided to use VOSviewer Software for a professional panorama regarding scientific papers published in the last years grouped in three main clusters. This image helps us to understand the topics discussed by the main authors, and the interrelation between them.

The social benefits of practicing sport and teaching within the natural environment are detailed by Eigenschenk, in a very large study with students from six European countries. They assumed that the main benefits of outdoor education are physical health, mental equilibrium, education, citizenship abilities, attitude, crime mitigation, and anti-social behavior [22,23]. Another author conducted a similar study in Viana do Castelo (Portugal) for school-age children and adolescents that were the beneficiary of nautical activities. Besides the advantages presented above, they also discuss environmental awareness [24].

Within the non-formal educational programs, "outdoor education" represents a learning process that takes place outside. Outdoor education includes environmental education to enhance the sense of responsibility towards the natural frame of outdoor activities; adventure education by setting the scene properly from the social and cultural point of view as to engulf the needs and desires of children as well as the newly established relationships within the context of outdoor activities; the benefits of camping as a useful tool for developing new relationships and for practicing perceptive feeling during different situations; outdoor therapy activities and certain aspects of outdoor recreation; notions that have grown so much in the last decades; notions that trigger a healthier state of mind and well-being. Thus, one considers that practicing outdoor education activities can be-

come a method of teaching youngsters, these activities being elaborated with a training purpose; for example, the group cooperation activities cultivate honesty, respect for the other members' feelings and rights, care for others, and self-discipline [25–28].

Recent research has shown the importance of outdoor education on character development, collaborative social behavior, and health for all the participants in nature activities. Concurrently, the subjects get to know nature, its laws, and balance based on elements and a whole. The subjects' nature experience stimulates creativity, engaging the body and the mind and amplifying a better memory of their previous experiences and activities; these qualities are generally inhibited by the closed, artificial, and stressful environment of cities [29].

As scientific research, outdoor education drifts its education methods away from quantitative research dominated by the descriptive and the statistical characteristic to research based on hermeneutics, that is on interpreting and analyzing the experimental facts and data, thus accomplishing the link between the objective and the subject of the research as a direct link [30].

The characteristics of the motile acts are kinesthetically different, depending on the effectuated physical activity: some are extremely complex involving a thorough control of the organism and its segment, while others separately follow certain qualities, skills, or motile abilities. The optimal level of motivation for these complex motile acts requires extremely sensitive coordination and the intervention of intellectual processes. To solve complex tasks, one needs moderate motivation, while for simple tasks one needs high motivation. The ones engaging in outdoor education activities must know very well their own psychological and motile characteristics for their respective age [31].

Man is quite reasonably structured: to know the surroundings he has at his disposal a universal set of sensory organs. Everybody can hear, see, feel and understand. It is true, that few people pay attention to the fact that when someone interacts with the outside world, in most cases, they do not use all the tools provided by nature, but only the selected ones. Such a holistic approach gives man the opportunity to feel and assimilate a different kind of learning experience, an event that enhances the senses, the personality, and the motor skills of the individual [32].

The research evaluates the visual, audio, kinesthetic, and digital characteristics as one of the most important in elaborating a person's psychological portrait. Knowing his/her psychological type will not only help to get along with his /herself but will also simplify the process of interaction with other people.

For some it is more important to receive the auditory information, while for others it is more convenient to see the information with their own eyes; nevertheless, others cannot learn anything unless it is projected in their personal life, while for others a common language can be found if one speaks in the language of strict logic. This is to say that everybody has a certain specific way of perceiving information and depending on that, everybody shares visual, auditory, kinesthetic, and digital information [32].

To identify to what extent the proportion between outdoor education activities and the sensory system exists, as well as the interaction between these two elements, these relations are expressed through practical and preferential methods such as native forms as the need for movement or through preponderantly social and educational methods such as the need for self-knowledge, sense of risk and its calculation, as well as the habit of practicing movement [33].

The study also presumes that the educational formers are the ones who have the role of appreciating the harmonious social relationships of the youngsters as a result of their participation in outdoor education activities. In this context, experiential learning cannot be permanently systematic or uniform; it addresses the different characters and personalities of each participant. These skills are developed in time and with maximum attention on behalf of educators, for example, through group cooperation activities that cultivate honesty, respect for the other members' feelings and rights, care for others, and self-discipline, as ethical values. Accomplishing this educational model also requires specific strategies,

through which the students can learn to communicate with each member of the group, take responsibility, and accept the differences and the compromises within a group. The physical education teachers must know the fact that these subjects are sometimes below expectations in this area, not because they do not want to participate in these activities but because they do not know, with gradual teaching of these skills being the natural step. This happens also because some subjects are not aware of the collaborative values within a group at home or in other contexts and because these values have never been consolidated [33,34]. As a consequence, teachers must not expect the participants to learn these values at a fast and automatic pace. Learning these collaborative skills is done just like learning any other skills. If the subjects do not understand the group collaborative concepts and practice, educators must never direct them in solving their misunderstandings or disputes outside the group, but through outdoor activities that generate beneficial multiplicative effects in the individual, group, and social areas [30,35].

3. Materials and Methods

This research aims to analyze if the type of sensory channel is influenced by the type of sport and the environment (urban/rural) of that practiced sport. We also analyzed the benefits brought by different sports and if these benefits influence the type of activity (visual, auditory, kinesthesis, and digital). The data have been collected through the help of an online survey, a questionnaire, using the Likert scale with the subjects having to choose from multiple answers; therefore, a multiple-choice type of questionnaire. Furthermore, the data have been allocated and reviewed based on a sample of 100 students from the Transylvania University of Brasov, students that are in the habit of practicing outdoor activities.

The sample is representative. Data were analyzed with Microsoft Excel 365 in the first stage. In the second stage, we used SmartPLs Software version 3.0 for a factor analysis (CFA), which measures the impact of factors on the dependent explanatory construct.

3.1. Stage I—Perception Analysis Based on the Likert Scale

3.1.1. Stage I Hypothesis

Hypothesis 1 (H1). *The research hypothesis: one presumes that no matter the outdoor education program or the motives related to the sensory system for students, the degree of satisfaction in obtaining performance and surpassing their limits is important.*

3.1.2. Stage I Method

The study has as a purpose the identification of the student's preferred means of outdoor education activities through the dominant sensory system. Each student was stimulated based on his/her perceptions—visual, auditory, kinesthetic, and digital—to appreciate the effectuated outdoor education activities within a practical stage in a specialized center for these kinds of activities.

One of the methods used in the research was the Likert scale, having as an objective the appreciation of outdoor activities included in 4 modules that have been effectuated within the practical stage.

The sensory analysis method was conducted through a questionnaire that has as an appreciation system of the measurement of the student's satisfaction towards the practical stage effectuated means and methods. The scale had 5 degrees, which indicated the intensity of the agreement or disagreement of the participants to such outdoor education activities. The Likert scale had the 5 following degrees: Total agreement (+2), Agreement (+1), Indifference (0), Disagreement (−1), and Total disagreement (−2). [36]

Another method of research is the rank ordering method [37] to classify the proposed outdoor activities for the students to effectuate them based on the intensity of a single sensory characteristic that is the preferred one; the objectives were the following:

- Facilitating a more precise evaluation;
- Facilitating the appreciation through acceptance of the proposed outdoor activities.

The research used the same sample of 100 students that have been asked to express their preferences regarding the proposed outdoor activities; this is a fast and quite accurate method in evaluating certain complex characteristics such as perceiving the activities through the preferred sensory canal. The students were invited to experiment with the outdoor activities in a practical stage in a specialized center and they were asked to express their satisfaction and preferences related to this experience. The 100 students grouped in 4 clusters of 25 students have effectuated the following outdoor activities:

- Trekking and hiking;
- Mountaineering hiking;
- Orienteering and movement in different types of the field;
- Climbing a fake wall;
- Rappel;
- Zipline;
- Rope garden;
- Touristic orientation;
- Rafting, kayak canoeing;
- Mountain biking;
- Building a boat;
- Writing maps;
- Static activities based on communication.

All these activities have been proposed with the stimulation of the 4 sensory canals as a main aim:

- Activity 1 (centered on the dominant visual sensory canal)—activities that have presumed excursions and hiking in which the students were asked to contemplate nature, to effectuate activities with precise tasks such as finding a hidden treasure and orientating on the field to write a map; in these activities one presented the beauties of nature, knowing different species of plants and birds, things that required evaluating the information given, especially through the preferred sensory canal—the visual one.
- Activity 2 (centered on the dominant auditory sensory canal)—these activities presumed precise tasks without useless details; their solution also presumed communication guided mainly by the auditory sensations.
- Activity 3 (centered on the dominant kinesthetic sensory canal)—the activities have presumed to solve the tasks based on experimenting with certain physical sensations, perceiving pain, coldness, hotness, the difficulties of solving tasks in different ways, solving certain difficult motile tasks such as the rope garden, climbing rocks, rappelling and undertaking expeditions for surviving.
- Activity 4 (centered in the dominant digital sensory canal)—these activities required the management of logic and thought process with clear planning; they were stressful activities such as building a boat from different objects and experimenting this on water and building certain objects with materials from nature without affecting nature, paths or maps.

3.1.3. Stage I Results

The students' opinions regarding the 4 types of activity are presented in Table 1. The score regarding each type of activity was calculated with the formula

$$\text{An} = [\text{NoA} \times (+2) + \text{NoA} \times (+1) + \text{NoA} \times 0 + \text{NoA} \times (-1)]: 100 \quad (1)$$

where An is the name of the activity and NoA represents the number of answers for each type of activity.

Table 1. The Likert Scale the students' appreciation.

Activity	Total Agreement (+2)	Agreement (+1)	Indifference 0	Disagreement (−1)	Total Disagreement (−2)
Activity 1—sensory	72	26	1	1	0
Activity 2—auditory	70	27	1	2	0
Activity 3—kinesthetic	75	23	1	1	0
Activity 4—digital	62	29	5	4	0

The global score of this study is calculated with the formula $\frac{\sum_{i=1}^{n} An}{n}$, where n = 4 in our case, the 4 types of activities from Table 1.

On a scale from −2 to +2, the global score was 1.65 positive value, and the most appreciated module was module 3 with a score of 1.73 (Figure 2).

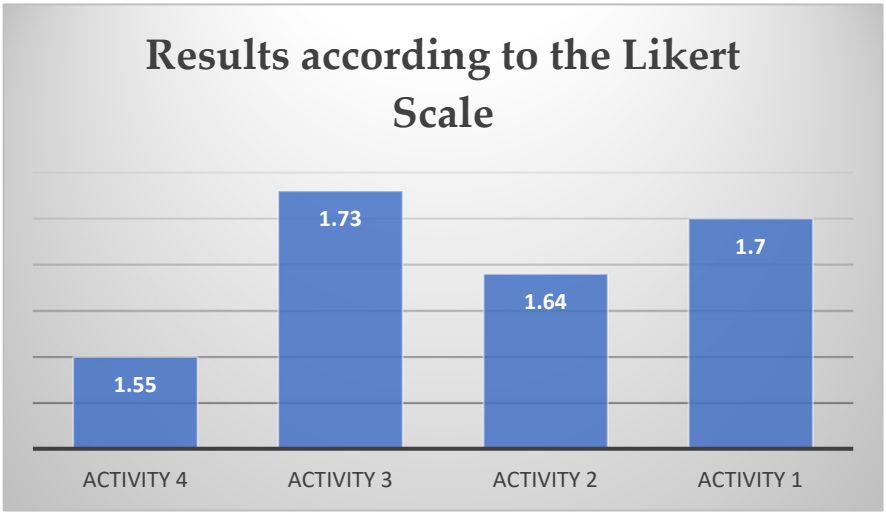

Figure 2. The research results according to the Likert Scale.

From the data research analysis, one can see that the overall image is positive, and the participant students have expressed through their options module 3 as a winner, the module centered on the dominant kinesthetic sensory canal with a score of 1.78, followed by module 2 centered on the dominant visual sensory canal with a score of 1.73.

Analyzing the research study results after the rank ordering method, one can conclude that the students preferred the activities from module 3 (centered on the kinesthetic sensory canal), with a first-place score of 1.73 followed by a tight score from module 1 activities (centered on the visual sensory canal) with 1.7. The third place was occupied by module 2 with auditory activity and a score of 1.64. The last place was occupied by module 4 with digital activity and a score of 1.55.

Thus, one can also confirm H1 by the results obtained: students' satisfaction and appreciation regarding outdoor activities are positive. The better the ability is to work with these canals the better one can communicate with oneself and those around them. A first step in training this ability is discovering the preferred sensory canal.

After closely observing the students' preferences, based on their behavior and observation charts, the ones who preferred module 3, with a score of 1.73 centered on the kinesthetic sensory canal, were aware of how they felt things and emotional reactions, and they preferred to gather information through touching, gesturing and smelling. They were willing to experiment with the emotion of the unknown and the need for movement, which contribute to improving and developing the collaborative coordination through activities that had as tasks moving on a varied field, without tracks, maintaining balance depending on the effectuated path, developing courage, the needs to affirm oneself, a

better understanding of others, and a better way of showing respect for the other's abilities and skills.

The students who marked as preference the activities from module 1 (degree score of 1.7 centered on the dominant visual sensory canal) stood out by solving tasks such as spatial orientation, using clear schemes, and often using the words "beautiful" or "ugly" in correlating the information provided by nature through images.

The ones opting for module 2, degree score of 1.64 (centered on the dominant auditory canal), resolved the tasks by hearing as a main source of information and by communicating; they also used the interior dialogue (what one says to oneself) with the very important role in consolidating the system of values; they were very sociable, centered on communication, and they did not orientate so well in space, but they were very precise in actions that did not require too many details. These students were the ones who organized evenings of radio and audiobooks.

The ones who preferred module 4, degree score of 1.55 (centered on the dominant digital sensory canal), stood out by planning tasks and analyzing each detail through their thought process without needing visual or auditory images. They perceived the information that they understood with the help of logic, being very focused and detached from the environment.

3.2. Stage II Factor Analysis

In stage II we designed a model based on Confirm Factor Analysis. The model restrictions were determined by 1 formative construct (PES = physical education and sports) and 2 reflective constructs (sensory activity; environment and sports). Our analysis measures the impact of each subitem/factor (loading factor = LF) but does not help us to establish the direction of the influence [38,39].

The SmartPLS software will estimate the model saturation based on a series of indices that enhance how well the model explains the variables and fits the hypothesis established. The relevance of the latent constructs designed was analyzed with Cronbach's alpha test, and the consistency of the model was evaluated with composite reliability, rho A, and average variance extracted (AVE). [40,41].

Our analysis is based on 3 variables (Figure 3 and Table 2):

- PES—a formative variable with 8 items, emphasizing the benefits brought by PES;
- Env Sport—a reflective variable with 2 items, emphasizing the type of sport and the environment of practice (urban/rural);
- Sensory activity—a reflective variable defined by the 4 types of activity (visual, auditory, kinesthesis, and digital) preferred by students.

Table 2. Variable analyzed.

Var Label	Var Subitems	Variable Definition	LF
Sensory activity	Visual	Activity 1 centered on the dominant visual sensory canal	0.975
	Auditory	Activity 2 centered on the dominant auditory sensory canal	1.086
	Kinesthetic	Activity 3 centered on the dominant kinesthetic sensory canal	0.941
	Digital	Activity 4 centered on the dominant digital sensory canal	0.734
Environment and Sports	Env	Environment: 1-urban or 2-rural	0.406
	Sport	Type of sports practiced by children	0.29
PES Role	Health	PES role: sanitation	0.932
	Fitness	PES role: fitness	0.774
	Body	PES role: body shaping	−0.17
	Learn	PES role: assimilation of movement concepts	−0.811
	Develop	PES role: psychosocial development	−0.882
	Relax	PES role: recreational activities	0.287
	Tolerance	PES role: promotes tolerance	0.266
	Discrim	PES role: cultural discrimination	0.42

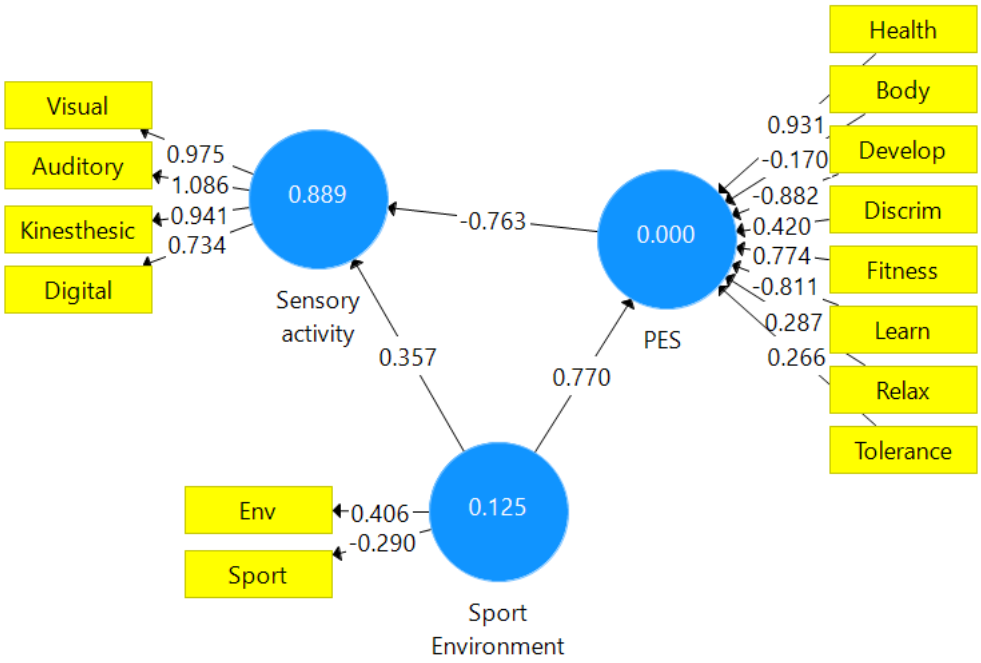

Figure 3. Cronbach's alpha coefficients and path analysis.

3.2.1. The Stage II Hypotheses of the Research Are

Hypothesis 2 (H2). *The students' preferences for the outdoor types of activity (Visual, Auditory, Kinesthesis, and Digital) do not depend on the students' environment provenience (rural or urban), but on the benefits that particular activity brings.*

Hypothesis 3 (H3). *The preference for different sports or outdoor activities has a strong and positive impact on PES outputs.*

As a result of the aforementioned questionnaire, based on the effectuated analysis, one does not see the environment the students are coming from, whether urban or rural, as a definitory factor in choosing a certain sport or a certain outdoor activity. The 4 sensory canals are a means for the students to make their choice regarding a certain outdoor activity based on their liking, their enjoyment of that particular action, and the actual perceptible feelings related to sensation [22].

Furthermore, the benefits taken out of these activities, such as communicating better, experimenting with different situations that require planning or organizational skills, experiencing different emotions through movement, etc., all have triggered needs for growth and personal development outside the routine (inside activities), actually in a new routine—that of nature [22].

It is already common knowledge that engaging in activities in the natural environment brings about quite a lot of health benefits, one of the first and most important ones being precisely the outside factor, the fresh air. Though it might be one of the most essential factors, it is completed by the students' willing to step out of their comfort zone and try different things, as the study results have provided. The students have scored very well in their sensory category, assimilating and implementing their perceptive skills in choosing their preferred outdoor activity.

3.2.2. Stage II Results

Construct Reliability and Validity—SmartPls software provides many tests that can be used to ensure a coherent analysis and interpretation of data and to assume the research outputs. For example, the consistency of our model was grounded on the validation steps provided in Table 3 [38,39]. All the considered variables present very high values for

composite reliability: Cronbach's alpha and rho_A (>0.7—the bottom value authorized), and average variance extracted (AVE) (>0.5—the bottom value approved), meaning that convergent validity can be assumed. These results empower us to believe that all our hypotheses are validated to different extents (Table 3, Figure 3).

Table 3. Validation steps/tests.

Variable	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted
	>0.7	**>0.7**	**>0.7**	**>0.5**
PES		1		
Sport and Environment	0.267	1		
Sensory Activity	0.968	0.984	0.969	0.889

The loading factors (LFs) for Sensory Activity latent constructs in Table 2 and Figure 3 enhance that all the items that form sensory activity are very well represented in the model. The visual, auditory, kinesthesis, and digital activities all have loading factors greater than 0.6, meaning that these 4 items evaluate very well student preferences for a different kind of activity.

The loading factors (LFs) for Sport and Environment latent constructs in Table 2 and Figure 3 are less than 0.6. The ENV (LF = 0.406) is important and has a positive influence on the PES role. Outdoor sports practiced in the natural environment have a greater impact on human health, fitness, and relaxation, than inside sports [39,40].

This could very well be a hypothesis proven by simple logic but based on the effectuated research and the scores the sample of 100 students have provided based on their sport or activity of choice, we can surely state that, while inside sports do also have their share of positive aspects, the outdoor activities engulf, through the 4 sensory canals experience, the best effects on human health, physical and psychological development and relaxation.

The type of sport has also a positive influence on the PES roles, but a smaller one (LF = 0.290). For a better model, the Sport and Environment latent constructs should contain some other subitems, such as: arrangements dedicated to each type of sport, integration of discoveries in the field of sports in its practice, and integration of technology facilities in sports training. These are students' suggestions to a question with an open answer. This is the reason that Cronbach's alpha has a small value (0.267) for this construct.

PES role is defined especially by Health (LF = 0.931), Fitness (LF = 0.774), Discrimination (LF = 0.420), and Tolerance (LF = 0.266). Students do not consider PES important for body shaping, personal development, and learning. We have to emphasize that this is a subjective opinion.

Discriminant Validity—Our model is statistically robust, as the Fornell–Larcker criterion and Heterotrait–Monotrait criteria are met because all values obtained are equal or less than 0.70 (Table 4) [39,40]:

Table 4. Discriminant validity.

		Fornell–Larcker Criterion		**Heterotrait–Monotrait Criterion**
Variable	**PES**	**Sport Environment**	**Sensory Activity**	**Sensory Activity**
PES				
Sport and Environment	0.700	0.353		0.398
Sensory Activity	−0.035	0.943	0.700	

The Path analysis presents the value below:

- Sports Environment → Sensory activity (0.945). The environment is important for students and has a positive influence on the PES role. Depending on the environment in which a sport is practiced, other types of senses are involved and students' preferences change.

- Sports Environment → PES (0.770). The outdoor sports, practiced in the natural environment have a greater impact on human health, fitness, and relaxation/recreation, than inside sports.
- PES → Sensory activity (−0.763). With a negative value, we may affirm that the role of PES does not influence the students' preference for a different kind of sensory activity. In other words, students consider PES important, no matter what the type of activity.

In Table 5 we may observe a strong positive correlation between the PES role and the environment, empowering H3 of our research. Outdoor sports are preferred by the students because of their positive influence on their physical and mental health. Another positive small correlation can be observed between the Sport and Environment and Sensory Activity. Outdoor sports need different sensory activities. Between PES and Sensory Activity, no correlation is presented. For students it is more important to practice sports than to choose a special type of sensory activity.

Table 5. Variable correlation.

	Latent Variable Correlation			R Square	R Square Adjusted	F Square	
Variable	**PES**	**Sport and Environment**	**Sensory Activity**			**PES**	**Sensory Activity**
Sensory Activity	−0.035	0.357	1	0.355	0.589		
Sport and Environment	0.770	1	0.357			1.456	0.572
PES	1	0.770	−0.035	0.593	0.589	0.373	

The steps presented in Tables 2–5 empower us to assume that our hypotheses are confirmed. The hypothesis tests (SRMR, d_ULS) also have higher estimates for the estimated model than for the saturated model. Thus, we may affirm that our model fits and that H1, H2, and H3 are accepted (Table 6). The standardized root means square residual (SRMR) has a value of less than 0.1, explaining a good fit [38–40]. d_ULS represents the squared Euclidean distance. Thus, our hypothesis is confirmed by a consistent model (Table 6).

Table 6. Model Fit.

Test	**Fit Summary**	
	Saturated Model	**Estimated Model**
SRMR	0.055	0.056
d_ULS	0.315	0.317

4. Discussion

After the survey results, the objectives have been fulfilled, and as such one can conclude that the outdoor activities from the perception systems point of view can be fitted according to the rank ordering method as follows: the activities included in module 3, centered on the dominant kinesthetic sensory canal, are in first place.

One notices that the majority of students favor a sensory canal, especially in stressful situations. It is important to say that they did not use exclusively a certain sensory canal, but they mainly had a preference and they identified it in selecting certain outdoor activities that would correspond to their needs. The effectuated outdoor activities proved the increase of efficacy in the functioning way of the psychological processes that depend on knowing the dominant representation system and on developing the accessibility of the representation system preferred by students. Knowing the dominant sensory system increases the possibility of knowing the students' preferences out of the four analyzed and numbered sensory systems. The practice has proved the necessity of diversifying the educational programs with outdoor education-specific activities according to the perception

mechanisms, resulting in the attraction of a higher number of students and avoiding the monotony among them.

We have also highlighted the formative potential of the outdoor activities bearing in mind the area of experimented methods ranging from using specific outdoor means to organizing activities depending on the main dominant sensory canal. Finalizing this study allows us to draft the following recommendations:

- Introducing in the curricular aria a program that offers outdoor education activities for students [41,42];
- As a particularity, the outdoor means must be selected depending on the dominant sensory canal of the student group and must be effectuated in real conditions benefiting from the best and most interesting "didactical material—the natural ecosystems or the artificial ones with their terrestrial or aquatic habitats;
- Selecting the specific means that must comprise the improvement of motile skills involved in these types of activities;
- Within the communication sessions, scientific seminars and other manifestations of this type, approaching an outdoor activity is thematic to accomplish an education from the natural value point of view at a national level.
- Sports Environment → Sensory activity (0.945) For students, the environment is crucial. the PES role, and has a favorable impact on it. Other senses may be engaged, and students' choices may change, depending on the environment in which a sport is played.
- Sports Environment → PES (0.770) In comparison to indoor sports, outdoor sports that are played in a natural environment have a stronger positive impact on a person's health, fitness, and leisure time.
- PES → Sensory activity (−0.763) With a negative result, we can state with confidence that PES's function has no influence on pupils' preferences for particular sensory activities. In other words, regardless of the activity, students think PES is important.

5. Conclusions

At the end of this research, we would like to accentuate the fundamental idea behind the chosen theme, which is that outdoor activities have a great and positive impact on students' physical and psychological development [2]. We have learned that the majority of students involved in the research have used their preferred sensory systems—visual, auditory, kinesthetic, and digital—in accordance with their correspondent needs when choosing a favorite outdoor activity [2]. Based on this, the research has proved that one needs to further diversify educational programs with outdoor education activities, to achieve a higher number of students involved in such activities and to keep away from day-to-day routine and dullness [21,26,27,30].

We also observed that the students' preferences for the outdoor types of activity do not depend on the students' environment provenience (rural or urban), but on the benefits that particular activity brings. It also depends on the student's limits in effectuating it and has a strong and positive impact on PES outputs [3].

The research has organized activities based on the dominant sensory canal by using specific outdoor means of the undertaking, using the scene in real conditions; these conditions were terrestrial or using water. This has led to a list of recommendations we think are suitable for the upcoming generations, such as implementing in the curricula a program that comprises different means of outdoor education, sorting out the best ways that motile skills can be encapsulated in the different types of activities and organizing communication sessions, seminars and other types of theoretical activities based on the notion of outdoor education, which can further extend and persuade the faculty and the students to perceive education from the natural point of view as one of the most rewarding types of education for the future [18,30].

The confirmation of the three hypotheses leads us to state that the application of the online questionnaire in the direction of the specific and relevant indicators of the research

process makes it possible to highlight the benefits provided by different sports and influence the type of activity (visual, auditory, kinesthetic, and digital).

Limitations: In this paper, there are still some limitations:

Our study employed a small number of subjects and expanding research could target many geographical areas and universities' cycles. This was preliminary research that will be further extended to national level in future research. Another objective of our next study is to evaluate what kind of abilities can be enforced and taught through different kinds of activity (visual, auditory, kinesthetic and digital).

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CONTEMPORARY FITNESS APPROACHES TO IMPROVE BODY COMPOSITION IN ADULTS

F. NECHITA[1] A. NECHITA[2]

Abstract: *Fitness plays an essential role in improving body composition by reducing fat mass and increasing muscle mass. Regular training, which combines cardio and strength exercises, stimulates metabolism and optimizes calorie burning. Sustained physical activity, along with a balanced diet, contributes to regulating body fat percentage and developing a harmonious body structure. In addition, monitoring progress and adapting the training program allows for effective and sustainable results. Thus, fitness becomes a practical and accessible strategy for improving body composition and maintaining overall health.*

Key words: *fitness, body composition, personalized training, physical activity monitoring.*

1. Introduction

In an increasingly hectic and technologically advanced world, where sedentary activities have become a dominant part of the daily routine, the concern for a healthy lifestyle is gaining increasing importance.

Fitness is no longer just a popular trend, but a real necessity, having a major impact on physical and mental health, fitness and body composition. [11-14].

The term „fitness" comes from English and refers to the general state of well-being of the body and mind, achieved through a combination of regular physical exercise, balanced nutrition and adequate rest [1-7].

Essentially, fitness means the body's ability to cope with daily demands without feeling excessive fatigue, but also to recover quickly after exertion.

Regular exercise supports overall health, increases energy and reduces the risk of disease, but factors such as muscle strength, endurance, stamina and intellectual capacity vary over time, declining with age. [4]. Furthermore, fitness stimulates the release of endorphins, known as „happiness hormones", having a positive impact on mental and emotional state [2].

Fitness is not limited to intense exercises in the gym. It can take various forms, from outdoor running, cycling or swimming, to yoga, pilates or functional training. Every person can find a type of physical activity that suits their lifestyle and fitness level.

[1] Department of Physical Education and Special Motricity", *Transilvania* University of Braşov.
[2] Student, Faculty of Physical Education and Mountain Sports, University of Transylvania Brasov

Fitness also requires discipline, perseverance, and a set of clear goals. It's not about quick results or spectacular overnight transformations, but about constant and sustainable progress.

Constant and sustained effort, based on personal motivation, causes the body to adapt, gradually leading to increased resistance, performance and achieving real benefits over time [5].

Nowadays, fitness has evolved significantly, and modern training methods are increasingly effective in achieving body composition goals.

These methods combine current scientific knowledge with technology and personalized approaches to maximize results:

a) High Intensity Interval Training (HIIT), which consists of alternating short periods of intense effort with periods of active recovery. HIIT is effective in burning fat and maintaining muscle mass, and results can be achieved in a relatively short time [12].

b) Functional training, which is a modern method and involves exercises that mimic the body's natural movements, training multiple muscle groups simultaneously. This type of training increases metabolic efficiency and contributes to muscle definition [13].

c) Weight training, remains essential for increasing muscle mass and accelerating basal metabolism. When combined with a proper diet, it leads to a significant reduction in body fat percentage [8].

d) Modern technology - in a society dominated by technology, experts consider physical activity a necessity of modern times [3]. Thus, technology plays an important role: smartwatches, fitness trackers, and mobile apps provide accurate data on heart rate, calories burned, sleep quality, and overall progress [6]. This information helps users adjust their workouts and monitor their body composition in real time.

In addition, workouts using fitness-specific equipment, such as a treadmill, fig. 1, allow access to personalized programs with real-time feedback.

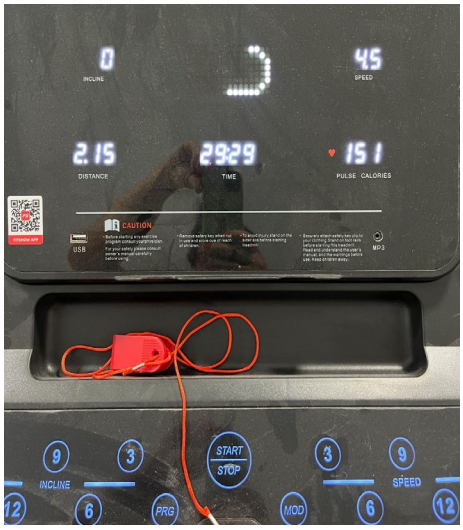

Fig. 1. *Treadmill _S1*

Monitoring physical activity plays an essential role in achieving and maintaining a healthy body composition. By tracking parameters such as the number of steps, calories burned, heart rate, or duration of workouts, the subject can have better control over their progress.

The use of smart watches, figure 2, fitness bracelets or mobile applications allows the collection of precise data, which can be analyzed to adapt training according to the desired goals: reducing body fat or increasing muscle mass [6].

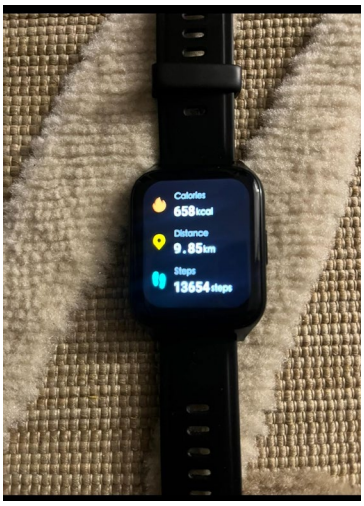

Fig. 2. *Smart watch _S1*

Monitoring also helps maintain motivation by providing constant feedback and encouragement when daily or weekly targets are reached. It is easier to correct mistakes or periods of stagnation early when you have access to concrete data.

In the long term, this process helps optimize physical effort and avoid overtraining or injuries.

These solutions are ideal for those who want flexibility and visible results without going to the gym.

Personalized training is one of the most effective ways to achieve rapid and lasting results in improving body composition [10].

It is designed according to each person's goals, level of training, age, possible conditions and lifestyle, which makes it much more effective than general or standardized plans.

A personalized program optimizes the ratio of cardio, strength and mobility exercises, depending on the goal pursued – whether it is weight loss, toning or increasing muscle mass. In addition, the gradual adaptation of the intensity and type of training prevents injuries and maintains motivation in the long term.

Through regular assessments and constant monitoring, the specialized application can adjust the plan in real time, depending on progress. This way, stagnation is avoided, and the body is always effectively challenged.

Holistic approaches to fitness have become increasingly popular, as they promote balance between body, mind, and emotions [15].

Improving body composition is no longer based solely on intense workouts and restrictive diets, but on a comprehensive understanding of the body's needs [9]. Thus, a combination of exercise, recovery techniques, and stress management methods becomes essential.

Regular training, whether strength, cardio or functional, contributes to burning fat and developing muscle mass. But without adequate recovery – through quality sleep, stretching and massage, the body cannot sustain healthy progress.

Overtraining without recovery can lead to stagnation, chronic fatigue and even injuries.

Stress management is also important, as chronic stress increases cortisol, a hormone that promotes fat storage, especially in the abdominal area. Practices such as yoga, meditation, mindful breathing, or walks in nature can reduce stress levels and support optimal hormonal balance.

The holistic approach does not mean perfection, but harmony: adapted training, sufficient rest, balanced nutrition, and mental health. This integrated vision ensures not only aesthetic results, but also a general state of well-being, sustainable in the long term.

2. Material and Methods

2.1. Date, place and subject of the research

The research was conducted between 01.02 – 31.08.2025.

The research subject is a female (S1), aged 48, with obesity grade I.

The following materials and technologies were used in the process of improving the body composition of the research subject: elastic bands of different resistances, bosu ball, light dumbbells, mechanical and classic stepper, treadmill, smart watch and smartphone calorie monitoring application.

2.2. Evaluation methods

a) Evaluation method of segmental perimeter measurement is one of the simplest, most accessible and frequently used methods to monitor body composition and physical progress, especially in fitness, weight loss or muscle mass programs.

It is a technique that involves measuring the circumference of certain body segments (arm, waist, hip, thigh) using a tailor's centimeter or a flexible measuring tape. The initial values are compared with those obtained periodically to evaluate changes in body composition.

Investigated segments and their measurement point:

- arm – in the middle of the biceps;
- waist – above the navel;
- hips – the widest point of the buttocks;
- thigh – in the middle of the distance between the hip and the knee;
- calf – the thickest point of the calf.

Method of realization: once every 2–4 weeks is recommended to see real changes.

Daily or weekly measurements are not helpful, as fluctuations can be caused by water retention or digestion.

Advantages of the method**:** easy to do at home, without expensive equipment.

Provides clear information about where your body is losing fat or gaining muscle mass.

Suitable for tracking progress over time, especially when body weight does not provide a complete picture.

Limitations and precautions: accuracy depends on the measurement technique: it must always be done in the same place and under the same conditions (time of day, body position, hydration status).

It does not provide information about internal composition (e.g. visceral fat or bone density).

It must be used in conjunction with other methods (e.g. scales, progress photos) for a complete picture.

b) **The scale method in monitoring body weight** The scale is one of the most widely used methods for tracking body weight. Although it provides a simple piece of information — total body weight — it can be useful when interpreted correctly and used in conjunction with other assessment methods.

Method of realization: It is recommended to weigh yourself in the morning, on an empty stomach.

It is done on the same day of the week, under the same conditions (without clothes, the same scale, on a flat surface).

Note the values and calculate the weekly average, not just a single value.

Advantages of the method: It is affordable and easy to use at home.

It provides a quick measurement, which can signal large changes in weight.

It can be useful for monitoring long-term trends, not short-term ones.

Limitations and precautions: Weight can fluctuate daily due to water retention, menstruation, digestion, or hydration.

Weight loss doesn't always mean fat loss — it can also be water loss or muscle loss.

Can be demotivating if used without other methods (e.g., body measurements or progress photos).

2.3. Research procedure

Period, methods and techniques used and specific objectives Table 1

Period	Methods and techniques used in improving body composition	Objection
Month 1 Initial Assessment and Adaptation	Body composition assessment (body mass index (BMI), segmental perimeters); Starting a basic training program (3-4 times/week): combination of light cardio (treadmill walking) and bodyweight exercises. Dietary adjustments: elimination of excess sugar, proper hydration, regular meals.	Setting SMART goals (Specific, Measurable, Attainable, Relevant, Timely); Setting realistic goals: weight loss, muscle gain, toning; Creating and initiating a basic workout routine and proper nutrition.
Month 2 Improving endurance and technique	Increasing the intensity of cardio training; Introducing strength exercises with light weights and moderate repetitions; Active stretching and mobility techniques to prevent injuries; Monitoring progress: first adjustments in nutrition (e.g.: macronutrient distribution – protein 25-30%, carbohydrates 40-50% and fat 20-30% of calories).	Increasing cardiovascular capacity (30 min of sustained effort, 3–4 days/week); Improving execution technique in basic exercises, Establishing a basic eating plan (with approximate calorie calculation), Adapting the body to effort without injuries.
Month 3 HIIT and nutritional control	Introducing HIIT (High Intensity Interval Training) workouts twice a week. Food tracking using mobile apps. Adjusting protein intake to support muscle mass. Foam rolling and stretching techniques after workouts.	Introducing HIIT workouts 1–2 times/week; Progress monitoring (photo, measurements, scale); First small calorie deficit to reduce body fat.
Month 4 Muscle mass gain	Integrate muscle group training (push/pull/legs); Continue to monitor body composition and physical progress.	Increasing the load on strength exercises. Increasing muscle mass + reducing fat percentage by 1–2%. Following a protein-rich diet. Integrating stretching and quality sleep into your routine.

Period	Methods and techniques used in improving body composition	Objection
Month 5 Active consolidation and recovery	Maintaining strength routine + 1-2 cardio/HIIT workouts per week; Introducing an active recovery day (yoga, pilates, swimming); Optimizing sleep: 7–8 hours/night, with an emphasis on sleep quality; Stress management through conscious breathing or meditation.	Maintain a training rhythm (4–5/week); Avoid overtraining and introduce active recovery; Optimize sleep and daily energy levels; Reduce stress by at least 30% through breathing/meditation techniques.
Month 6 Diversification and Personalization	Adapting the program according to the results obtained; Varying exercises to avoid plateauing; Focus on intuitive eating and maintaining caloric balance; Motivation techniques: training diary, weekly goals.	Increased joint mobility; Increased muscle strength; Increased balance; Relaxation of lower limb muscles.
Month 7 Definition, stabilization and maintenance	Slightly reducing caloric intake for muscle definition (if applicable); Interval training, functional training, circuits; Increasing active recovery time and therapeutic massage; Advanced monitoring with smartwatches or fitness apps. Maintaining a balanced schedule: 3–5 workouts/week; Integrating fitness into your daily lifestyle; Body reassessment and comparison with month 1; Establishing new habits as part of your long-term routine.	Additional 1–2% body fat loss (if needed); Visible improvement in muscle tone; Increased intensity of functional training; Optimization of muscle mass / fat ratio; Maintaining the results achieved without the yo-yo effect; Integrating fitness as a constant part of the lifestyle; Complete reassessment: comparison between month 1 and month 7; Creating a long-term plan for maintaining body composition.

3. Results and Discussions

Research parameter values_S1 Table 2

Parameters	Initial testing T1	Final testing T2	Value difference T1-T2
ARM	34cm	32, 5cm	1,5cm
WAIST	110cm	102 cm	8cm
HIPS	115cm	107 cm	8cm
TIGHT	70cm	64 cm	6cm
CALF	46cm	45,5 cm	0,5cm
BODY WEIGHT	95kg	81 kg	14kg
Calories/movement steps	325kcal/8000 steps	658kcal/13654 steps	333kcal/5654 steps
IMC	32.87kg/m Class I obesity	28.02kg/m Overweight	4.85kg/m

The results were obtained after careful examination of the subject throughout the training program. The subject was given the necessary assessments to generate the objectives of the training program but also to obtain feedback on the effectiveness of the applied program.

Over a period of 7 months, the subject executed a training program.

The initial assessment (T1) was carried out on the first day of the training program, and the final assessment (T2) at the end of the program.

Segmental perimeter measurements, figure 3, as well as body weight assessment, figure 4, were performed at the beginning and end of the training program.

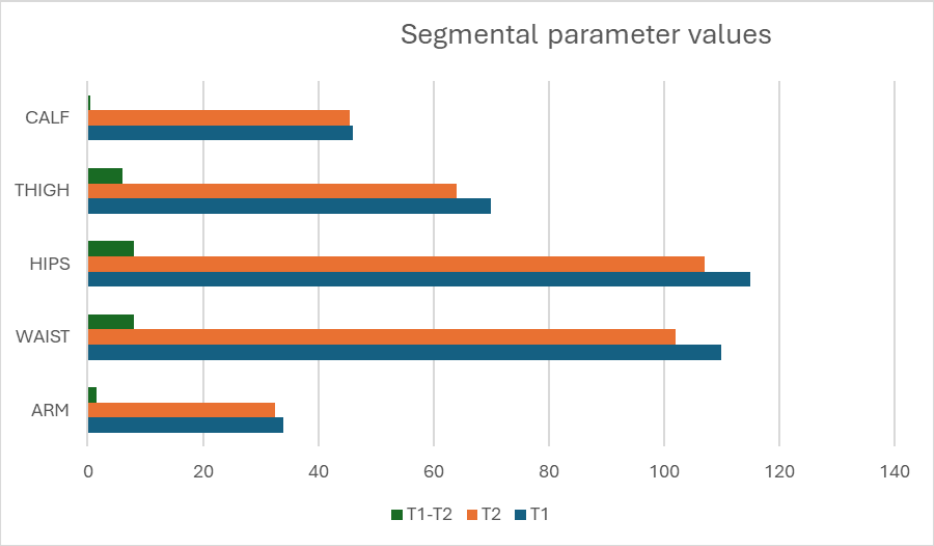

Fig. 3. *Interpretation of results for body segmental parameter values, S1*

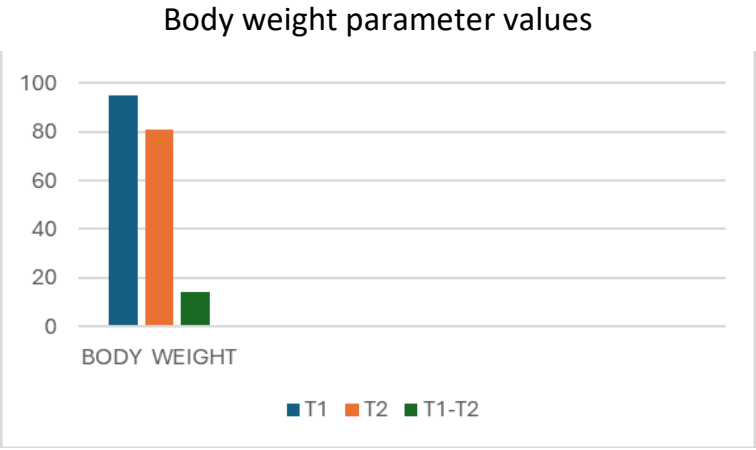

Fig. 4. *Interpretation of results for body weight values, S1*

The tests were actively conducted to provide the most accurate and efficient monitoring of the values obtained.

In order to track the progress of improving body composition through the use of a personalized training program as efficiently as possible, the results obtained from the assessments were compared, following ideal values specific to the imposed objectives, table 2.

After applying the training program for a period of 7 months, the subject achieved significant improvements in the values of the researched parameters. Thus, the subject's weight loss had a value of 14 kg, figure 4, for the subject with 0.5 kg/week in 7 months. This performance is due to the following factors: caloric deficit (balanced diet), level of physical activity (cardio and strength) and metabolism and individual factors (sex, age, health status).

Nutritional principles as a moderate calorie deficit are a reduction of 500-700kcal/day, which leads to a weight loss of 0.5 kg/week.

Another important parameter is the distribution as a percentage of the total daily calories – 2000kcal/day: proteins 30% - 600kcal – 150 g (1g of protein = 4kcal); carbohydrates 45% - 900kcal – 225g (1g carbohydrates = 4kcal) and fats 25% - 500kcal-55g (1g fats = 9kcal), fig. 5.

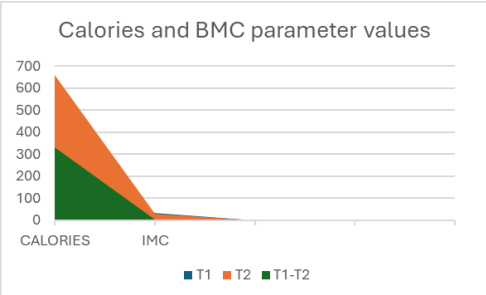

Fig. 5. *Interpretation of results for parameter values and BMI value, S1*

These aspects contribute to the progression from obesity class I to overweight, figure 5, which denotes that the personalized training program has maximum efficiency.

4. Conclusions

Fitness is much more than a physical activity – it is a way of life. By integrating it into your daily routine, each individual can significantly improve their quality of life, health and mood. In a society where challenges are numerous, fitness becomes a reliable ally on the path to balance, vitality and well-being.

Modern training methods offer a wide range of effective options for improving body composition. The key to success lies in adapting the method to individual needs, consistency and a balanced lifestyle.

Monitoring physical activity is not just an evaluation tool, but a real partner in the process of body transformation.

Personalized training not only accelerates body transformation, but also significantly increases the chances of maintaining results in the long term, in a safe, sustainable and adapted way to the needs of each individual.

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PHYSICAL THERAPEUTIC INTERVENTION TECHNIQUES IN IMPROVING FLAT BACK SYNDROME IN THE SCHOOL ENVIRONMENT

Florentina NECHITA[1]

Abstract: *The flat back symptoms are one of the most common degenerative spinal deformities among adults. This occurs due to incorrect posture over time in the school environment, as well as due to the unique lifestyle. The purpose of the paper is to highlight the important aspects related to flat back syndrome and the physiotherapy intervention methods in improving the quality of life in the school university environment. In this study, a case study with flat back syndrome was analyzed in which the role of improving the quality of life by improving the health status of the subject was highlighted.*

Key words: *flat back syndrome, physiotherapy intervention techniques, kinetic exercises.*

1. Introduction

Flat back syndrome is a postural deficit resulting from the extraction of vertebrae in the treatment of scoliosis. Patients suffering from flat back syndrome adopt certain postural attitudes to maintain a physiological posture that is as upright as possible. These postures consist of pelvic tilts, hip extensions, knee flexions, and spinal hyperextension [1].

Flat back syndrome is an abnormal condition in which the spine loses its natural kyphosis and/or lordosis and begins to flatten, causing the spine to become uneven. It is characterized by the gradual loss of normal kyphosis and/or lordosis, which results in a forward tilt of the trunk, inability to stand upright. From the subject's point of view, these changes may be subtle, but over time, the difficulties will increase, and the level of pain will increase [4], [11].

Patients suffering from flat back syndrome develop adaptive postural changes to maintain a physiologically and socially acceptable horizontal gaze [1].

Flat back syndrome was initially observed in patients who underwent surgery to reduce scoliosis. Physical impairment – scoliosis is an S-shaped curvature of the spine. Harrington rods were used in the surgery to improve the curvature. These instruments allowed the specialist to straighten and fuse the patient's curvature, which was a positive

[1] Faculty of Physical Education and Mountain Sports, *Transilvania* University of Braşov.

aspect. Many patients treated with this type of instrumentation did very well after the surgery [13].

Scientific technology is constantly developing, thus minimizing the long-term risk for patients.

Current interventional tools allow specialists to correct the spine in different planes, decreasing the risk of developing flat back syndrome.

The disappearance of lumbar lordosis can occur because of conditions such as degenerative disc disease, vertebral compression fracture, osteoporosis and ankylosing spondylitis, post-laminectomy kyphosis syndrome and post-lumbar laminectomy syndrome (flattening of the back following lumbar decompression surgery in the case of spinal stenosis) [14].

This condition can be observed both at the lumbar and thoracic levels and is manifested by the absence of the natural-physiological lordotic and kyphotic curves, respectively.

Symptoms differ and can worsen depending on the degree of advancement of flat back syndrome. In fact, the symptoms can often become disabling and can decrease the quality of daily life.

Many patients may end up relying on medications to relieve the pain caused by flat back syndrome.

In a person with flat back syndrome, the lumbar spine does not have its natural curvature, figure 1.

This causes the head and neck to lean forward, which can make it difficult to walk and perform daily activities. As a result, the affected person struggles to maintain balance and become fatigued, causing chronic stiffness and pain in the neck, upper back, and shoulders [16].

The position adopted in this deficiency puts stress on the vertebrae and spinal discs, causing recurrent back pain, as well as pain in the groin and thighs.

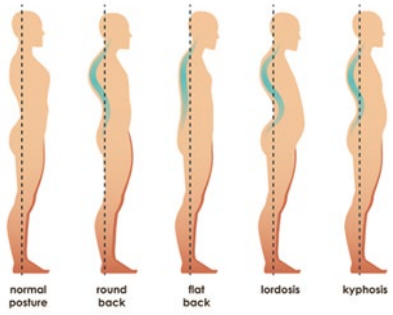

Fig. 1. *Spine posture* [15]

The patient's symptoms often worsen as the day progresses, as many patients flex their hips and knees to maintain a correct standing posture. These compensatory changes lead to mobility problems and increased muscle fatigue, as the muscles in those regions exhaust their resources [17].

Recent studies confirm that the disappearance of the normal upper thoracic kyphotic curvature causes a reduction in the anteroposterior diameter of the chest.

As a result of compression of the heart, chest pain and palpitations occur. This condition is more frequently associated with mitral valve prolapse and bicuspid aortic valve than with pseudoheart disease. The application of manual therapy to the appropriate thoracic and cervical areas, followed by daily performance of recommended exercises and stretching procedures, seem to have preventive roles in this case [9].

In another study, a patient was found to have a significantly shortened anteroposterior diameter of the chest, leading to the diagnosis of flat back syndrome. The heart was flattened and

oriented vertically, the spine was uncurved, and there was compression of the right ventricular outflow tract [3].

The spine becomes straight, the chest is flat, the abdomen is sucked in, and the pelvis is almost horizontal. The mobility of the spine suffers especially from the lack of lumbar curvature, and the spine completely loses its ability to cushion sudden movements due to the lack of these curvatures [18].

Flat back syndrome is a combination of inability to stand due to forward flexion of the trunk and pain in the back and/or legs. It usually occurs in the setting of decreased lumbar lordosis following spinal distraction instrumentation for scoliosis, vertebral fracture, or degenerative disease. Emphasis is placed on determining the factors responsible for the development and/or persistence of flat back syndrome in these patients, despite maintenance or partial surgical restoration of lumbar lordosis.

Given the essential role that the trunk extensor muscles play in maintaining upright posture, it is possible that a new onset of weakness (post-polio syndrome) in these muscles represents a major factor contributing to flat back syndrome in these patients [8].

Other common causes and exacerbating factors include failure to increase regional lordosis during lumbar fusion for degenerative spondylosis, development of pseudarthrosis or postoperative loss of correction, development of kyphosis at the thoracolumbar junction, development of cephalad or caudate degeneration and decompensation in previous fusion, and hip flexion contractures. Prevention of flatback syndrome involves preoperative assessment of sagittal balance, avoidance of distracting instrumentation and extension of long fusions in the lower lumbar spine, improvement of physiological lordosis during lumbar fusions, and intraoperative positioning with the hips extended [7].

Another study focused on sagittal realignment for flat back and associated kyphotic decompensation [6].

Untreated, flat back syndrome can worsen and lead to complications, such as the development of head-forward posture.

Often, people with flat back syndrome use a cane or frame to help distribute body weight evenly across the pelvis and legs; this is due to the effects of decentration.

2. Material and Methods

The research was based on an experimental study. The period of implementation was 6 months with initial testing - October 2022 and final testing - March 2023.

The study is based on a case study. The subject is a 28-year-old female student diagnosed with flat back syndrome.

2.1. Research procedure

In the research, to have the most objective picture possible of the deficiency treated, the following methods were identified:

a*. Evaluation of the spine* was carried out observing the appearance of the spine in the frontal and sagittal planes:

- The head and neck are prominently forward.
- The shoulders are bent forward.
- The thoracic spine and lumbar spine do not have the natural curvature observed in most people.

- The pelvis rotates posteriorly.

***b**. Evaluation by inspection and palpation*

In this case, we refer to the palpation of muscle groups, joints and the observation of the amplitude of movements.

The subject presented muscle hypotonia when palpating the spinal extensors and thigh flexors. He also complained of pain in the paravertebral muscles in the thoracic, lumbar, gluteal muscles, and hamstring muscles. He complained of muscle contraction and pain in the neck.

***c**. Using the Shirado and Sorensen Beiring tests*

The Shirado test is a static abdominal muscle endurance test currently used in the evaluation of back pain, figure 2 [2].

Fig. 2. *Shirado test* [19]

This examines the trunk flexors and is performed with the subject in supine position, thighs and knees flexed at 90°, arms at the sides. The subject raises the shoulders off the table, maintaining this position as long as possible, in isometry. In a subject, under normal conditions, the time maintained is 2'. In the case of the subject analyzed, the time was 1'30" [12].

The Sorensen Beiring test is commonly used to assess paraspinal muscle strength, figure 3, [10].

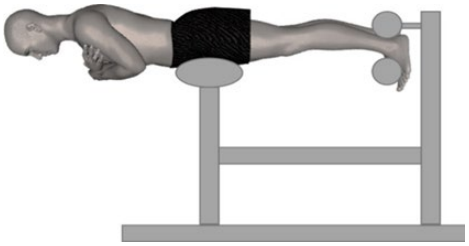

Fig. 3. *Testing position for the Biering-Sorensen test* [10]

This examines the extensors of the spine and is performed with the subject in a prone position, at the edge of the table, the pelvis and ankles are firmly held by the examiners. The subject will maintain the body weight for as long as possible. A healthy subject maintains the position for 2'. In the case of the analyzed subject, the time was 1'10".

The test has proven to be a good assessment tool for predicting the risk of non-specific back pain in patients [20].

***d.** Pain level assessment*

A visual analog scale (VAS) is a simple but valuable instrument that attempts to measure a characteristic or attitude that is believed to vary across a range of values and cannot be easily measured directly [5].

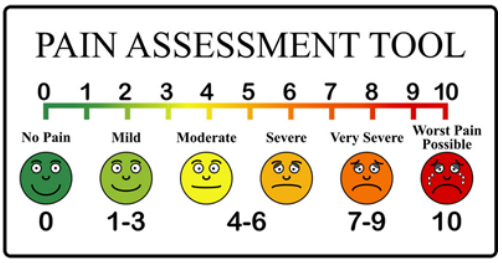

Fig. 4. *Visual analog scale* [21]

The visual analogue scale (VAS), figure 4, determines the intensity of pain, having a horizontal or vertical line 10 cm next to the patient, which indicates the level of pain. The scale ranges from 0 - no pain to 10 - intense pain. The patient is asked to indicate the level of pain.

2.2. Individualized recovery program

During the exercise program for correcting a flat back, the aim was to create the mechanical conditions corresponding to the appearance of physiological curvatures of the spine, to develop joint mobility of the whole body and to make the movements more coordinated and suitable for the purpose for which they are performed. Special attention was paid to relaxing and toning the muscles of the back and spine.

To correct a flat back, exercises that are performed on the spot and especially while moving, freely or with portable objects have been identified. Thus, the most important means used are static exercises in the form of positions derived from the basic positions of standing, sitting, kneeling and lying down, and dynamic exercises as follows:

a) exercises for the trunk in the form of flexion movements in the dorsal region, extensions in the lumbar region, lateral bending to the right and left, twisting to the right and left.

b) exercises with the arms in the form of forward, lateral and downward rotation movements, to amplify the dorsal flexion movement of the trunk.

c) leg exercises, in the form of extension movements, in which abductions, adductions, stretching, bending, sharing, pendulums and rotations were performed.

d) specific breathing exercises after each heavy core exercise, after weighted or applicative exercises.

e) applicative exercises in the form of rolling and walking.

f) exercises with portable objects that increase the corrective effects of the listed exercises.

The kinetic program was carried out based on the following objectives:

a. Reducing muscle pain because of muscle relaxation.
b. Developing mobility and coordination, flexibility and ability of the whole body.
c. Increasing chest elasticity and normal lung capacity.
d. Remodeling the physiological curvatures of the spine.

The recovery program, in which the subject participated, was carried out over a period of 6 months, weekly, with three sessions per week, the duration of a session being one hour - one hour and 30 minutes.

The exercises encompass several objectives, for this reason they were assigned taking into account the clinical picture of the subject and the level of difficulty of the exercises.

Regardless of the objective pursued, the exercises were performed at a slow and gradual pace to avoid possible injuries. After each exercise, the subject took a 20" break. The dosage of the exercises increased over time until the final stage, depending on the nature of the exercises and the patient's capabilities.

In the first two months, the subject performed exercises aimed at all objectives, but we focused more on the objectives of muscle relaxation and stretching, muscle toning, but also on developing spinal mobility.

In the next two months, all objectives

were pursued, but emphasis was placed on muscle toning and developing mobility to create physiological curves and on developing coordination, flexibility and overall body ability.

In the last two months, all objectives were also pursued, especially increasing muscle tone and muscle strength.

3. Results and Discussions

The following results were obtained during the research:

3.1. *Spine assessment – inspection and palpation*

Following this evaluation, it was observed that in the muscle groups analyzed at the initial evaluation, the subject no longer presented muscle hypotonia of the spinal extensors and no longer complained of pain in the gluteal muscles and hamstring muscles. Also, both the muscle contraction and the neck pain disappeared.

3.2. The *Shirado* test

The evaluation following the Sdirado test shows values of 1'30". at the initial testing and 2'10". at the final test. The subject managed to maintain the shoulder position in isometry for 2'10" (figure 5).

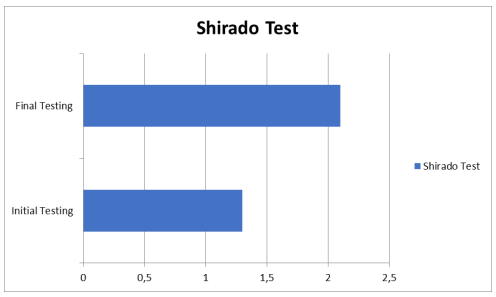

Fig. 5. *Values obtained from the Shirado test*

From figure 5. it can be seen that, at the final testing, the subject managed to maintain the shoulders raised in isometry for 2'10", compared to 1'30", the time obtained at the first evaluation, thus resulting in an increase of 0.8 percent compared to the initial result. Exercises to increase the muscle strength of the neck and to develop its coordination and suppleness led to an increase in the tone of the flexor muscles involved.

3.3. *Biering Sorensen* Test, (figure 6)

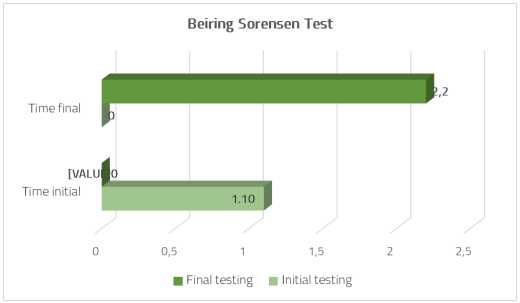

Fig. 6. *Biering Sorensen test values*

The values highlight the optimization of the time of maintaining the trunk in extension in a proportion of 50%.

Compared to the time of 1'10", obtained in the initial testing, the subject managed to maintain the trunk in isometry for 2'20". Since, initially, the subject felt intense pain in the area of the extensor muscles of the spine (erector spinalis, neck - posterior part), but also in the muscles located in the surface plane, in the first stage we focused on performing exercises to de-tension and stretch the paravertebral muscles, both in the thoracic and lumbar areas and on manual relaxation therapy.

In the next stage, we focused on performing exercises to improve muscle control and tone the muscles, so that at

the final evaluation the subject achieved an increase in the time he could maintain the trunk in extension.

3.4. Evaluation of pain intensity level on the VAS scale

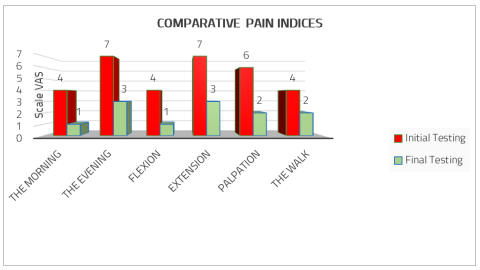

Fig. 7. *Pain intensity levels on the VAS scale*

The graph highlights considerable improvements in pain in all aspects analyzed. The thoracic and lumbar de-tensioning exercises with which the recovery program began were resumed monthly, especially since the subject highlighted pain as the main impediment in carrying out the activities presented. Also, the application of manual therapy, which involved local stretching of the fascia in the paravertebral area, the application of slight pressures in the area, while the subject sat on a chair, flexing the head and neck, the decontracting massage of the shortened iliocostal muscles, the application of transverse pressures in the contracted area, led to a considerable decrease in pain, fig. 7.

3. Conclusions

Research into pain in flat back syndrome can reveal several important aspects that can contribute to the understanding and management of this condition.

Pain can be from poor posture, muscle injuries, herniated discs or degenerative conditions, making it essential to identify the specific cause for effective treatment.

Flat back syndrome has a significant impact on quality of life, affecting daily activities, mobility and emotional well-being. It is important for patients to be aware of this impact and to use a therapy specific to pathology.

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STUDY ON THE DEVELOPMENT OF EXPLOSIVE FORCE IN ATHLETIC JUMPING THROUGH PLYOMETRICS EXERCISES AT THE LEVEL OF JUNIOR ATHLETES

I. SAMSON[1] F. NECHITA[2]

Abstract: *The purpose of this article is to demonstrate the importance of implementing plyometric exercises especially in the case of students in vocational mainstream education for improving relaxation and implicitly sports performance. The present paper highlights a study based on a theoretical and practical approach to the notion of plyometric by applying a specific program based on plyometric exercises for the development of explosive force in advanced groups, compared to subjects carrying out a regular training program. By implementing this type of exercise at the level of all students, regardless of the way in which they practice athletics, benefits are brought both in terms of sports performance and health.*

Key words: *athletics, plyometric exercise, explosive strength, sports performance.*

1. Introduction

Athletic jumping occupies a very important place both in physical education lessons and in sports training. The high level and degree of complexity of national athletic competitions require a standardized training, in which the originality of methods and means of work favours obtaining high performances.

Plyometric training is widely used by specialists to improve athletic performance in a wide variety of sports [8].

Plyometric exercises are widely used by athletics specialists in various phases of sports training [2], [11].

Plyometric exercises are recognized by specialists as the most suitable means of combining strength with speed to achieve the "power" needed in jumping and sprinting athletic events [3]. The popularity and appeal of these exercises has increased among students and performance athletes thanks to current international trends in the use of explosive force.

To increase the potential of future performances, it is important to apply plyometric training from an early age. Among other things, research indicates that this type of exercise has a particularly

[1] High school with sports program, Brasov, Romania
[2] Faculty of Physical Education and Mountain Sports, Transilvania University in Brasov, Romania

beneficial effect on the health and development of students (middle school and high school), regardless of the regime in which they practice sports (performance, mass education, etc. [5].

2. Plyometrics - Method of Explosive Force Development

The etymology of the term plyometrics comes from the Greek language, where “pleion” translates as “more” and “metrikos” which means “to measure” [1].

The study of the plyometric method comes to the attention of researchers in the early 1960s when the Russian school implements plyometric programs in the training of high jumper athletes [12].

The method was quickly picked up by other athletes who perfected it through numerous studies and methodologies [1].

2.1. The peculiarities of the plyometric regimen

Plyometric muscle activity involves motor actions performed by jumping. Whether they are done on one or two legs, in the kicking phase, the athlete's body lowers it’s the center of gravity, directing its speed towards the ground, thus creating the damping phase or the shock absorption phase. Thus, this phase is shorter, the stronger the concentric muscle contraction [7].

Exercises with jumps and jumps are of particular importance in plyometric training, as they determine a much more efficient and ergonomic release. In other words, relaxation is improved, the value of which is already well known.

Verkhoshansky, Y. classifies plyometric training into two categories [12]:

1. *Maximum plyometric training*, where the depth jump intensity is high and the number of repetitions is low.
2. *Submaximal plyometric training*, where contact with the ground is longer and the number of repetitions is higher.

Respecting the principles of sports training and the particularities of the age of athletes, the choice of working methods is a continuous concern for those involved in sports performance.

2.2. The laws of sports training through the plyometric method

First, we focus on the athlete's background and experience in the field. If he has well-structured and applied strength training over several years, the potential plyometric performance can be significantly increased.

The athlete's previous strength experience is very valuable, as it gives them good motor skills, endurance and efficiency.

Plyometric training is a complex one, which requires a good coordination and correlation of the motor qualities of the individual. If they are already formed, as I mentioned before, it will only be up to the plyometric coach to combine them and perfect the strength-speed complex.

However, strengthening in plyometrics is a long process that requires a lot of patience, both on the part of the athlete and the coach.

Second, we consider the individual's psychological profile. As mentioned above, patience is crucial.

This can also be trained in certain ways, such as understanding the entire course of the training and its potential results.

In other words, the principles and laws of the plyometric method must be

explained to the athlete in a synthetic and understandable manner. The individual needs to be aware of both the importance of a consistent approach to this training regime and the special performances he can access in this way.

Psychological counselling plays an important role in maintaining the athlete's motivation and perseverance. Psychologists specialized in sports performance resort to specific counselling methods, managing to maintain the psycho-emotional condition of the athlete [4].

Plyometric exercises should be introduced gradually from the age of 14. However, a recent study indicates that the application of plyometric training at the level of puberty (10-14 years) leads to a significant increase in performance in sporting events that require explosive strength, without putting the children at any kind of risk [3].

Research suggests practicing 50-60 plyometric jumps twice a week for 8-10 weeks [6]. After this initiation period, which period can extend even up to 2 years, the training intensity can be increased, taking into account the needs and ability of the athlete.

From here we deduce another law of plyometric exercise, otherwise universally valid in the world of sports, namely the careful monitoring of the athlete. The volume and intensity of plyometric training must be adapted by the teacher to the requirements imposed by the individual's condition.

Another notion that we can fit into the laws of plyometric training is the number of repetitions. It varies according to the intensity of the exercise and the requirements of the trainer [3].

Finally, we mention a particularly important aspect in sports training through the plyometric method, namely fatigue, specifically its anticipation, prevention and management. To begin with, it should be known that fatigue has two main compartments, i.e. local fatigue and nervous system fatigue.

1. Local fatigue implies the exhaustion of the reserves of molecules with macroergic bonds (adenosine triphosphate and phosphorcreatine). Muscle contraction requires energy. ATP is hydrolyzed to release the energy stored in the bond between the second and third phosphate groups. This is how the ADP (adenosine diphosphate) molecule appears, which must be phophorylated at the level of the mitochondrion in order to be restored to ATP.

This process requires nutrients, especially acid and molecular oxygen. When local fatigue occurs, anaerobic cellular respiration sets in, which produces very small amounts of ATP and a lot of lactic acid, a negative action on muscle fibres.

Stopping the exercise is necessary, so that aerobic respiration can be resumed and the reserve of ATP and CP restored.

2. Nervous system fatigue – fatigue of synaptic transmission, caused by the depletion of neurotransmitter stores in the button endings of axons.

The main chemical mediator (neurotransmitter) at the level of the neuromuscular junction is acetylcholine. When adequate amounts of neurotransmitter are not present, the postsynaptic cell is not properly stimulated, the nerve impulse being diminished from “synapse-to-synapse”.

If the stimulus on the muscle fiber is not strong enough, the Ca2+ channels (an element with a fundamental role in muscle contraction) at the level of the sarcoplasmic reticulum do not

open/partially open, and calcium will not reach the myofibrils in adequate quantities or even at all [3], [9,10].

Fatigue is followed by exhaustion, a condition of the athlete that leads to injury and injury. That is why the effective management and anticipation of fatigue is an important law of plyometric training.

3. Material and Methods

The research was carried out between October 2022 and March 2023 at the High School with Sports Program Brasov (HSSPBV), athletic department.

The study included three stages:

1. Initial Testing (IT) between October 1 and 6, 2022
2. Conducting the research by applying the independent variable to the experiment group
3. Final testing (TF) between March 20 and 25, 2023.

The study was carried out on 2 groups of athletes:

1. *Experimental group* – eight athletes from the advanced group of LPSBV.
2. *Control group* – eight athletes from the advanced group of HSSPBV.

The period of the experiment extended over approximately 5 months, starting in October and ending in March, when the sports competitions began. In this time interval, the independent variable was applied to the experimental group, made up of carefully selected and adapted means of action specific to athletics.

The independent variable, consisting of plyometric means specific to athletics, was applied to the experimental group during the research period.

3.1. The procedure for carrying out the research

The research included three main stages:

1. *The ascertaining stage*, in which the training level of the subjects is established by applying the tests and specific tests for the assessment of the biomotor capacities. The initial testing gives a clear vision of the existing training baggage, a fact that allows the following training to be customized, depending on the case, so the work plan can be developed as efficiently as possible.

2. *The experimental stage* represents the longest period of the research, because the targeted results do not appear immediately. This involves applying the training models after leveling the study samples. The experimental group will be acted upon with the plyometric exercise program with the aim of significantly increasing indices of explosive strength.

3. *The verification stage* is the one in which we ascertain the final results in various ways, such as the verification tests, or through the results obtained in certain competitions, which are ultimately the object of the applied training. The differences between the two groups will be analyzed from a mathematical point of view, thus ascertaining the level of the students. The conclusions established after this stage will confirm or not the veracity of the hypothesis presented at the beginning of the paper.

3.2. Specialized training model

Objectives:

- improving physical development
- general
- strengthening the technique of running with acceleration/step launched;

- development of general strength;
- development of explosive strength with light plyometric exercises;
- consolidating/perfecting the technique
- long jump with elk;
- theoretical training related to plyometric methods.

• The preparatory part:
- easy run 1000 m
- joint mobility 10 min
- special exercises 2 x 40 m
- sprint run 4 x 60 m, I 75%

•The fundamental part
- accelerated running 5 x 30 m
- alternating jumping rope (S-D) 6 x 30, I 75%, P 2 min
- jumps over small hoops 40 cm 2 x 5 x 20m, I 80%, P 4 min
- alternative gymnastic bench jumps (S-D) 5 x 20
- counter jumps 40 cm 5 x 20, I 80%, P 4 min
- standing long jump 5 x 20, I 75%, P 2 min

• The closing part:
- joint mobility 20 min;
- easy run 1000 m

4. Results and Discussions

4.1. Research-specific evidence

a) Long jump without momentum

b) The Sargent Jump test - the detent on vertically

a) Long jump without momentum

Table 1

Long jump results without momentum and correlated values in the experimental group

Experimental group	Ti (m)	Tf (m)	Δd (m)
S1	2,20	2,45	0,25
S2	2,00	2,18	0,18
S3	2,15	2,35	0,20
S4	2,25	2,45	0,20
S5	2,05	2,20	0,15
S6	2,35	2,55	0,20
S7	2,40	2,60	0,20
S8	2,38	2,55	0,17
Arithmetic mean $\bar{X}$ (m)	2,22	2,42	0,19
Standard deviation – S	0,14	0,15	0,02
The coefficient of variability - CV	6,30%	6,19%	10,52%
Amplitude – W (m)	0,40	0,42	0,1

Table 2

Long jump results without momentum and correlated values in the control group

Control group	Ti (m)	Tf (m)	Δd (m)
M1	2,05	2,08	0,03
M2	2,15	2,20	0,05
M3	2,00	2,05	0,05
M4	2,10	2,13	0,03
M5	2,05	2,09	0,04
M6	2,10	2,12	0,02

Control group	Ti (m)	Tf (m)	Δd (m)
M7	2,12	2,15	0,03
M8	2,16	2,20	0,04
Arithmetic mean $\bar{X}$ (m)	2,09	2,12	0,03
Standard deviation – S	0,05	0,06	0,01
The coefficient of variability - CV	2,39%	2,83%	33,33%
Amplitude – W (m)	0,16	0,15	0,03

b) Sargent Jump Test

Table 3

The Sargent Jump test results and correlated values in the experimental group

Experimental group	Ti (m)	Tf (m)	Δd (m)
S1	58	66	8
S2	55	65	10
S3	59	65	6
S4	62	68	6
S5	60	74	14
S6	67	78	11
S7	65	79	14
S8	69	83	14
Arithmetic mean $\bar{X}$ (m)	61,87	72,25	10,37
Standard deviation – S	4,48	6,7	3,23
The coefficient of variability - CV	7,24%	9,27%	31,14%
Amplitude – W (m)	14	18	8

Table 4

Sargent Jump Test Results and Correlated Values in the Control Group

Control group	Ti (m)	Tf (m)	Δd (m)
M1	53	57	4
M2	52	58	6
M3	61	64	3
M4	59	67	8
M5	65	72	7
M6	64	69	5
M7	63	70	7
M8	67	73	6
Arithmetic mean $\bar{X}$ (m)	60,5	66,25	5,75
Standard deviation – S	5,14	5,69	1,56
The coefficient of variability - CV	8,49%	8,58%	27,13%
Amplitude – W (m)	15	16	4

a) The long jump without momentum is an event that relies solely on the explosive force required to lift off the ground.

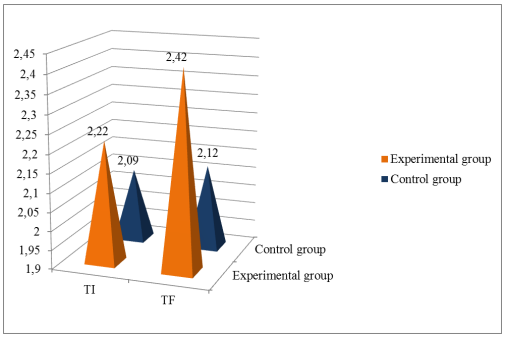

Fig. 1. *Graphical interpretation of the long jump results without momentum for the two groups*

If we follow figure 1 that centralizes the averages of the two groups over time, we notice that the experimental sample enjoys much higher performances (from 2.2 m to 2.4 m), while the average TF and TI of the control group is almost identical. This is due to plyometric training, the purpose of which is to increase the relaxation of the athletes.

When analyzing the coefficient of variability, we realize that, for the experimental group, it is decreasing at the final moment compared to the initial one, showing the appearance of homogeneity at the collective level. This phenomenon testifies to the fact that, over time, the applied training raised all subjects to approximately the same level. The rest of the numerical differences are small.

When we study the CV values in the control sample we notice a visible increase (from 2.4% to 2.8%). Although the difference is not dramatic, it is understood that the applied classical training causes a slight increase in intracollective heterogeneity.

If we correlate the values recorded in this trial with those from the height, we find the following: Although DE, who is at the final moment the tallest (189.5 cm), he does not register by far the best performance in the jump. On the contrary, the record is held by CL (185 cm) at that time, a fact that proves that somatic privileges are not the defining factors in achieving performance.

b) Taking into account both the values recorded at the level of the two samples of subjects and the values of the related relaxation and qualification of the Sargent Jump test, we can classify the average result of the experimental group from the qualification "excellent", which attests to the increased effectiveness of the plyometric training method that was applied.

We also track the discrepancies between the two groups in terms of evolution over time. Although neither stagnates, the mean at TF of the experimental sample is noticeably higher than that of the control group, figure 2.

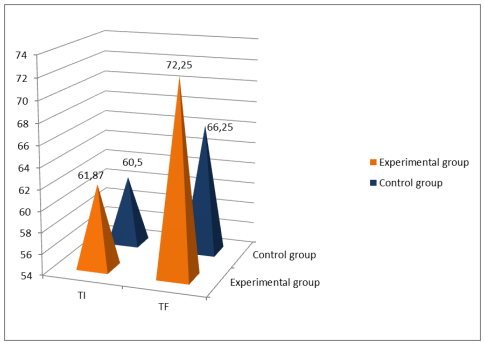

Fig. 2. *Graphical interpretation of Sargent Jump test results for the two groups*

The coefficient of variability of the collected values is, in both cases, at the optimal parameters, indicating a good homogeneity of the groups. At the Δ section, it shows increased values, which suggest a varied evolution of the measured values and confirm the diversity of the changes that occurred in order to obtain increased and relatively homogeneous results.

The graphic representation of these statistical values highlights the differences between the two applied training methods, confirming again the special effect of the plyometric exercises.

3. Conclusions

All systematized theoretical notions, recorded results and outlined statistics confirm the implementation of plyometric exercises for the development of explosive force in junior athletes.

The results obtained in the research tests are superior in the case of the experimental group, a fact that attests to the importance and special effectiveness of plyometric training.

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THE ROLE OF MOVEMENT GAMES IN THE EDUCATION OF SPEED INDICES IN THE PRE-UNIVERSITY SYSTEM

Florentina NECHITA[1]

Abstract: *Exercise games form basic motor knowledge, skills and abilities such as: walking correctly, running economically, jumping and throwing efficiently, while developing the basic motor skills needed in daily life or for subsequent sports. The aim of the research is the possibility to educate the motor quality, speed, through the introduction in the didactic projects of some dynamic and varied movement games at the level of the schoolchildren, which determine an increase of the general motor skills. A good selection of them and properly directed, they present an important means of psycho-physical development of the individual, the formation of motor and volitional qualities, as well as the strengthening of health.*

Key words: *physical activity, movement, speed, motor skills.*

1. Introduction

Physical education and sports is the main form of training exercises on the human personality, establishing a balance between physical and mental.

Today's society imposes an education based on the formation of an active, harmonious, healthy personality, where the social role of undertaking sports activities is indisputable.

Physical education, as a component of general education, contributes to: the development and improvement of the child in terms of motor skills; stimulation of intellectual activity and emotional processes; developing group relationships; dynamization of psychic processes; training skills and qualities in the work process; improving the organs, functions, apparatuses of the body; the improvement of particular notes that appear in the activity of some organs, apparatuses, processes, as an effect of the physical exercise: the sense of the ball, the sense of rhythm, of the slip, peripheral sight, tactical thinking, motor memory, kinaesthetic sensations etc.

In accordance with these provisions, physical education programs reflect the fundamental ideas and organizational measures that underlie the reform of pre-

[1] Department of Physical Education and Special Motricity, *Transilvania* University of Braşov.

university education:

- Decreasing the age of entry of children in the first grade;
- Focusing the teaching process on equipping children with attitudes, knowledge and skills, established by the framework objectives for the entire cycle and by the reference objectives specified for each of its classes;
- Understanding the contents as means that lead to the achievement of precisely structured reference objectives and not as a learning goal;
- Essentializing the contents and reporting their volume to the minimum number of hours provided in the curricula;
- Orientation of the didactic process on learning activities in which the action (practical) component of the students is predominant;
- Adaptability to the diversity of conditions in which the teaching of physical education is carried out, so that the reference objectives are achieved regardless of the conditions of technical-material endowment;
- Providing the possibility for teachers and students to choose to approach alternative content categories, corresponding to individual or group interests in accordance with local traditions.

In this context, the rigors of the scientific design of physical education in the pre-university system find application in the projects of recovery of our field of activity [9].

2. Peculiarities of the Physical Education Lesson in the Pre-university System

2.1. Characteristics of the school physical education lesson

The definition that addresses both sides of the problem is conceived by Cerghit, I. as follows: existing conditions corresponding to the intended purpose.

In the most general way, the content of the lesson (imposed by its typology) consists of all means, methods, methodical procedures and other teaching measures (effort dosing, choice of training, differentiated treatment, assessment methods, etc.), which all converge towards the achievement of the projected themes and objectives [4]".

2.2. General methodological guidance on basic motor quality education - speed in the lesson

When selecting the exercises for the development of different forms of speed manifestation, it is necessary to take into account the particularities of speed manifested at different ages, so that the training process is carried out in accordance with the individual possibilities of students. The requirements for developing speed in physical education lessons are as follows:

- speed development exercises will be planned at the beginning of the lessons;
- the duration of the speed exercises must be in the time -interval minimum 5-6 seconds and maximum 40-43 seconds;
- the breaks between repetitions must be long enough to allow the return of vegetative functions, but not the reduction of the optimal state of excitability obtained at the level of the cerebral cortex as a result of performing exercises with maximum speed;
- for the development of the speed the subject must have well mastered the motor structure that make up the exercises;

- the exercises to request the maximum indications of speed manifestation;
- each exercise should last as long as the speed of execution at high parameters can be maintained;
- the effort must be repeated (after an almost complete recovery pause) as long as the speed does not decrease due to fatigue;
- repeating the effort with maximum speed, is the main way to develop speed;
- at each resumption of the effort, the subject must tend to exceed the previous performance;
- during the development of speed, the development of other motor qualities must not be neglected either.

2.3. Means for developing speed in the physical education lesson

Wanting to develop speed in the lesson of education, we can use all the movements that make up the content of the means of physical education, performing them with maximum speed under normal conditions of execution, in light conditions to increase the speed of execution and in conditions of difficulty to increase the effort with maximum speed.

These means of developing speed can be:

- ”for the selective influence of the locomotors system, exercises performed in fast tempo, these developing the execution speed, the repetition speed and the sense of rhythm, they being recommended both in classes I-IV and in classes V-VIII;
- front and order exercises, formations, changes of directions, restoration of certain formations in other work areas, changes of formations, orders given by surprise and reverse commands. All these develop the speed of reaction, the speed of execution and the ability to concentrate attention, being recommended to all classes;
- motion games and application relays that require attention and quick reactions to various pre-set signals, or given by surprise. They develop reaction speed, accuracy, repetition speed; they can be used in all classes;
- exercises and ball games: quick throws and catches, catching the ball thrown or bounced off the wall, catching and passing two or three balls simultaneously or alternately, etc. These exercises will develop all forms of manifestation of speed in complex conditions; they can be applied to all classes;
- starting and stopping from and in different positions (sitting, squatting, lying down, with your back to the direction of travel, etc.), at different signals (audible or visual), movements are performed at maximum speed, developing the reaction speed, that of repetition and execution. These exercises are recommended for all classes;
- by performing various jumps with a beat on one or both legs, the speed of execution and the speed in force regime - relaxation will be developed;
- the running school exercises used mainly for speed running;
- the acceleration runner step, the speed launch step, the bottom start and the start;
- develops the speed of repetition as well as other forms of manifestation of speed;
- technical elements and procedures from sports games performed at high

speeds (fast passes, counterattacks, quick rebounds, driving the ball at speed, etc.); develops the speed of reaction in complex actions, the other forms of manifestation of speed in different conditions of demand as well as the ability to anticipate and decide; it is recommended to be used only after thorough mastery of the basic mechanisms of technical procedures;

- bilateral sports games with simplified rules performed on small fields, in short halves, elimination of some rules and procedures for the dynamisation of the game; It is preferable to use it in teams that have a good command of the technique and tactics of the game "[8].

Depending on the space in which the activity takes place and the specifics of the respective lesson, the concern for the development of speed, must be permanently realized both by specific and non-specific means. Speaking of speed, it should be noted that after obtaining the maximum speed to continue running with the same intensity, depends on the quality of endurance. From this point of view, it is recommended that the programmed accelerations be performed over distances between 15-30m, repeated several times, with complete recovery breaks after each series..

3. The Role of Dynamic Games in Speed Education in the Physical Education Lesson

The game is a complex activity predominantly motor and emotional, carried out spontaneously according to pre-established rules, for recreational, sports and at the same time to adapt to social reality [7].

Movement games are an important means by which an important part of the tasks of physical education is achieved. They develop in students, in addition to the large baggage of basic motor skills, a sense of community, inventiveness and especially knowledge [13].

Ștefan, M. (2006) defines the game of movement as follows: "Playful activity through which the motor qualities of children are enhanced, responding to their need for movement. It is based on physical exercise, in which the child knows and develops his strength and endurance, but also courage and will. I am, the one more often, games with rules, requiring the manifestation of the team spirit, of the fair-play attitude in the competition" [11].

Among its benefits, the game also brings:

- improving the condition of the body;
- removing boredom caused by inaction;
- game - resting element;
- agent of social manifestation;
- way of transmitting ideas, habits from one generation to another.

At school age, the importance of these movement games is materialized by:

- a slow physical development, the child gaining weight faster at the expense of height;
- the ossification process is in continuous development, the muscles and implicitly, the muscular force develops, including the fine muscles of the fingers (necessary for writing) [6];
- skills for more complex activities begin to form;
- mental capacity develops under the influence of school; new motor attitudes and behaviours appear;
- -learning becomes a type of fundamental activity especially due to radical changes conditioned by mental

development. Increases the ability to operate mentally with more or less abstract elements, moving from contemplation and intuitive understanding to logical operation with elements that fall under the scope of thinking;

– the child's personality gains a lot, especially in terms of developing interests, attitudes, characteristics. Personality traits begin to stabilize, become more balanced and gradually approach their specific forms, which will accompany the entire attitude and behaviour of the child in all areas of his activity [10].

3.1. The formative character and the effectiveness of using the movement games in the lesson

The characteristics of the game are determined by their nature, but also by the age of those who practice them, and the most important characteristics of the game are the following:

- play is a natural activity that springs from the natural needs of movement and manifestation of the qualities of the human being;

- it is a free activity, with voluntary participation, in which the human desire and need to play prevails [14].

It has a spatial limitation, in which its own order reigns; the game creates and imposes order; any deviation from the rules distorts its character and suppresses its value; order and tension lead to its rules which are obligatory and indisputable [1].

In choosing the game must take into account:

- the tasks and lesson objectives chosen and achievable through the game;

- the particularities of age, sex, training and physical and motor development [2].

Speed education motion games:

1. The game "Race on numbers", the class will be divided into equal teams as the number of students. Each team will be counted in depth as each student will have a number (figure 1). When saying the number, the performer leaves the line and runs at full speed, bypasses the landmark and returns to the formation. The game continues in this way, the teacher saying the following numbers one by one.

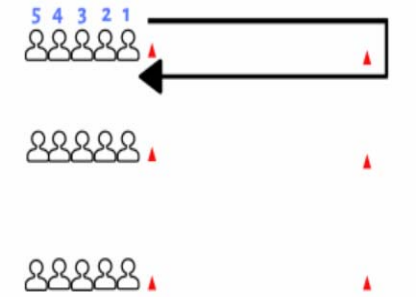

Fig. 1. *The game "Race on numbers*", [15]

2. The game "Catch the circle", the work teams will be the same as in the previous game. The difference from the work formations from the previous game is that the first student in each team with the number “1” will have a circle in his hand (figure 2).

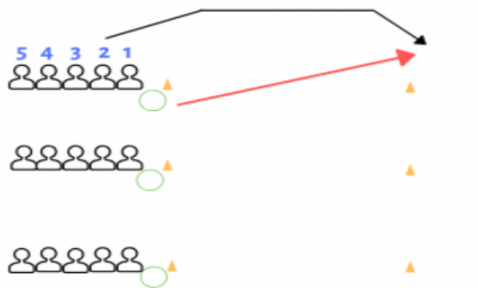

Fig. 2*. The game "Catch the circle*”, [15]

At the teacher's whistle the first student rolls the circle forward, when the circle

rolls the teacher shouts a number, the number comes out of the running team and catches the circle from his team before it falls. After the student has caught the circle, he returns with the circle to his team and returns it to the first student and he sits down where he started.

3. The game "Square of speed", A square with a side of 4-5 meters will be made. In the middle of the square will be a landmark, and in front of it in the middle at a distance of 6-7 meters will be another landmark.

These landmarks will be numbered exactly as in figure 3. The game will start with a student at landmark no. 0. The teacher will say a number. The student runs, bypasses the marker with number 1, returns to point 0, after which he runs at maximum speed to the marker with number 5.

After a certain number of repetitions the teacher will say two numbers, then three numbers and finally four numbers. When two numbers are said the student has the following route:

- the student runs to the first said number;
- returns to point 0;
- run to the second said number;
- returns to point 0;
- finish running in point 5.

This order is also observed when three or four numbers are said. After each execution, the student walks back to his own team's tail. Several teams and such workshops can be held.

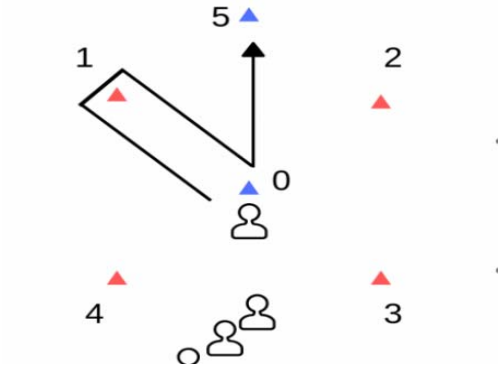

Fig. 3. *The game "Square of speed*, [15]

The staggering of different movement games in the school curriculum contributes to the improvement of the subjects' speed indices. Thus, as specific tests regarding their evaluation we present: the Illinois agility test and the running agility test clockwise.

The Illinois agility test is a test that has a length of 10 meters and a width (distance between points of departure and arrival) of 5 meters. Four milestones are used to mark the start, end and two bypasses. Four other milestones are placed in the center at an equal distance. Each milestone in the center is spaced 3.3 meters apart, figure 4.

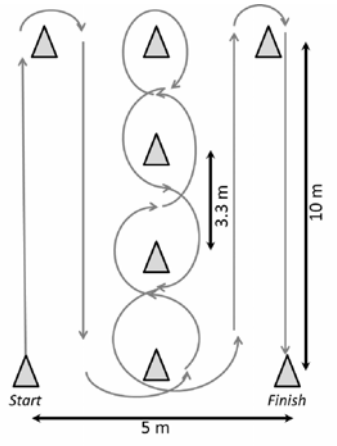

Fig. 4. *Illinois Agility Test*, [16].

Clock running test - the milestones are placed according to the diagram, the four milestones placed in the shape of a diamond and one in the middle, figure 5.

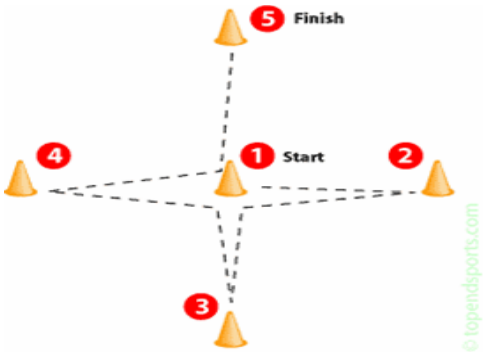

Fig. 5. *Clock running test*, [4].

The comparative analysis of the values obtained in an experiment at pre-university level can be found in figures 6 and 7.

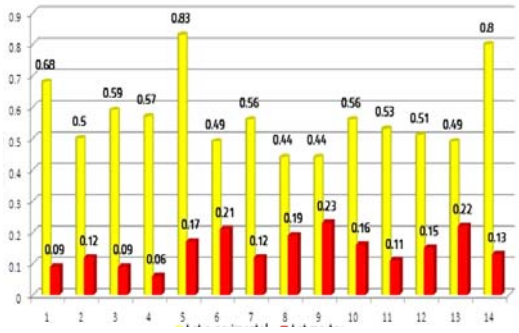

Fig. 6. *Illinois Agility Test Values*

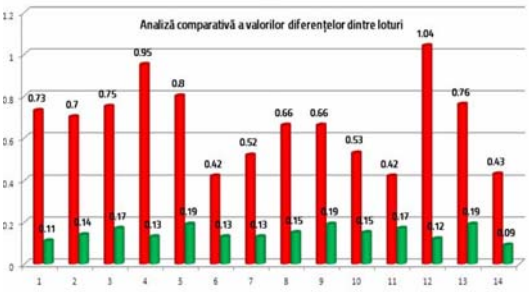

Fig. 7. *Clock running test*

The values obtained are significant, which indicates the possibility to educate the motor quality, speed, through the introduction in the didactic projects of some dynamic and varied movement games at the level of the schoolchildren, which determine an increase of the general motor skills.

4. Discussions

Movement games have as an essential element the movement subordinated to certain ever-changing rules and conditions. In order for the games to have the desired efficiency, the location, the teaching materials used and the number of subjects involved must be taken into account.

The use of different movement games in physical education lessons leads to the development and improvement of psychomotor skills, along with the improvement of basic motor skills to practice the game independently [3].

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Unitatea: AMISTIM MEDICAL EQUIPMENT S.R.L.
Sediul in: SECTOR 1, BUCURESTI, BULEVARDUL IOAN CUZA NR 28 A SECT 1 BUCURESTI
CUI: 36869749

CONTRACT INDIVIDUAL DE MUNCĂ
încheiat și înregistrat sub nr. 17 din 29.10.2025 în registrul general de evidență a salariaților

A. Părțile contractului

Angajator: **Persoana juridica, AMISTIM MEDICAL EQUIPMENT S.R.L.,** cu sediul în **SECTOR 1, BULEVARDUL IOAN CUZA NR 28 A SECT 1 BUCURESTI BUCURESTI,** cod fiscal **36869749,** telefon: _____, reprezentat legal prin **AMOIRIDIS GEORGIOS** în calitate de **administartor** ,
Și
Salariatul: **NECHITA FLORENTINA**, domiciliat în **BRASOV, STR CARPATILOR , NR 47, BL. D22,SC A, AP 6**, județ **BRASOV**, posesor al cărții de identitate seria **_ZV_** nr. **189054,** eliberată de **SCLEP BRASOV** , la data de **_22.02.2018** , cu CNP **2770318080010,** dată naștere **18.03.1977,**
am încheiat prezentul contract individual de muncă în următoarele condiții asupra cărora am convenit:

B. Obiectul contractului: prezentul contract are ca obiect prestarea muncii de catre Salariat, sub autoritatea angajatorului in schimbul salariului datorat acestuia de catre Angajator.

C. Durata contractului:
Determinata, de 26 luni si 29 zile, pe perioada cuprinsa de la data de 03.11.2025 si pana la data de 31.01.2028 pe perioada de desfasurare a proiectului : COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01

D. Perioada de probă: nu este cazul
a) durata de ___-____ zile calendaristice;
b) condițiile perioadei de probă (dacă există) _____.

E. Locul de muncă
1. Activitatea se desfășoară la locul de muncă **_Bucuresti _**, punctul de lucru -_____ din județul **___sector 1____**, localitatea **_Bucuresti _ , Bdul Alexandru Ioan Cuza , nr 28A, corp B**
2. În lipsa unui loc de muncă fix salariatul va desfășura activitatea astfel: _____ (pe teren/la sediul clienților/arie geografică _____, grup de unități etc.). În acest caz salariatul va beneficia de: _____
a) prestații suplimentare _____ (în bani sau în natură);
b) asigurarea/decontarea transportului de către angajator _____ (după caz).

F. Felul muncii
Funcția/ocupația **MANAGER PROIECT,** conform cod COR **242101**.

G. Durata timpului de muncă și repartizarea acestuia:

1. **O fractiune de norma de 8 Ore/luna.**

a) Repartizarea programului de muncă se face după cum urmează **Ore de zi** (~~zilnic (uniform)~~)/**inegal**/~~schimburi/ture/flexibil/individualizat), _____ (ore de zi/ore de noapte/ore in perioada de repaus).~~ **INEGAL , in functie de cerintele proiectului-, 8 ore/ luna**

b) Programul de muncă se poate modifica în condițiile regulamentului intern/contractului colectiv de muncă aplicabil.

c). Nu se vor efectua ore suplimentare cu exceptia cazurilor de forta majora sau pentru alte lucrari urgente destinate prevenirii producerii unor accidente sau inlaturarii consecintelor acestora.

2. Modalitatea de organizare a muncii în schimburi, după cum urmează: _____.

H. Concediul

Durata concediului anual de odihnă este de ____**21**___ zile lucrătoare, în raport cu perioada lucrată.

De asemenea, beneficiază de un concediu suplimentar de _____ zile lucrătoare.

I. Salariul

1. Salariul de baza lunar brut: **200** lei.
2. Alte elemente constitutive:

a) sporuri ;

b) indemnizații _____;

c) prestații suplimentare în bani _____;

d) modalitatea prestațiilor suplimentare în natură _____;

e) alte adaosuri _____.

3. Orele suplimentare prestate de salariații cu normă întreagă în afara programului normal de lucru se compensează cu ore libere plătite în următoarele 90 de zile calendaristice după efectuarea acesteia, conform contractului colectiv de muncă aplicabil sau Legii nr.53/2003 - Codul muncii. În cazul în care compensarea prin ore libere plătite nu este posibilă, orele suplimentare prestate în afara programului normal de lucru vor fi plătite cu un spor la salariu în cuantum de _____.

4. Munca prestată în zilele de sărbători legale, precum și în zilele libere plătite stabilite prin acte normative/contracte colective de muncă aplicabile, se compensează cu timp liber plătit sau cu un spor la salariu, conform contractului colectiv de muncă aplicabil sau Legii nr. 53/2003 Codul muncii.

5. Data/datele la care se plătește salariul este/sunt _____.

6. Metoda de plată _____.

J. Alte clauze:

a) perioada de preaviz în cazul concedierii este de _____ **zile lucrătoare**, conform Legii nr. 53/2003 - Codul muncii sau contractului colectiv de muncă aplicabil, după caz;

b) perioada de preaviz în cazul demisiei este de _____ **zile lucrătoare**, conform Legii nr. 53/2003 - Codul muncii, cu modificările și completările ulterioare sau contractului colectiv de muncă aplicabil;

c) în cazul în care salariatul urmează să-și desfășoare activitatea în străinătate, informațiile prevăzute la art.18 alin. (1) din Legea nr. 53/2003 - Codul muncii se vor regăsi și în contractul individual de muncă;
d) alte clauze _____.

K. Atribuțiile postului
Atribuțiile postului sunt prevăzute în fișa postului, anexă la contractul individual de muncă.

L. Riscurile specifice postului
Riscurile de accidentare și îmbolnăvire profesională specifice postului sunt prevăzute în evaluările de risc ale locului de muncă/postului de lucru și în fișa de identificare a factorilor de risc profesional.

M. Criteriile de evaluare a activității profesionale a salariatului:
- **ÎNDEPLINIREA SARCINILOR**: se ține seama de precizie, curățenie, îndemânare, organizarea muncii, utilizarea riguroasă a materiilor prime și materialelor;
- **RELAȚIONARE**: se ține seama de folosirea integral a programului de lucru, volumul de muncă realizat și capacitatea de a respecta planul lucrării în condiții normale de muncă;
- **PERSONALE**: se ia în considerație capacitatea de a face față schimbărilor condițiilor de muncă, de a se acomoda cu noi situații, ușurința de a învăța noile îndatoriri;
- **SITUAȚIONALE**: se ia în considerație capacitatea de a evalua o idee sau o situație nou apăruta, de a trage concluzia corectă, capacitatea de a lua o decizie corectă;
- **MANAGERIALE**- se ia în considerație abilitatea de folosire eficientă a resurselor puse la dispoziție de unitate, de corelare a inițiativei cu capacitatea de previziune și control:

N. Semnătura electronica
Utilizarea semnăturii electronice, semnăturii electronice avansate și semnăturii electronice calificate se realizează după cum urmează: _____, în conformitate cu prevederile actelor normative/Regulamentul intern/contract colectiv de muncă aplicabil.

O. Formare profesională
Formarea profesională se realizează în următoarele condiții: _____ în conformitate cu prevederile actelor normative/Regulamentul intern/contract colectiv de muncă aplicabil.

P. Condiții de muncă:
Activitatea se desfășoară în condiții normale/~~vătămătoare/deosebite/speciale de muncă/deosebit de periculoase~~, în conformitate cu prevederile legale.

Q. Drepturi și obligații ale părților privind sănătatea și securitatea în muncă:
a) echipament individual de protecție __-_____;
b) echipament individual de lucru ____-___;
c) materiale igienico-sanitare ____da___;
d) alimentație de protecție _-_____;
e) alte drepturi și obligații privind sănătatea și securitatea în muncă _____.

R. Drepturi și obligații generale ale părților:

1. Salariatul are, în principal, următoarele drepturi:

a) dreptul la salarizare pentru munca depusă;
b) dreptul la repaus zilnic și săptămânal;
c) dreptul la concediu de odihnă anual;
d) dreptul la egalitate de șanse și de tratament;
e) dreptul la securitate și sănătate în muncă;
f) dreptul la acces la formare profesională;
g) ale drepturi și obligații prevăzute de lege sau de contractele colective de muncă aplicabile, după caz.

2. Salariatului îi revin, în principal, următoarele obligații:

a) obligația de a realiza norma de muncă sau, după caz, de a îndeplini atribuțiile ce îi revin conform fișei postului;
b) obligația de a respecta disciplina muncii;
c) obligația de fidelitate față de angajator în executarea atribuțiilor de serviciu;
d) obligația de a respecta măsurile de securitate și sănătate a muncii în unitate;
e) obligația de a respecta confidențialitatea informațiilor și documentelor utilizate în îndeplinirea atribuțiilor de serviciu;
f) obligația de a adera la un fond de pensii administrat privat, în conformitate cu prevederile art.30 din Legea nr.411/2004, privind fondurile de pensii administrate privat, cu modificările și completările ulterioare.

3. Angajatorul are, în principal, următoarele drepturi:

a) să stabilească atribuțiile de serviciu și norma de muncă pentru fiecare salariat;
b) să dea dispoziții cu caracter obligatoriu pentru salariat, sub rezerva legalității lor;
c) să exercite controlul asupra modului de îndeplinire a sarcinilor de serviciu;
d) să constate săvârșirea abaterilor disciplinare și să aplice sancțiunile corespunzătoare, potrivit legii, contractului colectiv de muncă aplicabil și regulamentului intern;
e) să stabilească obiectivele de performanță individuală a salariatului, precum și criteriile de evaluare a realizării acestora;
f) să suporte asigurarea medicală privată, contribuțiile suplimentare la pensia facultativă sau la pensia ocupațională a salariatului, în condițiile legii, după caz;
g) să acorde, orice alte drepturi, stabilite ca urmare a activității profesionale a salariatului.

4. Angajatorului îi revin, în principal, următoarele obligații:

a) sa înmâneze salariatului un exemplar din contractul individual de muncă, anterior începerii activității;
b) să înființeze registrul general de evidență a salariaților și să opereze înregistrările prevăzute de lege;
c) să acorde salariatului toate drepturile ce decurg din contractele individuale de muncă, din contractul colectiv de muncă aplicabil și din lege;
d) să asigure permanent condițiile tehnice si organizatorice avute în vedere la elaborarea normelor de muncă si condițiile corespunzătoare de muncă;
e) să informeze salariatul asupra condițiilor de muncă și asupra elementelor care privesc desfășurarea relațiilor de muncă;

f) să informeze angajatul cu privire la obligația de a adera la un fond de pensii administrat privat, în condițiile legii;
g) să elibereze, un document care să ateste calitatea de salariat a solicitantului, respectiv activitatea desfășurată de acesta, durata activității, salariul, vechimea în muncă, în meserie și specialitate sau un extras din registrul general de evidență a salariaților, datat și certificat pentru conformitate;
h) să asigure confidențialitatea datelor cu caracter personal ale salariatului.

S. Dispoziții finale
1. Nivelul la care contractul colectiv de muncă aplicabil a fost încheiat (ex: unități/grup de unități/sector de unitate) _____ _____ _____.
2. Prevederile prezentului contract individual de muncă se completează cu dispozițiile Legii nr. 53/2003 - Codul muncii și ale contractului colectiv de muncă aplicabil prevăzut la litera S pct.1.

Orice modificare privind clauzele contractuale în timpul executării contractului individual de muncă impune încheierea unui act adițional la contract, conform dispozițiilor legale, anterior producerii modificării, cu excepția situațiilor în care o asemenea modificare este prevăzută în mod expres de lege sau în contractul colectiv de muncă aplicabil.

T. Conflictele în legătură cu încheierea, executarea, modificarea, suspendarea sau încetarea prezentului contract individual de muncă pot fi soluționate atât pe cale amiabilă prin procedura concilierii, cât și de instanța judecătorească competentă material și teritorial, potrivit legii.

Prezentul contract individual de muncă s-a încheiat în două exemplare, câte unul pentru fiecare parte.

Angajator,

AMISTIM MEDICAL EQUIPMENT S.R.L.

AMOIRIDIS GEORGIOS
Semnătura

Salariat,

NECHITA FLORENTINA

Semnătura

Sunt de acord cu prelucrarea datelor personale (G.D.P.R.) potrivit REGULAMENTULUI (UE) 2016/679 în scopul încheierii unui contract individual de muncă și derulării raporturilor de muncă,
Am primit un exemplar în original
Semnătura

29.10.2025

Obiectivul principal al proiectului de cercetare: **101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01: Intervenții personalizate prin evaluare funcțională în demență** este *îmbunătățirea evaluării funcționale și a protocoalelor de antrenament personalizat pentru adulții în vârstă: rolul AMI în proiectul COMFORTage.*

*Despre **AMISTIM MEDICAL EQUIPMENT S.R.L. (**AMI) și misiunea noastră.*

AMI, își desfășoară activitatea dedicată dezvoltării, testării și optimizării protocoalelor de fizioterapie care vizează îmbunătățirea calității vieții și a capacității funcționale, în special pentru adulții în vârstă și persoanele cu risc de afecțiuni neurodegenerative, cum ar fi demența. În centrul filosofiei AMI se află angajamentul față de știința mișcării bazată pe dovezi, intervenția timpurie și personalizarea îngrijirii prin evaluare continuă și integrare tehnologică. Prin participarea noastră la proiectul COMFORTage, ne propunem să aducem o perspectivă funcțională și a sănătății fizice în cercetarea și prevenirea demenței - punând accentul pe corp ca o componentă cheie a sănătății.

Cercetarea specifică se concentrează pe trei axe principale:

1. Colectarea de date funcționale și de mișcare detaliate de la adulți în vârstă, inclusiv de la cei cu semne precoce de declin cognitiv.

2. Evaluarea diferitelor intervenții, comparând antrenamentul tradițional de forță cu antrenamentul de forță combinat cu TENS (stimulare electrică transcutanată a nervilor).

3. Contribuția cu date anonimizate și structurate pentru a sprijini crearea de modele predictive și protocoale personalizate pentru prevenție, reabilitare și luarea deciziilor clinice.

Justificare: Rolul mișcării în prevenirea demenței

Deși screeningul cognitiv și cercetarea biomarkerilor sunt piloni centrali ai cercetării în domeniul demenței, funcția fizică este un predictor puternic și adesea sub utilizat al declinului cognitiv și al calității vieții la adulții în vârstă. Deficiențe subtile ale echilibrului, mersului și dexterității pot adesea preceda sau oglindi simptomele neurocognitive, ceea ce le face indicatori critici pentru intervenția timpurie. La AMI, recunoaștem că îmbunătățirea funcției fizice este atât un obiectiv, cât și un instrument – aceasta îmbunătățește viața de zi cu zi, reduce riscul de căderi și contribuie la neuroplasticitate și reziliență cognitivă. În cadrul COMFORTage, ne propunem să cuantificăm și să validăm aceste relații într-un mod riguros și reproductibil.

Evaluări funcționale în cadrul AMI

Pentru a susține această viziune, AMI efectuează o serie detaliată de evaluări într-un mediu de laborator controlat, utilizând instrumente de nivel clinic și protocoale validate.

Măsurătorile noastre se concentrează pe:

- stabilitate posturală și echilibru (folosind platforme de forță și instrumente de captare a mișcării);
- analiza mersului (lungimea pasului, cadența, viteza mersului, variabilitatea);
- dexteritatea membrelor superioare (sarcini de control al motorului fin, testul Grooved Pegboard);
- coordonarea și eficiența mișcării;
- mobilitatea funcțională (teste de ridicare din așezat, test de ridicare și deplasare cronometrat, testul de întoarcere la 360 de grade etc.)

Aceste evaluări sunt efectuate înainte și după intervenție, permițându-ne să evaluăm atât profilul de risc de bază al participanților, cât și eficacitatea diferitelor protocoale de antrenament în timp. Toate datele sunt procesate, anonimizate și structurate pentru includerea în baza de cunoștințe COMFORTage, sprijinind dezvoltarea modelului de inteligență artificială interinstituțională și urmărirea rezultatelor pe termen lung.

Studii de intervenție: Compararea modalităților pentru impact maxim

În colaborare cu alți parteneri COMFORTage, AMI compară diferite modalități de antrenament:

- antrenament de forță individual: Exerciții tradiționale de rezistență care vizează grupele musculare majore (flexorii șoldului și flexorii plantari), concentrându-se pe supraîncărcarea progresivă și controlul neuromuscular;
- antrenament de forță + TENS: Aceleași exerciții de rezistență combinate cu stimulare electrică de suprafață pentru a îmbunătăți potențial recrutarea musculară, propriocepția și neuroplasticitatea;
- grup de control: Participanți care își mențin activitățile regulate fără intervenții suplimentare prin exerciții fizice, utilizate pentru a evalua progresia naturală și a diferenția efectele antrenamentului.

Aceste intervenții sunt implementate pe o perioadă de mai multe săptămâni, cu monitorizare și feedback continuu.

Obiective mai ample: Personalizare bazată pe date și colaborare deschisă

Prin contribuțiile noastre la COMFORTage, AMI contribuie la conturarea unui viitor în care protocoalele preventive nu sunt generice, ci individualizate și bazate pe dovezi. Ne focusăm pe identificarea instrumentelor care pot ghida clinicienii, pacienții și cercetătorii în luarea celor mai eficiente alegeri bazate pe date funcționale din lumea reală.

Obiectivele noastre pe termen lung includ:

- sprijinirea dezvoltării unui instrument de asistență decizională care integrează datele de evaluare fizică cu parametrii cognitivi și clinici;
- contribuția la stabilirea unor modele prognosticuri dinamice pentru declinul funcțional și cognitiv;
- promovarea transformării digitale a datelor noastre, cu monitorizare de la distanță și planificare a intervențiilor asistată de inteligență artificială;
- partajarea constatărilor prin resurse cu acces deschis care permit altor instituții și profesioniști din domeniul sănătății să se bazeze pe rezultatele noastre.

În acest context, proiectul **101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01** urmărește integrarea multidimensională a rezultatelor clinice, a feedback-ului furnizat de participanți și a datelor fiziologice obiective. Pe baza acestei sinteze, AMI va contribui la dezvoltarea, validarea și rafinarea unor protocoale de intervenție optimizate și personalizate, ajustate în funcție de valorile funcționale de referință proprii fiecărui participant și de profilurile individuale de risc cognitiv. Această abordare va permite o înțelegere mai precisă a mecanismelor implicate în menținerea funcționalității și va sprijini elaborarea unor strategii terapeutice cu impact clinic relevant.

Manager proiect,
Conf. dr. Florentina NECHITA

amistim
advanced medical innovation

Universitatea Transilvania din Brașov
FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE

Nr. 261/29.10.2025

Nr.17/29.10.2025

ACORD DE PARTENERIAT

ÎNTRE

UNIVERSITATEA TRANSILVANIA DIN BRAȘOV
FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE

ȘI

AMISTIM MEDICAL EQUIPMENT S.R.L.
BUCUREȘTI

Acest Acord de Parteneriat (Acord) se semnează între:

FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE (FEFSM), din cadrul **UNIVERSITĂȚII TRANSILVANIA DIN BRAȘOV**, cu sediul pe Str. Universității, nr. 1, 500068 – Brașov, tel.: (+40) 268.474.060, f-efsm@unitbv.ro, www.unitbv.ro/efsm, prin conf. dr. Ioan TURCU în calitate de decan, pe de-o parte

și

AMISTIM MEDICAL EQUIPMENT S.R.L. (AMI), cu sediul în **Sector 1, Bulevardul Ioan Cuza nr 28A sector 1 București,** cod fiscal **36869749**, reprezentat legal prin **AMOIRIDIS GEORGIOS** în calitate de **administrator**, pe de altă parte.

INTRODUCERE

Obiectivul principal al proiectului de cercetare: **101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01: Pilot 10: Intervenții personalizate prin evaluare funcțională în demență** este *îmbunătățirea evaluării funcționale și a protocoalelor de antrenament personalizat pentru adulții în vârstă: rolul AMI în proiectul COMFORTage.*

*Despre **AMISTIM MEDICAL EQUIPMENT S.R.L.** (AMI) și misiunea noastră.*

AMI, cu sediul în România, este o companie specializată dedicată dezvoltării, testării și optimizării protocoalelor de fizioterapie care vizează îmbunătățirea calității vieții și a capacității funcționale, în special pentru adulții în vârstă și persoanele cu risc de afecțiuni neurodegenerative, cum ar fi demența. În centrul filosofiei AMI se află angajamentul față de știința mișcării bazată pe dovezi, intervenția timpurie și personalizarea îngrijirii prin evaluare continuă și integrare tehnologică. Prin participarea noastră la proiectul COMFORTage, ne propunem să aducem o perspectivă funcțională și a sănătății fizice în cercetarea și prevenirea demenței - punând accentul pe corp ca o componentă cheie a sănătății. Munca noastră se concentrează pe trei axe principale:

1. Colectarea de date funcționale și de mișcare detaliate de la adulți în vârstă, inclusiv de la cei cu semne precoce de declin cognitiv.
2. Evaluarea diferitelor intervenții, comparând antrenamentul tradițional de forță cu antrenamentul de forță combinat cu TENS (stimulare electrică transcutanată a nervilor).
3. Contribuția cu date anonimizate și structurate pentru a sprijini crearea de modele predictive și protocoale personalizate pentru prevenție, reabilitare și luarea deciziilor clinice.

Justificare: Rolul mișcării în prevenirea demenței

Deși screeningul cognitiv și cercetarea biomarkerilor sunt piloni centrali ai cercetării în domeniul demenței, funcția fizică este un predictor puternic și adesea subutilizat al declinului cognitiv și al calității vieții la adulții în vârstă. Deficiențe subtile ale echilibrului, mersului și dexterității pot adesea preceda sau oglindi simptomele neurocognitive, ceea ce le face indicatori critici pentru intervenția timpurie.

La AMI, recunoaștem că îmbunătățirea funcției fizice este atât un obiectiv, cât și un instrument – aceasta îmbunătățește viața de zi cu zi, reduce riscul de căderi și contribuie la

neuroplasticitate şi reziliență cognitivă. În cadrul COMFORTage, ne propunem să cuantificăm şi să validăm aceste relații într-un mod riguros şi reproductibil.

Evaluări funcționale în cadrul AMI

Pentru a susține această viziune, AMI efectuează o serie detaliată de evaluări într-un mediu de laborator controlat, utilizând instrumente de nivel clinic şi protocoale validate.

Măsurătorile noastre se concentrează pe:

- stabilitate posturală şi echilibru (folosind platforme de forță şi instrumente de captare a mişcării);
- analiza mersului (lungimea pasului, cadența, viteza mersului, variabilitatea);
- dexteritatea membrelor superioare (sarcini de control al motorului fin, testul Grooved Pegboard);
- coordonarea şi eficiența mişcării;
- mobilitatea funcțională (teste de ridicare din şezut, test de ridicare şi plecare cronometrat, testul de întoarcere la 360 de grade etc.)

Aceste evaluări sunt efectuate înainte şi după intervenție, permițându-ne să evaluăm atât profilul de risc de bază al participanților, cât şi eficacitatea diferitelor protocoale de antrenament în timp. Toate datele sunt procesate, anonimizate şi structurate pentru includerea în baza de cunoştințe COMFORTage, sprijinind dezvoltarea modelului de inteligență artificială interinstituțională şi urmărirea rezultatelor pe termen lung.

Studii de intervenție: Compararea modalităților pentru impact maxim

În colaborare cu alți parteneri COMFORTage, AMI compară diferite modalități de antrenament:

- antrenament de forță individual: Exerciții tradiționale de rezistență care vizează grupele musculare majore (flexorii şoldului şi flexorii plantari), concentrându-se pe supraîncărcarea progresivă şi controlul neuromuscular;
- antrenament de forță + TENS: Aceleaşi exerciții de rezistență combinate cu stimulare electrică de suprafață pentru a îmbunătăți potențial recrutarea musculară, propriocepția şi neuroplasticitatea;
- grup de control: Participanți care îşi mențin activitățile regulate fără intervenții suplimentare prin exerciții fizice, utilizate pentru a evalua progresia naturală şi a diferenția efectele antrenamentului.

Aceste intervenții sunt implementate pe o perioadă de mai multe săptămâni, cu monitorizare şi feedback continuu.

Obiective mai ample: Personalizare bazată pe date şi colaborare deschisă

Prin contribuțiile noastre la COMFORTage, AMI contribuie la conturarea unui viitor în care protocoalele preventive nu sunt generice, ci individualizate şi bazate pe dovezi. Ne focusăm pe idnetificarea instrumentelor care pot ghida clinicienii, pacienții şi cercetătorii în luarea celor mai eficiente alegeri bazate pe date funcționale din lumea reală.

Obiectivele noastre pe termen lung includ:

- sprijinirea dezvoltării unui instrument de asistență decizională care integrează datele de evaluare fizică cu parametrii cognitivi şi clinici;

- contribuția la stabilirea unor modele prognostice dinamice pentru declinul funcțional și cognitiv;
- promovarea transformării digitale a datelor noastre, cu monitorizare de la distanță și planificare a intervențiilor asistată de inteligență artificială;
- partajarea constatărilor prin resurse cu acces deschis care permit altor instituții și profesioniști din domeniul sănătății să se bazeze pe rezultatele noastre.

Părțile au convenit să coopereze în condițiile prezentate mai jos:

Articolul 1. Obiectul acordului

Scopul prezentului Acord este de a oferi un cadru de cooperare și de a facilita colaborarea părților în vederea aprofundării cercetării asupra strategiilor care pot genera cele mai semnificative îmbunătățiri ale echilibrului postural, coordonării motorii și mersului – parametri esențiali asociați riscului crescut de declin funcțional și deteriorare cognitivă.

În acest context, proiectul **101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01** urmărește integrarea multidimensională a rezultatelor clinice, a feedback-ului furnizat de participanți și a datelor fiziologice obiective. Pe baza acestei sinteze, AMI va contribui la dezvoltarea, validarea și rafinarea unor protocoale de intervenție optimizate și personalizate, ajustate în funcție de valorile funcționale de referință proprii fiecărui participant și de profilurile individuale de risc cognitiv. Această abordare va permite o înțelegere mai precisă a mecanismelor implicate în menținerea funcționalității și va sprijini elaborarea unor strategii terapeutice cu impact clinic relevant.

Articolul 2. Durata si modificarea acordului

Cooperarea propusă în prezentul Acord este neexclusivă și se derulează pe perioada de implementare a proiectului.

Denunțarea unilaterală poate fi efectuată de oricare dintre părți, printr-o notificare scrisă transmisă celeilalte părți cu cel puțin două luni înainte de data încetării.

Părțile pot conveni să extindă prezentul Acord, în scris. Prezentul acord poate fi modificat numai prin acordul scris al ambelor părți.

Articolul 3. Domenii de cooperare

Părțile au convenit să coopereze în domeniul sportului sustenabil și educației pe parcursul întregii vieți.

Articolul 4. Implementarea proiectului "COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01"

AMISTIM MEDICAL EQUIPMENT S.R.L. este coordonatorul parteneriatului european care pune în aplicare proiectul "**101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01**", răspunde de realizarea obiectivelor și obținerea rezultatelor proiectului și se obligă:

- să pună la dispoziția Facultății de Educație fizică și sporturi montane din Brașov conținutul

proiectului "**101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01**";

- să dezvolte programul de formare " **101137301 - COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01**" pentru beneficiari și voluntari;
- să implice în seminariile și mobilitățile trans-naționale specialiști ai FEFSM Brașov;
- să pună la dispoziția FEFSM Brașov toate rezultatele finale obținute în cadrul parteneriatului trans-național în vederea diseminării acestora în rândul studenților FEFSM Brașov și spre alte instituții și comunități cu care aceasta lucrează și interacționează;
- să nu utilizeze însemnele oficiale ale FEFSM Brașov fără acordul acesteia;
- să sprijine FEFSM Brașov în publicarea de eventuale metodologii privind modelele de bună practică rezultate în urma derulării proiectului.

FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE DIN BRAȘOV se obligă:

- să desemneze persoană de contact care să realizeze schimbul necesar de informații cu **AMISTIM MEDICAL EQUIPMENT S.R.L.**;
- să decidă care sunt persoanele care vor participa la mobilitățile și seminariale trans-naționale organizate prin proiect;
- să sprijine organizarea și desfășurarea programului de formare pentru îmbunătățirea calității vieții persoanelor din proiect;
- să disemineze rezultatele finale ale proiectului către alte organizații și instituții cu care lucrează și interacționează;
- să popularizeze în media – când are posibilitatea – proiectul ca aparținând **COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01** pe baza căruia FEFSM din Brașov a încheiat prezentul parteneriat;
- să comunice **COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01** orice modificare apărută în componența echipei implicate în proiect;
- să decidă asupra oportunității publicării de eventuale metodologii privind modelele de bună practică rezultate în urma derulării proiectului.

Articolul 5. Comunicarea și schimbul de informații

Partenerii vor conveni de comun acord întâlniri regulate pentru a discuta progresul înregistrat în implementarea activităților planificate, dar și pentru a planifica activități viitoare.

- comunicarea pentru derularea proiectului **COMFORTAGE-HORIZON-HLTH-2023-STAYHLTH-01** se realizează prin intermediul persoanei desemnate conf. dr. Florentina NECHITA din partea FEFSM Brașov și a dlui Georgios AMOIRIDIS din partea AMISTIM MEDICAL EQUIPMENT S.R.L.
- cele două entități vor comunica prin persoanele desemnate folosindu-se modalitățile de comunicare prin telefon, internet sau prin deplasarea directă la sediile celor două entități;
- părțile stabilesc împreună modul de desfășurare a activităților comune din proiect și modul de rezolvare a sarcinilor proiectului, inclusiv a situațiilor nou apărute și necuprinse în prezentul acord;
- orice situație conflictuală apărută se rezolvă pe cale amiabilă și se mediază de către managerii

celor două instituții.

Articolul 6. Notificări și adrese

Orice notificare sau cerere necesară în cadrul prezentului Acord se va realiza în scris, prin poștă sau e-mail la:

FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE din cadrul UNIVERSITĂȚII TRANSILVANIA DIN BRAȘOV, cu sediul pe Str. Universității, nr. 1, 500068 – Brașov, tel.: (+40) 268.474.060, f-efsm@unitbv.ro, www.unitbv.ro/efsm

și

AMISTIM MEDICAL EQUIPMENT S.R.L., cu sediul în **Sector 1, Bulevardul Ioan Cuza nr 28A sector 1 București,** cod fiscal **36869749**, reprezentat legal prin **AMOIRIDIS GEORGIOS** în calitate de **administartor**, poșta electronică: office@amistim.ro, website: https://amistim.ro/ro/

Articolul 7. Intrarea în vigoare a acordului de parteneriat

Prezentul Acord este semnat în 4 exemplare câte 2 exemplare pentru fiecare parte, fiecare dintre acestea având valoare de original, toate formând, atunci când sunt semnate, un singur document integral. Prezentul acord conține un număr de 6 pagini.

Acordul intră în vigoare la data 29.10.2025, data semnării de către ambele părți.

Facultatea de Educație Fizică și Sporturi Montane Universitatea Transilvania din Brașov

Decan,
Conf. dr. Ioan TURCU

ROMÂNIA UNIVERSITATEA „TRANSILVANIA" DIN BRAȘOV FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORTURI MONTANE-DECANAT MINISTERUL EDUCAȚIEI ȘI CERCETĂRII

Coordonator proiect,
Conf. dr. Florentina NECHITA

AMISTIM MEDICAL EQUIPMENT S.R.L.

Administrator,
AMOIRIDIS GEORGIOS

SOCIETATEA COMERCIALĂ AMISTIM MEDICAL EQUIPMENT S.R.L. BUCUREȘTI, ROMÂNIA