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Physical education

A COMPARATIVE STUDY OF THE LEVEL OF PHYSICAL ACTIVITY OF OVERWEIGHT AND NORMAL WEIGHT SECONDARY SCHOOL GIRLS

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Abstract:
The prevalence of overweight in the population aged 2-19 years rose from 10% to 12.7%. The prevalence of this condition rose from 16.9% to 23.8% in boys and from 16.2% to 22% in girls in industrialized nations. The objective of the study is to assess and examine the physical activity level of overweight students in the high school cycle in comparison to those with a normal weight status. To acquire unbiased data about the physical fitness level of high school students, we performed a study involving 48 pupils. These students were separated into two categories: those with a normal weight and those who were overweight. The findings reveal that the normal-weight group had an average body mass index (BMI) of 21.90, whereas the obese group had an average BMI of 24.90. The overweight group of pupils performed less well on functional tests, with an average capacity index of 49.66 ± 1.85 units, in contrast to the normal weight group, which achieved a score of 61.20 ± 2.3 units. The Ruffier test yields comparable findings, with mean values of 6.70 ± 0.95 for the overweight cohort and 2.10 ± 0.65 for the normal weight cohort. Integrating body weight correction into the instructional-educational process of physical education has the potential to enhance the pupils' health. The somatometric indices in the overweight group are significantly lower compared to the normal weight group, which exhibits a higher level of these indices. Based on the analysis and generalization of the results, it is evident that there is a pressing requirement to introduce a physical activity program for overweight kids in the high school cycle. This curriculum is essential in the current societal settings due to the escalating prevalence of obesity and its detrimental effects on the physical growth and well-being of students.

Key-words: overweight, physical activity, girls, process, pupils, BMI, Ruffier test, curriculum.

1. Introduction

Overweight is a condition characterized by the body weight surpassing the recommended limit because of an excessive accumulation of fat deposits (Cojocaru, 2012, p. 199). The increasing occurrence of overweight and obese children and adolescents has become a serious and alarming global problem (Fang, 2019, p. 745). The incidence of obesity in the population aged 2–19 years has increased from 10% to 12.7%. In industrialized countries, the occurrence of this illness has increased from 16.9% to 23.8% in males and from 16.2% to 22% in females (Neculaeș, 2014, p. 106). The high occurrence of overweight and obesity has accelerated research endeavours to identify treatments, possible factors, and harmful consequences of these conditions, in both children and adults (Savițchi, 2023, p. 87).

According to the data published by the World Health Organization (WHO), there are presently more than 41 million children below the age of 5 and 340 million children between the ages of 5 and 19 who are experiencing excess weight

(https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight). Out of the total number of affected children, which is 35 million, the majority come from developing countries. In these regions, the occurrence of obesity is increasing (Stoica, 2012, p. 3)

Contrary views argue that there has been a significant increase in the incidence of obesity among children and adolescents in the latter part of the 20th century. This has led to the emergence of a distinct public health problem in different regions (Pop, 2012, p. 49). Today's society confronts parents with a significant problem: the prevalence of overweight children (Justamente, 2020, p. 4). Teenagers or children who gain excess weight at an early age are more likely to acquire obesity later in life.

2. Material and method

The aim of the research is to compare and analyze the physical activity level of overweight secondary school pupils with those of normal weight, identify any differences, and determine the impact of weight status on their physical activity level.

Research hypothesis. It is assumed that there are significant differences in the level of physical activity between overweight secondary school girls and those with normal weight status, which would allow us to determine the shortcomings in the methodical guidelines of physical training for these girls and improve the instructional-educational process in physical education and physiotherapy.

Research objectives:

- to assess and compare the physical activity level and anthropometric indices of overweight and normal-weight secondary school girls.
- to identify and analyze factors that might influence the physical activity level of secondary school students, including socio-economic factors, lifestyle, and physical activity.
- formulate recommendations for the development of intervention programs and educational policies to promote physical activity and health among secondary school girls based on the results obtained.

3. Results and Discussions

The first parameter considered in the assessment is *height*. In the comparative analysis between the normal weight group with a height of 156 ± 3.4 cm and the overweight group with a height of 157.2 ± 3.25 cm, there is a mean difference of 1.2 cm between the heights of the two groups, and the value of the student's t-criterion is only 0.25, not significant ($P > 0.05$) (Fig. 1).

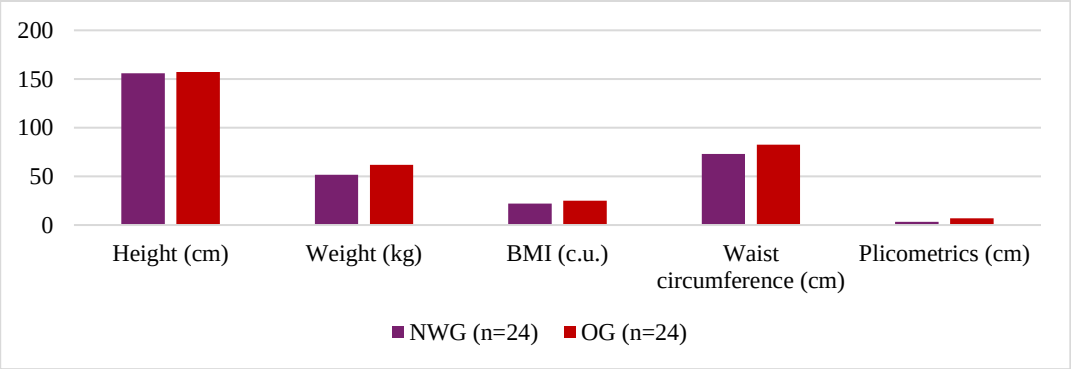

Figure 1. *Graphical interpretation of somatometric indices between normal weight and overweight groups*

Nevertheless, even if the disparity in height is not substantial, it can still have ramifications for the physical activity program, as even slight changes in height can impact the biomechanics of the body. Customizing the physical education curriculum could consider various variations to maximize activities based on the specific attributes of each group. When addressing weight status correction for these two diverse groups, it is crucial to consider that aspects like body composition and health conditions, in addition to height similarities, can greatly influence the strategy.

The *weight* data shows a substantial distinction between the group with normal weight status (51.6 ± 3.2 kg) and the overweight group (61.9 ± 2.5 kg), with a t-value of 2.53 and a significance level of $P<0.05$. This substantial disparity indicates that the overweight group possesses a significantly greater average weight compared to the normal weight group.

The rehabilitation regimen is significantly affected by the additional weight, as it places additional stress on joints and muscles. The substantial difference in weight between the group of individuals with normal weight and the group of individuals who are overweight has major consequences for choosing and modifying therapeutic exercises during the recovery phase. A meticulous and tailored strategy is necessary due to the varying weight disparities that exert distinct demands on the musculoskeletal system and can impact diverse responses to physical effort.

The BMI statistics indicate a substantial disparity between the group with a normal weight status, characterized by BMI values of 21.9, and the overweight group, characterized by BMI values of 24.9. This difference is statistically significant, with a t-value of 4.76 and a p-value less than 0.001. The data is displayed in Fig. 1. This disparity indicates that the students in the overweight group possess a notably greater average BMI value compared to those in the normal weight status group.

The disparity in physical education or physiotherapy activities for secondary school girls might have a significant influence. As *BMI* is a measure of the weight-to-height ratio, large variations in BMI might impact an individual's reaction to physical exertion and rehabilitation programs. Due to the fact that BMI is a measure

of the weight-to-height ratio, this notable difference had an impact on how individuals responded to physical exercise.

Significant differences are observed in the analysis of pertinent data on *waist circumference and plicometry between* the group with normal weight status and the group with overweight status. The study shows that those in the overweight group had a greater waist circumference, measuring 82.7 ± 2.00 cm, compared to those in the normal weight group, who had a waist circumference of 73 ± 1.2 cm. The statistical analysis revealed a t-value of 4.16 and a p-value of less than 0.001. Additionally, plicometry measurements indicate that individuals in the overweight group had a higher skinfold thickness of 6.80 ± 0.43 cm, compared to the normal weight status group which has a thickness of 3.14 ± 0.41 cm. This difference is statistically significant, with a t-value of 3.97 and a p-value less than 0.001 (Fig. 1).

The variations in waist circumference and skinfold thickness will have a substantial impact on the different phases of physical activity and physiotherapy programs, as these measurements are important indications of body composition and the distribution of fat. Therefore, we will customize the intervention measures to target the unique characteristics of the overweight population, considering notable differences in body composition and potential consequences for physical fitness and overall well-being.

Concurrently with the objective of addressing weight status, our study also prioritized optimizing the amount of motor training. To evaluate and showcase girls' achievement, we implemented a set of motor exams that are part of the mandatory physical education curriculum. We conducted tests on both groups involved in the research endeav or to illustrate the heterogeneity of the subject groups. The results of the motor tests showed substantial differences in physical fitness levels between the normal weight group and the overweight group.

Regarding the *"3 × 10m (sec.) run*" test, distinct outcomes were documented in the group of individuals with normal weight and the group of overweight individuals, with corresponding values of 8.55 ± 0.07 seconds and 8.9 ± 0.11 seconds. The curriculum assessment scale classified these values as "low average," causing dissatisfaction among certain participants in the overweight group.

A student's t-test was conducted to determine if there were any significant differences between the two groups. The test yielded a t-value of 2.69 with a p-value of less than 0.01. The results indicate a notable disparity in the performance of the normal-weight and overweight groups in the 3 × 10m shuttle running test, with the normal-weight group outperforming the overweight group (Fig. 3).

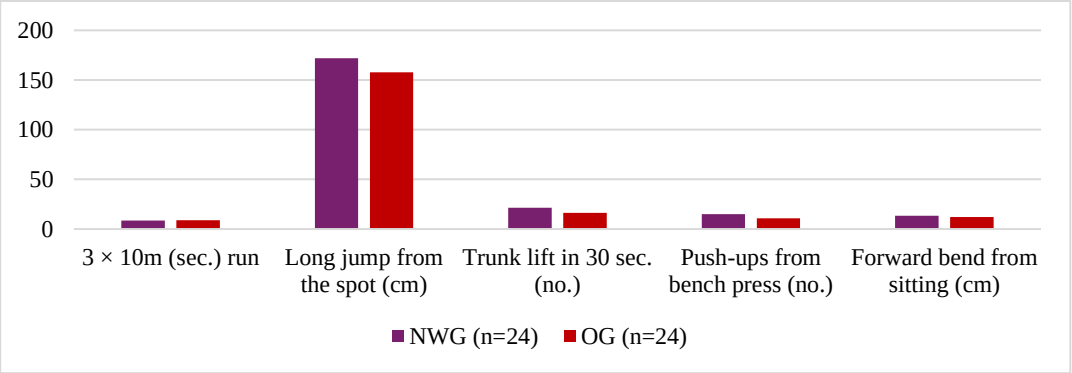

Figure 3. *Graphical interpretation of the motor indices obtained by the normal weight and overweight groups.*

The results may suggest an enhancement in aerobic capacity and general fitness for the group with normal weight status due to the notable disparity in running time. A shorter duration of jogging may indicate improved cardiovascular endurance and general functionality. This disparity could potentially impact the kinesiological methods used to enhance motor and functional performance in secondary school children, prompting the customization of programs based on the unique requirements of each group.

The "*Long jump from the spot (cm)"* test yielded findings of 172.00 ± 2.10 cm for the normal weight status group and 157.6 ± 2.60 cm for the overweight group (Fig. 3). The ratio of these two lengths is 4.31, and the P-value is less than 0.001, indicating that the difference is statistically significant. The standing long jump is an assessment that measures muscular strength, coordination, and agility. The significant difference indicates that students in the overweight category could potentially improve these areas by implementing jumping exercises and strength training to strengthen these abilities.

The" Trunk *lift in 30 sec. (no.)"* test yielded 21.3 ± 0.64 repetitions for the normal weight status group and 16.3 ± 1.25 repetitions for the overweight group. The ratio between the two outcomes is 3.47, and the P-value is less than 0.01, indicating that the difference is statistically significant (Fig. 3). The trunk lift test reveals considerable disparities in the physical and functional capabilities between the normal weight status group and the overweight group, indicating notable variations in their performance. The findings indicate that children with a normal body weight exhibit greater strength and flexibility in the trunk region.

The group of individuals with a normal weight can derive advantages from physical training programs that preserve and enhance their already elevated performances. On the other hand, the overweight group can benefit from an adapted physical activity program that emphasizes the enhancement of strength and coordination while also promoting physical activity to foster an active lifestyle.

In order to assess the degree of muscular strength in the upper extremities, we employed the *"Push-ups from bench press (no.)"* test (Fig.3). The findings

revealed that those with a normal weight status achieved an average of 15.08 repetitions, while those in the overweight group managed an average of 10.71 repetitions. The ratio of these two outcomes is 4.40, and the P- value is less than 0.001, indicating a statistically significant difference (Fig.3). The push-up performance findings show statistically significant differences between the overweight group and the group with normal weight status. Nevertheless, it is important to note that there may still be practical variations that can be addressed by a customized physical training program tailored to meet individual needs and abilities.

We used the *"Forward bend from sitting (cm)"* test to assess the mobility of the girls. We found that there were significant differences in the results between those with normal weight (+13.54 ± 0.44 cm) and the overweight group (+12.12 ± 0.37 cm), with a P-value less than 0.05 (refer to Fig.3)

The findings suggest a marginal disparity in the ability to do forward bends among female students of normal weight and those who are overweight. It is crucial to highlight that this distinction should not be viewed as a restriction for overweight female students but rather as a chance to implement physical activity programs that explicitly target flexibility and overall health.

The disparities discovered between the pupils in the normal weight category and those in the overweight category highlight the unique intricacy of each student. We should tailor the means and instructional-educational methodological principles to the distinctive qualities and specific needs of each group, as there is no universally applicable technique that suits everyone. The primary goal of the educational process should be to promote a healthy, inclusive, and well-rounded existence that contributes to the holistic development of pupils.

4. Conclusion

The statistical-mathematical analysis of the data showed considerable disparities between the groups of kids with normal weight and those who were overweight. When comparing the functional level, including somatometric indices and functional and motor skills, we can clearly see a significant difference in the health status of the children in the two groups. The results suggest that the group with a normal weight had an average body mass index (BMI) of 21.90, while the group that was overweight had an average BMI of 24.90.

Thus, integrating body weight adjustment into the instructional-educational process of physical education has the capacity to improve the students' well-being. The somatometric indices in the overweight group have a significantly lower average compared to the normal weight group, which has a higher level of these indices. Upon analyzing and generalizing the results, there is an urgent requirement to implement a physical activity program for overweight secondary school adolescents. This curriculum is crucial considering the current socioeconomic climate, as there is an increasing prevalence of obesity and its adverse impact on the physical growth and well-being of children. The need to develop and implement a theoretical-methodical framework for the physical education of overweight children stems from

the observation that the school curriculum lacks explicit instructions on how to classify these children into distinct groups. These students, who are members of the primary cohort, encounter diverse health problems and have a restricted level of psychomotor skills training. It is crucial to have a well-designed and effective framework that properly addresses the distinct needs and demands of these students as they go through their physical growth.

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TECHNOLOGY FOR PHYSICIAL TRAINING OF STUDENTS SPECIALIZING IN PORTS GYMNASTICS

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Abstract

The presented article examines the issues of the development of physical training of students in the process of training and training sessions of the course "Sports and pedagogical skill". Scientifically substantiated program of gradual development and improvement of qualification requirements for years of study. *Objective of the study*: to identify the most significant factors affecting the level of physical preparedness of students in the process of training-level classes of the course "Sports-pedagogical skill". *Methods of investigation*: analysis of educational and methodological literature, pedagogic testing, pedagogical observation, educational experiment, methods of mathematical statistics. Results. The practical results of the study are as follows: the proposed program of development of motor qualities is confirmed by the progressive dynamics of growth of "school" indicators of movements and physical qualities, the means used for training and timely control of the process of "use" of exercises of basic gymnastics in the qualities studied are effective and can be recorded for inclusion in the working programmes of the course of athletic-pedagogical skill. *Conclusions*. The proposed version of the rational distribution of training funds in the training and training classes of the course of intellectual pedagogical skill proved to be the most productive in the issues of consistent development of special motor qualities and training of exercises on the types of gymnastic multi-combat, and indicate the effectiveness of the developed and experimentally based program of training of students.

Key words: *special motor training, general physical training, technical training, motor training*

1. Introduction

Mastering of special-motor training in the professional activities of specialized gymnasts when performing exercises on shells depends to a great extent on the level of physical qualities (Gaverdovsky, 2005; Menchin, 2003).

Study and analysis of the review of special literature and data of preliminary studies of the training and training process of gymnasts of different levels of preparedness showed that the provision of special motor activity of the gymnast when performing exercises on shells is largely determined by the level and skill coordinated by the interaction of physical qualities and, first of all, joint mobility, manifestation of strength and coordination abilities, determination and courage. Exercises on each projectile require a specific structure of abilities (Gaverdovsky, 2005, Zuravina, 2008; Menchin, 2003, Umarov and Estheev, 2004, 2006).

To successfully master the exercises on the fold, you need good mobility in the shoulder joints, the strength of the muscles of the hands, the abdominal press and the

back. The braces require mobility in the shoulder and hip joints, dynamic and static strength of the muscles of the hands and upper shouldering belt, and strength and endurance. The mastery of support jumps requires good jumping, coordination of movements, orientation in space, determination and courage. In free exercises, success depends on mobility in all legs of the body, coordination of movements and jumping, and on rings, on the manifestation of strength abilities in dynamic and static mode, mobility of the shoulder and hip joints. On a horse the gymnast must have a high level of coordination of movements, movement in the hip joint, dynamic strength, strength and co-ordination endurance (Gaverdovsky, 2005; Smolevsky and Gaverdovsky, 1999).

Y.K. Gaverdovsky in co-auth. (2005), Y.V. Menhin (2003), V.M. Smolevsky Gaverdovsky (1999), M.N. Umarov and Estheev (2004, 2009) guided by scientifically substantiated results of many years of observations, argue that in the process of mastering gymnastic exercises the special-motor, physical and technical preparedness of the gymnast manifest in unity, in interrelation. The authors showed that there is a close relationship between the value of the integral indicator of the above-mentioned abilities and the success of the mastery of the next sports degree program (r=0.8790).

Objective of the study: to identify the most significant factors affecting the level of physical preparedness of students in the process of training-level classes of the course "Sports-pedagogical skill".

2. Material and method

The survey was conducted between 2019 and 2021.The objects of the study were students of 1-3 courses of specialization "Gymnastics", sports qualification 1st and 2nd grade, a contingent of 45 gymnasts - boys.

Students 1-3 courses of specialization "Gymnastics", sports qualification 1 and 2nd grade. During six semesters (1-3 courses) exercises and complexes of general and special physical training (SPF) and applied gymnastics (PG) were used. In the subsequent semesters, all the work on motor skills development was already based on the recommendations and regulatory requirements of the Physical Training Qualification Program (FP) for the class under study.

3. Results and Discussions

During the formation of a comprehensive programme on special-motor and technical training of students of the experimental group (1-3 course, specialization "Gymnastics"), special attention was given first of all to the problem of consistent improvement of physical qualities due to the rational distribution of time, means and methods of training in the preparatory and final parts of the academic and training sessions of the course "Sports and pedagogical skill.

The materials of pedagogical observations of the level of motor preparedness of students participating in the experiment allowed to reveal a certain pattern (Fig. 1). The results of all students to the final semester have been substantially improved,

regardless of the number and focus of motor activities. However, the FP indicators of the control group students did not reliably exceed the data recorded by us in the second semester (7.6±1.43 and 7.11±1.11 respectively). While the results of the experimental group increased more significantly (P<0,05) and most significantly in the size of speed-force qualities (SSC - 12.7%), choreographic training (16,5%) and coordination abilities (28.1%).

The effectiveness of the engine development program we have proposed is confirmed by the progressive dynamics of the growth of the "school" indicators of movement and physical qualities (by 16.7%), as well as the variation coefficient (V%). Thus, the value of fluctuations V% in the students of the experimental group is much more uniform, relative to the data of variation of the characteristics of the control group (5.05 and 16.5% respectively). Thus, the means used for training and timely control over the process of "use" of exercises of basic gymnastics in the qualities being studied are effective and can be recommended for inclusion in the work programs of the course "SPM".

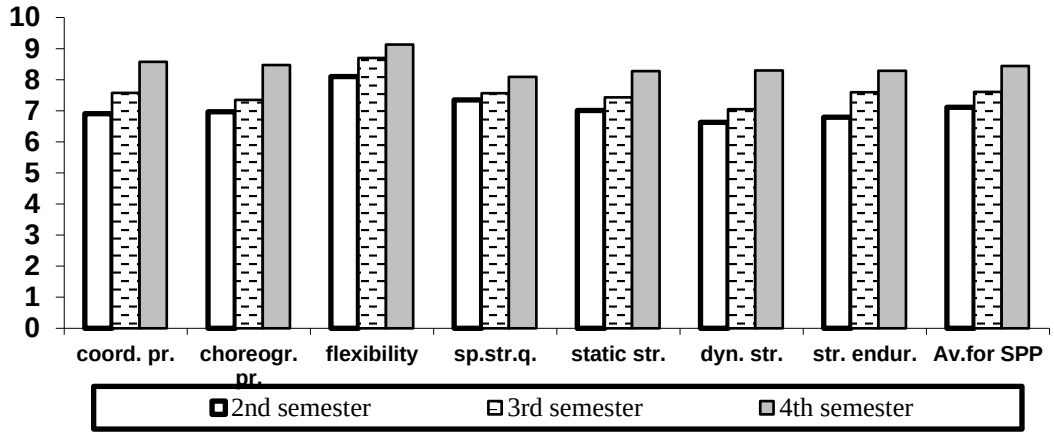

Fig. 1. Results of expert evaluation of test competitions on physical training of students of the experimental group

The motor skills of the students of the experimental group were formed by repeated stereotypical repetition of movements or the exercise being studied in general during the training (academic) and training sessions of the SPM course. (1,2,3,4,5). At the same time, the structure of the exercise was not substantially changed, it was performed, as a rule, in the same conditions. The technique of performance gradually, from semester to semester, approached the planned pattern, to the technique of exercises of the qualification program, through: - in the first phase (1 semester) - the main hangings and points, waving in them, standing on arms on the floor and on stands, spaghetti, advance and side overturns, slow overturn. Work on the development of FP and FP, elementary jumping on trampoline, choreographic training.

- on the second (2-3 semesters): - ORU, PG, rotating, flake, salto forward and back, in a lounge and a pebble hole, circles two on a mushroom and one on a horse,

climbing by bending and two, jumping in depth with a soft landing, supporting jump of legs apart and bending legs across the horse in width and length (or jumping table), jumping on a bat, choreographic preparation.

- in the third (4-8 semesters) – elements, bonds, connections and combinations of the qualification program II, and the most motorically trained students – I-class. The analysis of the results of the control and official competitions in multi-fighting allowed to assess the effectiveness of the training program developed by us and to identify the objective reasons that influenced them (Figure 2). This increased motor (coordination, 28.1% and choreography, 16.5%) and physical fitness, 16.7% (Figure 1) allowed the students of the experimental group to master the more complex program "A" of the third (2nd semester). In time to begin to study the elements of the second class and show, starting from the fifth semester (8.07±0.24 points) quite stable, rising score, exceeding the qualification barrier on all shells and the average score (7.15±0,54 points) for multi-fighting of the control group.

The fact that most of the students in the control group were not able to fully master the exercises on horses-maches, rings and bushes, which was recorded by us at the stage of pre-cooking studies, makes sense. The average score on these shells' ranges between 7.65±0.60 points (Figure 2). While this indicator, according to the qualification requirements, should be not less than 8.0 points. This is due, first and foremost, to the inadequate physical fitness, as noted above, namely, strength and co-ordination capabilities.

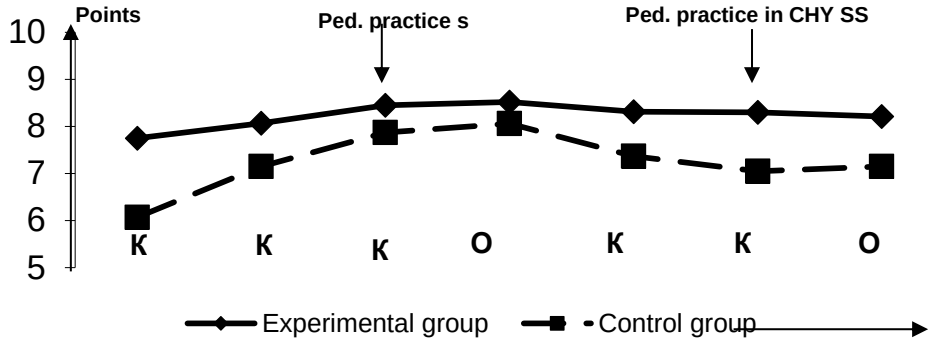

Fig. 2 Dynamics of the results of the test (K) and official (O) competitions in the 2nd grade (qualification program "B") of the students of the experimental and control group

The results of the correlation analysis are a visible confirmation of that. The high degree of interrelationship and interaction of the majority of the components under consideration is due to the significant increase in the motor training of the students of the experimental group, through the rational use of effective means of training and learning methods in the process of academic classes and the course of SPM. Increased coordination abilities directly influenced the success of learning program elements (r=0.8217) and the progressive development of basic physical qualities (r =0.9523).

4. Conclusions

Thus, the studies have led to the conclusion that: - the proposed version of the rational distribution of training resources in training and training classes (course SPM) proved to be the most productive in the issues of consistent development of special motor qualities and training exercises on the types of gymnastic multi-combat, and indicate the effectiveness of the time-botanic and experimentally based program of training of students of the experimental group.

- the same gymnastics exercise present different difficulty. More in motor and physically trained students were much easier than beginners, mastered strength and flexibility exercises, were more determined and bolder. At the same time, exercises requiring complex coordination of movements, large muscle tensions and strength endurance were given to all, without exception to students significantly more difficult and needed a longer process of learning and improvement;

- successful training of gymnastics exercise is possible if the trainer-teacher is well aware of the requirements that sports gymnastics poses to the engaged, and therefore, and the structure of abilities necessary for the successful mastery of the exercise and sports skill, the dynamics of this structure at different stages of becoming a sports skill; the peculiarities of the relationship between individual abilities and psycho-physiological mechanisms that determine this relationship; the ability to evaluate and develop abilities. At the same time, much depends on the pedagogical skill of the trainer-teacher, the quality of teaching and upbringing.

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Sport Performance

MIGRATION OF ATHLETES AS THE A MAIN FACTOR IN THE FORMATION OF VOLLEYBALL TEAMS

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Abstract

This research is aimed at identifying the tendencies that exist in the migration of volleyball players, which is global in nature in modern sports of higher achievement. Based on the analysis of the transfer of 4040 players of the International Volleyball Federation, the features of migration processes in professional volleyball are determined, taking into account the concentration of athletes in world confederations, taking into account the players' playing roles. It has been determined that the process of migration of players in high-performance sports, in particular in volleyball, is influenced by a number of factors, the main of which are the need for professional development, recognition through changes in social status by increasing wages, and expanding international relations. The results of the study indicate a tendency for players to migrate to European clubs (83,0%), with priority given to the national championships of France and Italy. At the same time, the greatest demand of the modern labor market is for players of various roles, where the central place is given to outside hitter ones (47,4%), which is explained by the versatility of their actions and powerful attacking potential. The obtained results of the study made it possible to determine the trends in the formation of the international club system of competitions in volleyball, where the priority is given to the parameters of technical and tactical preparedness of players of different playing roles.

Keywords*: migration, volleyball, confederation, professional skills*

1. Introduction

In today's highly competitive environment in team sports, which is intensified by globalization, the sports industry is trying to achieve the highest sports results in the international arena by constantly searching for highly qualified players, which leads to migration processes.

The migration of athletes at the current stage of development of game sports is global in nature, which is manifested in their movements within countries and continents and significantly affects individual and team performance (Tertuliano, Machado, Oliveira, Montiel, 2020). One of the main factors of migration is the transition of highly skilled athletes from lower-level leagues and their concentration in the stronger leagues of the world, which is manifested in the presence of migration flows of players, resulting in an increase in legionnaire players in national championships of different countries (Borysova, et al., 2020). From the one side, this trend contributes to the transition of the strongest and most talented players to professional leagues in countries that have certain achievements in certain sports, which leads to a weakening of the national championship, from the other side, legionnaire players who are members of the national teams of countries have the opportunity to demonstrate their professional abilities gained through international experience and participation in leading foreign clubs.

International scientific experience shows that there is a significant number of works dedicated to the problems of migration processes in sports games. Current scientific studies point out that migration corridors depend on the characteristics of national migration of athletes (Lee; Ko and Huang, 2021), international migration trends (Guimarães; Santos; Santos, Tavares, & Janeira (2018)), the impact of international transfers on player movements (Poli, R., 2006), the peculiarities of participation of legionary and migrant players in official international competitions (R. Sushko, 2017). Currently, the development of volleyball in the world is concentrated in Brazil, Turkey and Italy, whose national championships are the most powerful (Pontes, Ribeiro at al, 2018). Therefore, the study of the peculiarities of the course of world migration in volleyball, due to the lack of coverage of this scientific direction, is extremely significant and relevant, which requires a detailed study and analysis.

The aim of our research is to identify the main trends in the formation of teams in the club competition system taking into account the processes of player migration in volleyball.

2. Material and methods

Based on the generalized analysis of special scientific and methodological literature and the use of electronic databases Scopus, Web of Science Core Collection, Google Scholar, the main trends that can be traced in the process of player migration in team sports were determined. To identify the peculiarities of player migration in volleyball between different continents of the world, the method of comparison and contrast was used. Based on the results of the International Volleyball Federation transfer data, the migration paths of 4040 athletes were analyzed, which helped to substantiate the importance of the national championship as a significant factor that affects the transition of players to other clubs and leagues.

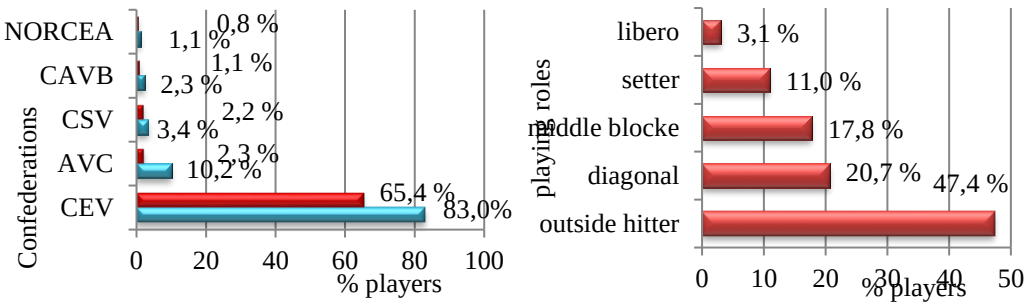
3. Results and Discussions

The migration of athletes in game sports has been significantly influenced by the processes of professionalization and commercialization, which is noted in its social and economic aspects and is manifested in the increase in the international level of salaries for the world's leading players, great interest of the media and popularity among fans.

Migration of athletes began to develop rapidly in top-level sports in the 1990s, facilitated by changes in European legislation on the fulfillment of players' contractual obligations and payment of monetary compensation by the club in case of transfer to another club. The development of migration processes in volleyball began to be traced back to the 1980s, which is marked by the need in the European labor market for Brazilian volleyball players, where the determining factor was the high achievements of the Brazilian men's national team in the Olympic Games and World Championships. This is a consequence of the pioneering actions of the

president of the South American Confederation of Volleyball (CSV), who proposed to sponsor both national teams and in the club competition system, which contributed to the expansion of competition on the continent and led to the training of talented players capable of achieving high performance in official international competitions. At this time in the European championship appear such players as William Silva, Bernard Raisman, Jose Montanaro. This fact indicates the beginning of the development of market relations between legionary players and clubs, which led in the early 1990s to an increase in the number of athletes in the European Championship. On the example of the European Volleyball Confederation, it is worth mentioning the participation of Bulgarian volleyball players as legionnaires in the national championships of other countries, which provided them with world recognition, among them - Sviatoslav Angelov, Nedyalko Delchev, Ivaylo Barutov, Matei Kaziski, etc. If in the early 1990s the migration of Bulgarian volleyball players was limited only to the European confederation, nowadays they choose mostly the national championships of Azerbaijan, Iran or the USA. This is a consequence of the political-economic conditions that European clubs have undergone after 2008, still remaining the leader in the labor market for the selection of talents in volleyball.

A significant impact on the popularization and development of volleyball was influenced by the creation of a single governing structure - the International Volleyball Federation (FIVB), which currently unites 222 associations in 5 confederations of the world: European (CEV), Asian (AVC), African (CAVB), North, Central America and the Caribbean (NORCEA) and South American (CSV) with national teams and clubs of the countries. With this in mind, a necessary component of our study is to analyze the migration processes in volleyball that take place in its different confederations, presented in Figure 1.



a) b)

Figure 1: Comparison of volleyball players who take part in the championships of different continental confederations (a), playing roles (b), %:

– overall migration of volleyball players;

– migration of volleyball players within the federation.

The analysis of migration processes in different confederations (Fig. 1 a) shows that volleyball currently has a concentration of foreign players in CEV, which

is 83.0% of the total number of athletes. The AVC is in second place with 10.2%, CSV, CAVB NORCEA have much lower rates, which range from 11.1 to 2.3% respectively. The intra-continental migration rates deserve special attention, where the results in the European confederation are also the most important, with 65.4% of the total number of legion players. The most prioritized countries for intra-continental migration in the European confederation are the national championships of France and Italy. It is worth noting that the regulations of the Italian volleyball championship specify that there should be at least 4 domestic players on the playing court during the game, others may be legionnaires, which attracts in this aspect legionnaire players to the Italian championship. Thus, there is a tendency to attract more foreign players, which is confirmed by their presence in the leaders of the championship – "Perugia" (6), "Monze" (8); «Trentino» (4). These circumstances increase the competition among players in the club system of competitions and Olympic reserve, which allows the effective formation of national teams, the consequence of which are the high sports achievements of the Italian national team in the Olympics and World Championships.

The confederation of North, Central America and the Caribbean ranks second in terms of internal migration, which corresponds to 0.8% with a ratio of 1.1% of players. An interesting fact of internal migration of volleyball players is observed in the Asian Volleyball Confederation, where the internal migration rate is 2.3%. The highest number of legionary players is observed in Vietnam, which also indicates a high level of socio-economic conditions for foreign players. The current situation confirms the changes that have taken place in the international labor market. Mostly it is connected with the attraction of foreign players of the middle level for much higher monetary remuneration, which has a northern divergence with the national players of a certain country and contributes to a decrease in motivation and disruption of the system of training the immediate reserve in those countries where volleyball is just beginning to develop.

The results of volleyball national teams' performances at the Olympics and World Championships from 2016 to 2023 indicate that volleyball is becoming a more strength and athletic sport. But along with this there are negative trends, which is manifested in a lower technical plan of preparation of players, their narrow specialization, which does not allow the coach to carry out effective management of the starting lineup. All this requires justification for trends in team formation in the club volleyball competition system.

The formation of teams in volleyball, taking into account the main trends of the game, increasingly puts forward requirements for players of different roles, which is manifested in the consideration of anthropometric data, morphophysiological characteristics and a high level of technical and tactical preparedness. The compliance of a player with these parameters makes him valuable and in demand, which corresponds to the international conditions of the modern labor market. The analysis of migration of players of different playing roles (1, b) allows us to state that the most attractive in selection to the teams of different

confederations is the outside hitter players, the volume of which is 47.4% of the total number of players, which is explained by the powerful attacking potential and versatility of game actions. At the same time, the least attractive offensive player to migrate is the middle blocke, as evidenced by the 17.8% figure. According to Bruno Rezende, the most valuable player in the team is the setter, due to his organizational functions in the formation of technical and tactical style of play. However, as the results of the study show, this player from the position of migration has a low value (11,0%), which is explained by the fact that several playing seasons are needed to prepare a player for this playing role, so coaches for this position often use players from the national championship. In this context, the migration corridor of professional volleyball players opens when there is a need to ensure the team's composition in specific players, which depends on the contractual conditions, the financial balance of the team and the priority of preparation for the current season.

4. Conclusions

1. The development of the modern high performance sport, in particular its team-playing types, is inextricably linked to the processes of globalization, where the main trend is the migration of athletes and depends on the following factors: recognition through professional growth, increase in social status through higher wages, exchange of cultural and national values in order to expand international contacts and participation in the national championship of another country or in the national teams.

2. The peculiarities of migration processes in volleyball between different confederations were analyzed. Based on the results of the study it was found that the largest number of athletes migrated to the European confederation, which amounted to 83,0 % of the total number, to the Asian confederation – 10,2 %. The indicators of internal migration deserve special attention, where the maximum value is noted for CEV (65,4 %), the lowest value for AVC (2,3 %).

3. The study of volleyball players' migration issues in different confederations of the world allowed to determine the main trends existing in the formation of teams by legionary players taking into account their playing role, peculiarities of technical and tactical preparation and contractual conditions between the club and the player. It was found that the biggest demand among players of different playing roles in the conditions of migration belongs to outside hitter, the volume of which is 47,4 %, the smallest value of libero players – 3,1 %.

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STRENGTH DEVELOPMENT THROUGH PLYOMETRICS IN THE TRAINING OF JUNIOR VOLLEYBALLISTS II (U16)

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Abstract

The game of volleyball, like other sports games, is characterized by explosive efforts that are repeated several times during a match, so that the main characteristics of volleyball are explosiveness and repeatability. The major role that the force has in the practice of volleyball in the current period, requires the realization of a modeling of the muscular training and its peridization during a competitive season. Most authors who have dealt with this motor quality believe that the strength of the human body lies in the ability to make efforts to overcome, maintain or yield to an external or internal resistance, by the contraction of one or more muscle groups. Analyzing the strength of the human body, we can say that it is the object of study of physiological and methodological investigations aimed at sports training.

Key words: volleyball, strength, plyometrics

1. Introduction

Muscle strength is the ability to resist endurance through muscular effort. In volleyball we can speak of dynamic force or power, it represents the relationship between the work done and time. Dynamic force is the ability of the neuromuscular system to overcome resistance at the highest possible speed. By force is meant the ability of the athlete to resist resistance (Adam, A.M., Simion, G., Iconomescu, T., 2018, p. 11-16)

Strength training is used in the physical training of athletes with two purposes: the development of players' muscles and the acquisition of athletic fitness. (Calleja-Gonzalez, J., Mielgo-Ayuso, J., Sanchez-Urena, B., Ostojic, S. M., Terrados, N., 2019, p. 982-93)

In the modern methodology of training in the field of sports games, as well as in volleyball, there have been important changes in the design of the content, in the structure and organization of the training of players and teams.

A high-level volleyball game means the use of alternating high-intensity and low-intensity exercise (for example, sprinting and fast running or standing in a low position to receive services). (Cojocaru, A.M., Cojocaru, M., 2021, p. 51-56)

The balanced level of teams at both the regional, continental and global levels is the result of the technical, human and material investments that volleyball has benefited from. The processing of everything that is valuable, together with the

optimization of all performance links and the capitalization of any potential reserves, is the condition of progress materialized in the entire work of conception and execution (Zaţiorski, VM, 2004, p. 27)

Due to the specifics of the volleyball game, the physical training (multilateral, specific) must be permanently linked to the technical, tactical and psychological one, its contribution in consolidating and capitalizing on the technical-tactical potential being special (Niculescu, M., Vladu, L., 2005, p. 57).

It was found in the competitive evolution, that regardless of the specific structure of most of the sports branches, the results obtained are determined by the level of functional-energetic support, these being conceptualized through physical training (Wang, Y., 2016, p. 550-554).

The lower the physical training of an athlete, the faster he gets tired. When the athlete gets tired, the skills deteriorate. A high level of fatigue also affects tactical reasoning during the game, which means more mistakes, and consequently poorer performance (Weineck, J., 2003, p. 159). Therefore, physical training must be perpetuated and evaluated in this way, having an effective control over the training of athletes.

Effective performance of the game actions throughout the match requires a high level of general and special motor skills (Mârza, D. 2006, p. 112)

Research hypothesis: given the crucial role of strength in defining physical training in volleyball players, we assume that the application of plyometrics to develop specific strength, creates the premises for a multilateral training compared to the classical methods used by coaches.

2. Material and method

The experiment took place in the gym of the Alexandru Dima National College, the sample submitted to the experiment being the LPS Piteşti cadet girls volleyball team participating in the National Volleyball Championship. The team consists of 12 players and is registered in the LPS Pitesti Sports Club.

In order to confirm the hypothesis we used the following research methods:

- analysis and generalization of data from the specialized and interdisciplinary literature;
- method of pedagogical observation;
- method of measurements and testing (somatic, physiological, motor).
- pedagogical experiment;
- benchmarking;
- statistical-mathematical method;
- graphic and tabular method.

3. Results and Discussions

The systematization of statistical indicators regarding somatic growth tests in cadet volleyball players, a representative sample of our experiment, highlights the level of morphological development.

Table no 1 *Statistical-mathematical indicators in somatic growth tests*

Nr. crt.	Somatic growth tests	$\overline{X}$		σ		CV%	
		IT	TF	IT	TF	IT	TF
1.	Height	173 cm	175 cm	5.25	5.05	3.03	2.76
2.	Weight	59 kg	60 kg	10.77	9.75	18.26	15.05
3.	span	170 cm	172 cm	7.29	7.02	4.28	3.98
4.	Long. mb. lower	102 cm	103 cm	4.03	3.76	3.95	3.43

From the data presented in this table, it can be seen that the measured anthropometric parameters are the height, weight, span and length of the lower limbs.

The height has an average value of 173 cm at the initial test and 175 cm at the final test, and if we analyze the degree of homogeneity of the sample, we can see a coefficient of variability of 3.03% and 2.76% which shows that it is it is a homogeneous group in both the initial and the final test.

Body weight, the second somatic indicator, was determined using a person scale. The average weight is from 59 kg the initial test and 60 kg to the final test. Although the coefficient of variability improved in the final test compared to the initial test, we still have an inhomogeneous sample.

The third somatic indicator measured is the magnitude that shows the maximum opening between the arms. Analyzing the recorded data, it is observed that the average recorded wingspan was 170 cm at the initial test and 172 cm at the final test, and the fourth somatic indicator measured, lower limb length, was made with the metric band, the average length being 102 cm at the initial test and 103 at the final test.

For both statistical indicators, the values of the coefficients of variability can be seen from the table 4, 28% and 3.95% respectively at the initial test and 3.76 and 3.43 at the final test, which shows that the sample has a high degree of homogeneity.

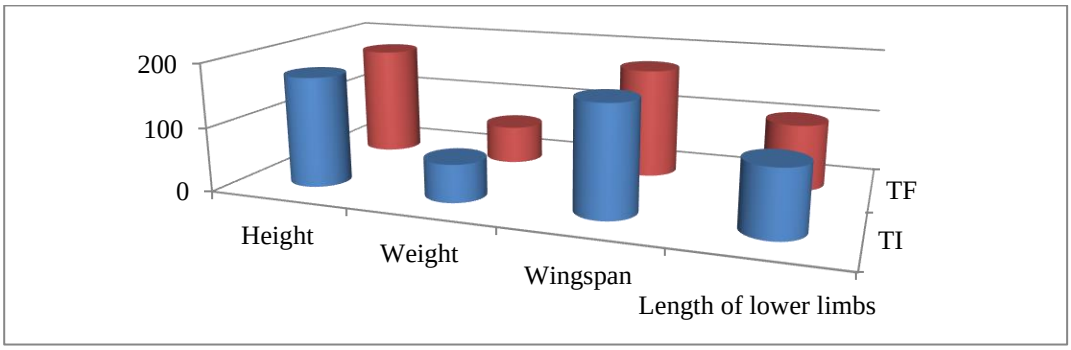

Figure no. 1 *Statistical-mathematical indicators in somatic growth tests (average)*

As can be seen from the table below, the functional tests that were taken into account are: pulse statostatism - orthostatism, blood pressure cliostatism - orthostatism, Ruffier test and Sargent test.

Table no 2 *Statistical-mathematical indicators for functional tests*

Nr. crt.	Functional tests	$\overline{X}$		σ		CV%	
		IT	TF	IT	TF	IT	TF
1.	Pulse clinostatism	81 / min	75 / min	12, 58	10.32	15.53	13.35
2.	Pulse orthostatism	90 / min	85 / min	15.09	13.11	16.77	14.54
3.	Ruffier test	7.8-good	6.4-good	6.8 - good	4.76	8.77	6.98
4.	Sergeant test	102-satisf	96-satisf	7.85	6.56	7.69	6.21

The pulse taken in clinostatism and orthostatism is an important indicator of the body's functional capacity, it was measured individually for one minute. At this indicator the average value 81 at the initial test and 75 pulses / minute at the final test in clinostatim and 90 and 85 pulses / minute at orthostatism, falls between the normal parameters, the value of the coefficient of variability is 15.53% at the initial test and 13.35% at the final test which shows a good homogeneity at the final test compared to the initial one and 16.77% and 14.54% at the pulse in orthostatism, indicating a relatively homogeneous experimental group.

Ruffier test - is a test to assess fitness and is based on the reaction of the heart rate to a standard effort (kneeling) and the application of a formula results in an index with mathematical expression easy to follow in dynamics.

Following the data recorded in the table above we can see that the average evaluation of the Ruffier test was 7.8 in the initial test and 6.4 in the final test, which corresponds to the good grade.

In the Sargent test which indicates the maximum anaerobic power expressed in kgm / s, we notice an average of 102 in the initial test and 96 in the final test, which on the scale of assessment is considered satisfactory.

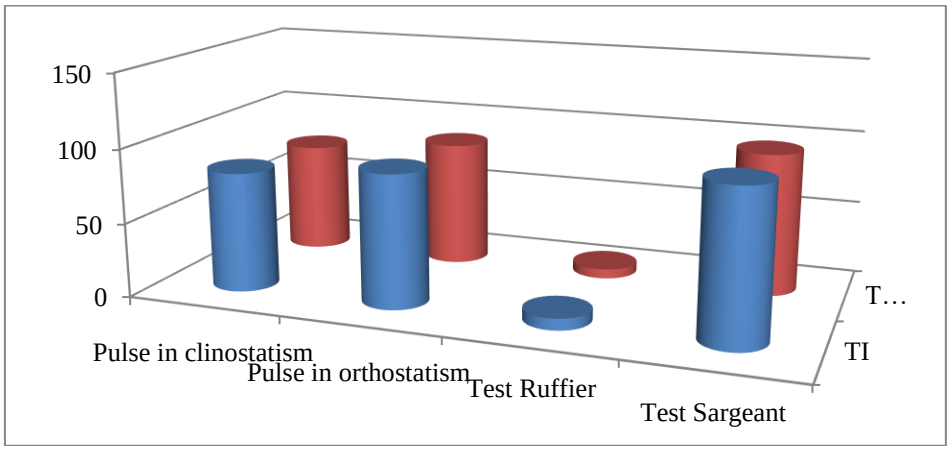

Figure no. 2 *Statistical-mathematical indicators for functional tests (average)*

The general motor tests were chosen based on the data provided by the level of muscle training in the experimental sample.

Table no. 3 *Statistical-mathematical indicators for general motor tests*

Nr. crt.	General motor tests	$\overline{X}$		σ		CV%	
		IT	TF	IT	TF	IT	TF
1.	Jump. in height from the spot (cm)	37	44	3.89	3.87	10.52	10.35
2.	Jump. in height. with one hand (cm)	39	46	4.17	4.35	10.70	9.76
3.	Jump. in height. with two hands (cm)	37	42	3.90	4.12	10.55	9.98
4.	Jump. in the long run. from the spot (cm)	200	213	8.76	7.99	4.38	5.45
5.	Launch mg. med. of2 kg (m)	4,55	5.11	0.62	1.54	13.68	13.03
6.	Abdomen for 30 sec. (no. repeat)	26	31	3.47	4.23	13.36	12.98
7.	Triple jump on two legs (m)	6	6.21	0.21	0.65	3.54	4.54

High jump without momentum and with momentum are considered tests that measure the explosive force in the lower limbs.

From the data obtained, we can see that the average high jump without momentum is 37 cm at the initial test and 44 cm at the final test, and at high jump with momentum it is 39 cm and 46 cm, while the coefficient of variability at the final test is 10.35% and 9.76%, respectively, which shows a homogeneous group.

The long jump from the spot (test that measures the explosive force of the lower limbs) obtained an improvement of the average at the final test compared to the initial test by 13 cm, and the coefficient of variability is 4.38% at the initial test and 5, 45 % which shows us that the sample has a high degree of homogeneity.

The strength of the upper limbs was tested by the "launch of the 2kg medicine ball" test. The averages obtained in these tests show an improvement of about 56 cm, the coefficient of variability was 13.68% in the initial test and 12.98% in the final test.

Abdominal 30 sec is a test that measures abdominal strength. Looking at the table above we can see an average of 26 repetitions / 30 seconds in the initial test and 31 repetitions / 30 seconds in the final test and a coefficient of variability of 13.03%.

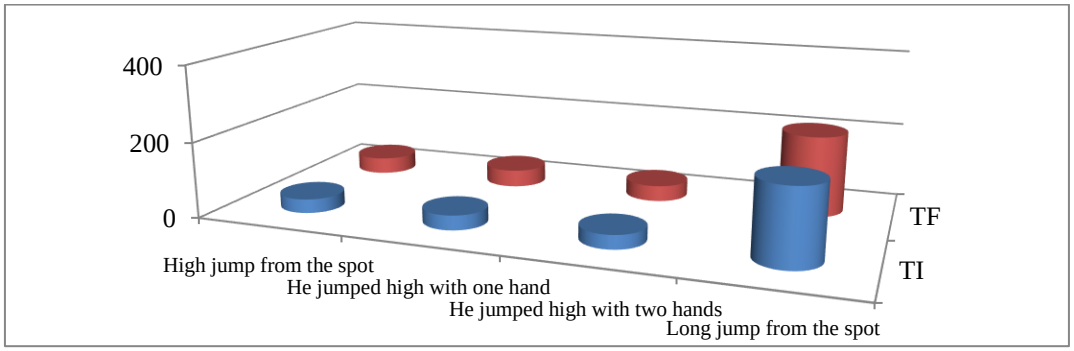

Figure no. 3 Statistical-mathematical indicators for general motor tests

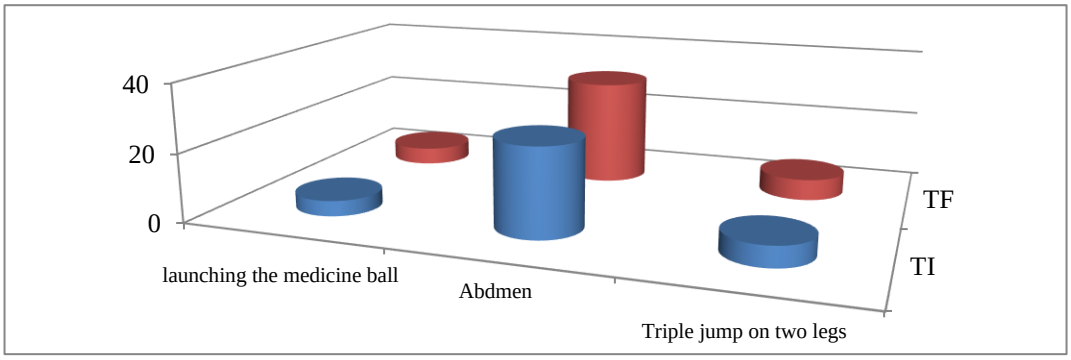

Figure no. 4 Statistical-mathematical indicators for general motor tests

The last test was "triple jump on two legs", at which the average was 6,00 m, and the coefficient of variability is 3.54% which shows a high degree of homogeneity of the group under test.

At this age, multilateral training must be continued, especially in the pre-competitive period, but still the emphasis must be placed on specific training and on the use of training methods and techniques that increase the level of specific efficiency, especially during the competitive period.

The improvement and improvement of technical elements and processes in volleyball must be done by means that ensure correct execution from a biomechanical point of view and efficient from a physiological point of view.

4. Conclusions

From the evaluation of the records at each test, we notice improvements from the initial test to the final one, but summing up the final results we notice that the volleyball index falls in average values, which shows us that the physical training at the club level is below the desired level;

According to the results, energetic measures are required to optimize the physical specialization training of players with waist at the level of juniors.

Most specialists use well-known and generally applied methods in their training, being unfamiliar with modern training methods that produce beneficial results for performance sports.

The use of plyometric means in the training leads to a multilateral training of volleyball players.

It is especially important to ensure a relaxing interval during training, after each repetition, series, between exercises and between sessions, to allow the recovery of muscle energy reserves.

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DETERMINING THE CHARACTERISTICS OF BALANCE IN YOUNG FOOTBALL PLAYERS

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Abstract

The main objective of this study is to analyze the characteristics of static balance in young football players, providing a solid basis for developing training strategies aimed at optimizing athletic performance and ensuring players' safety on the field. The research involved 18 football players aged 11 from the FC Argeș Sports Club in Pitești. The assessment of static balance was conducted using the MiniBoard platform (Sensamove), measuring parameters such as: performance (%); front, back, left and right average deviation. The statistical analysis was performed by means of KyPlot software (version 6.0), using descriptive indicators such as standard deviation, confidence interval of the mean and the lower and upper limits of the mean. The evaluation of bipedal and unipedal static balance in young football players revealed an average performance of 80.17% for bipedal balance and 82.5% for unipedal balance on the right foot, respectively 80.67% on the left foot, indicating a good ability to maintain stability under different conditions. Also, the unipedal position, especially on the right foot, showed superior performance, highlighting the importance of balance in the efficiency of sport-specific movements. The bipedal position, although more stable overall, presented greater variability in balance control. In conclusion, the results suggest that specific training for improving balance could significantly contribute to the development of young football players' athletic performance and injury prevention.

Key words: *balance, football players, performance, training, stability*

1. Introduction

Balance is an essential component of athletic performance, serving as a fundamental factor in sports that involve rapid changes in direction, stability and postural control, such as football (soccer) (Hrysomallis, 2011; Zemková, 2014; Zemková & Zapletalová, 2022). Young football players, who are in the midst of physical and motor development, require good stability and coordination to optimize their performance on the field and prevent injuries (Cook, 2003; Myer et al., 2011; Leyhr, et al., 2018). Recent studies show that balance is not only a fundamental aspect of motor control but also a critical element for improving the efficiency of football-specific movements, such as dribbling, quick direction changes and maintaining stability during physical duels with opponents (Deutsch et al., 2023; Owen, 2023).

Although balance can be influenced by numerous factors, including sports experience, proprioceptive ability and the development of the neuromuscular system, it is often trainable and susceptible to significant improvement through specific training (Rogers et al., 2005; Kim et al., 2011; Fort-Vanmeerhaeghe et al., 2016). In this context, it becomes important to understand and assess the characteristics of balance in young football players in order to design effective interventions that support their athletic development (Davids et al., 2003; Lloyd & Oliver, 2013; Zemková & Hamar, 2018).

Postural balance, defined as the ability of the body to maintain a stable position both at rest and in motion, is a key element of athletic performance (Cook, 2003; Zemková, 2014; Ivanenko & Gurfinkel, 2018). Balance can be divided into two main categories: static balance, which involves maintaining stability in a fixed position, and dynamic balance, which means to maintain stability during movement (Hrysomallis, 2011; Ricotti, 2011). Both forms of balance are crucial in football. Static balance is important in moments such as maintaining position while taking free kicks, while dynamic balance is vital during running, dribbling and quick changes of direction (Paillard & Noé, 2006; Pau et al., 2016).

Research highlighted that young football players exhibit a high potential for improving dynamic balance due to the neuromuscular plasticity typical of their age. The ability to manage rapid changes in body position and respond efficiently to external stimuli contributes to better on-field performance and helps avoid injuries, such as ankle sprains - common among young athletes (Ramírez-Campillo et al., 2015; Mandroukas, 2019; Pau et al., 2019; Arsham & Sarabandi, 2020).

The training meant to improve balance in young football players relies on exercises that involve controlled instability and multitasking. These workouts contribute to better proprioception, improved motor responses and adaptation to external factors (Myer et al., 2006). Research also suggests that well-developed balance can have a positive effect on football-specific technical abilities, such as dribbling and ball striking (Plakias et al., 2024).

Given the importance of balance in athletic performance, we believe that integrating specific training for both static and dynamic balance into the training program of young football players is essential not only for the improvement of technical skills such as dribbling and kicking the ball but also for preventing injuries. Thereby, a sustainable athletic development is ensured.

2. Material and method

The main objective of this paper is to determine the characteristics of static balance in young football players and to provide a solid foundation for the development of training strategies that optimize athletic performance and safety.

The research hypothesis is that young football players exhibit greater stability in unipedal positions compared to bipedal positions. Training focused on unipedal balance will lead to improved sports performance and reduced risk of injury on the playing field.

A number of 18 football players, aged 11 years (U12), from the FC Argeș Sports Club of Pitești participated in this study.

The miniboard platform (Sensamove) was used to assess static balance. The measured parameters included: Performance (%), Front, avg. deviation (degrees), Back, avg. deviation (degrees), Left, avg. deviation (degrees) and Right, avg. deviation (degrees).

Statistical analysis was performed using KyPlot software (ver. 6.0), using the following descriptive indices: ±SD - standard deviation; Confidence Level of Mean; Lower and Upper Confidence Limits of Mean.

3. Results and Discussions

The comparative analysis of the static balance results in young football players can be conducted by comparing each specific parameter: performance, average deviations forward/backward and left/right, standard deviation, coefficient of variation and the lower and upper limits of confidence intervals. These comparisons are detailed hereby (Tables 1, 2, and 3):

Table 1. *Results of the bipedal static balance in young football players*

Descriptive indices	Performance (%)	Front, avg. deviation (grade)	Back, avg. deviation (grade)	Left, avg. deviation (grade)	Right, avg. deviation (grade)
mean	80.17	0.93	-1.12	-0.93	1.37
SD	10.37	0.48	0.73	0.42	0.92
CV(%)	12.94	51.35	65.54	44.99	67.34
CLM (0.95)	5.16	0.24	0.36	0.21	0.46
LCLM	75.01	0.69	-1.48	-1.13	0.91
UCLM	85.33	1.17	-0.75	-0.72	1.83

Note. SD- standard deviation; CLM - Confidence Level of Mean; LCLM - Lower Confidence Limit of Mean; UCLM - Upper Confidence Limit of Mean

Table 2. *Results of the unipedal static balance (right foot) in young football players*

Descriptive indices	Performance (%)	Front, avg. deviation (grade)	Back, avg. deviation (grade)	Left, avg. deviation (grade)	Right, avg. deviation (grade)
mean	82.5	0.86	-1.16	-0.38	1.09
SD	7.85	0.40	0.51	0.48	0.69
CV(%)	9.51	46.68	44.02	126.7	63.7
CLM (0.95)	3.90	0.20	0.25	0.24	0.35
LCLM	78.59	0.66	-1.41	-0.61	0.74
UCLM	86.40	1.06	-0.91	-0.14	1.43

Table 3. *Results of the unipedal static balance (left foot) in young football players*

Descriptive indices	Performance (%)	Front, avg. deviation (grade)	Back, avg. deviation (grade)	Left, avg. deviation (grade)	Right, avg. deviation (grade)
mean	80.67	1.05	-1.15	-1.19	0.56
SD	7.66	0.52	0.59	0.83	0.51
CV(%)	9.49	49.82	51.2	69.6	90.36
CLM (0.95)	3.81	0.26	0.29	0.41	0.25
LCLM	76.85	0.79	-1.45	-1.61	0.31
UCLM	84.47	1.31	-0.86	-0.78	0.82

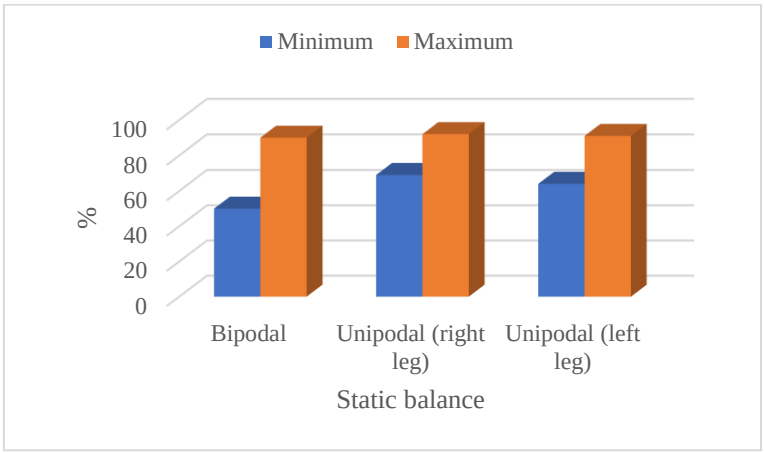

Fig. 1. *Value of minimum and maximum static balance performance in young football players*

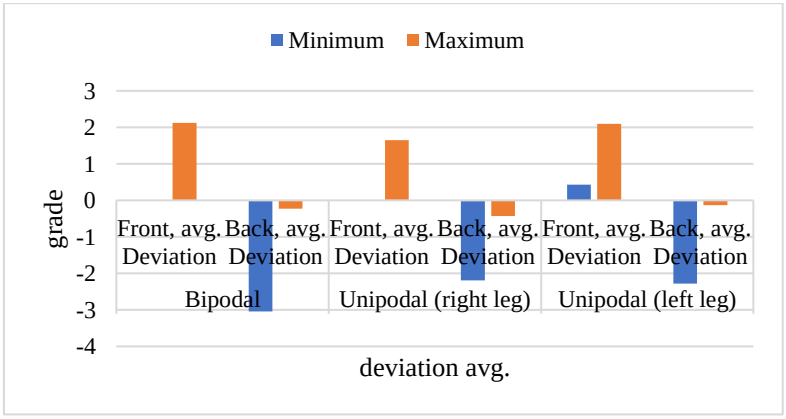

Fig. 2. *Value of minimum and maximum front-back average deviations from static balance in young footballers*

Performance (%) (Fig. 1): Static balance performance is highest in the unipedal position on the right foot (82.5%), lower on the left foot (80.67%) and bipedal (80.17%). In unipedal positions, the standard deviation is smaller, indicating better

stability compared to the bipedal position, which is consistent with the findings of studies highlighting the importance of single-leg balance in sports activities such as football (Paillard & Noé, 2023).

Average deviations (degrees):

Forward deviation: smallest in the unipedal position on the right foot (0.86), compared to bipedal (0.93) and the left foot (1.05).

Backward deviation: values are similar across positions, with a slightly larger difference on the right foot (-1.16) (Fig. 2).

Lateral deviation: deviations to the left and right vary significantly. The left deviation is smallest on the right foot (-0.38) and largest on the left foot (-1.19). The right deviation is largest in the bipedal position (1.37).

These variations confirm that balance is influenced by body position and the distribution of load on the lower limbs, a common finding in biomechanical analyses of balance in athletes.

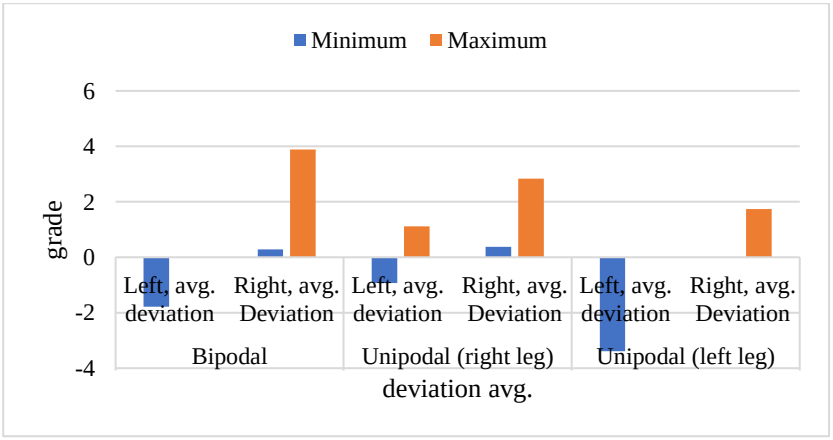

Fig. 3. *Value of minimum and maximum lateral average deviations from static balance in young footballers*

In conclusion, the bipedal position shows greater instability and variability, reflected by higher standard deviations and coefficients of variation, as well as wider confidence intervals. In contrast, unipedal positions, particularly on the right foot, demonstrate higher stability and precision in maintaining balance, a crucial aspect in football-specific movements.

Both Hrysomallis (2011) and Zemková (2014) emphasize the importance of balance in athletic performance, highlighting the need for sport-specific balance training to optimize movement efficiency in athletes. The role of neuromuscular control in postural and core stability, as analyzed by Zemková and Zapletalová (2022), is very important for enhancing functional movement, a concept also supported by Cook (2003) in his work on achieving balance in athletic bodies.

Myer et al. (2011) and Leyhr et al. (2018) explore the benefits of integrative training for young athletes, focusing on reducing injury risk and supporting long-term athletic success, a topic further studied by Deutsch et al. (2023) and Owen

(2023) in the context of soccer-specific demands and coaching methodologies.

Rogers, Rogers and Takeshima (2005) highlight the importance of balance training in older adults, while Kim, Van Ryssegem and Hong (2011) challenge the traditional views on proprioceptive training, suggesting that more targeted approaches are needed for effective balance improvement. Fort-Vanmeerhaeghe et al. (2016) and Lloyd and Oliver (2013) demonstrate the value of integrative neuromuscular training in youth athletes, pointing out its role in injury prevention and performance enhancement. The dynamical systems theory explored by Davids et al. (2003) aligns with the work of Zemková and Hamar (2018), which underscores the importance of sport-specific neuromuscular training assessments to optimize athletic development in young athletes.

Cook (2003) and Zemková (2014) emphasize the importance of balance, both static and dynamic, in athletic performance, while Ricotti (2011) and Ivanenko and Gurfinkel (2018) deal with the mechanisms of postural control in young athletes, highlighting how dynamic balance can be particularly affected. In this regard, Pau et al. (2016) observed impairments in balance after a match in elite young soccer players.

Ramírez-Campillo et al. (2015) demonstrate how different types of plyometric training can improve explosive power, balance and endurance in young soccer players, while Mandroukas (2019) and Arsham and Sarabandi (2020) examine the physiological and neuromuscular differences in balance control between trained athletes and non-athletes. Pau et al. (2019) further emphasize that dynamic postural stability is closely linked to the competitive level in youth soccer players, revealing the importance of targeted training for performance optimization.

Myer et al. (2004) and Wollesen et al. (2022) highlight the importance of integrating multitasking exercises, particularly motor-cognitive tasks, in injury prevention programs for young athletes, which could also enhance cognitive and motor coordination during gameplay.

Meha et al. (2024) and Asadi (2020) underline that structured training programs, such as the 'FUNBALL' injury prevention initiative and strength and plyometric training, not only improve physical performance but also positively influence cognitive abilities, which are crucial for young football players in maintaining high game intensity and performance consistency.

4. Conclusions

The results obtained from the evaluation of bipedal and unipedal static balance in young football players indicate an average performance of 80.17% for bipedal balance and 82.5% for unipedal balance on the right foot, respectively 80.67% on the left foot, highlighting a good ability to maintain stability under various conditions. At the same time, the average front and back deviations suggest significant variations in postural control, revealing the importance of specific training aimed at improving balance and motor adaptation to external factors.

The unipedal position, especially on the right foot, stands out with superior

performance and greater stability in maintaining balance. This reflects the specificity of sports activities, where single-leg balance is highly important for movement efficiency. Additionally, the bipedal position, while more stable in a general context, shows greater variability in balance control, as demonstrated by the higher coefficients of variation and wider confidence intervals. These observations are supported by the specialized literature on balance in sports.

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NAVIGATION AND SAFETY TECHNIQUES IN KAYAKING

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Abstract

Kayak navigation represents a complex activity, involving not only the knowledge and application of paddling techniques but also a high degree of awareness of safety measures. This study aims to analyse various effective navigation techniques for kayakers, assess the risks associated with this activity, and identify the most effective safety measures to prevent accidents and improve practitioners' preparedness. The analysis was based on a systematic review of specialized literature, including scientific articles, case studies, and research reports published in the last decade. Among the most important techniques are paddling with a firm grip, handling slalom kayaks in windy conditions, and self-rescue techniques. Risks associated with slalom kayaking navigation include hypothermia, collisions, capsizing, and losing contact with the group. Preventing these incidents requires careful route planning, checking weather conditions, using appropriate safety equipment, and knowing first aid techniques. The study highlights the importance of an integrated approach in kayakers' training, combining advanced navigation techniques with robust safety strategies. Therefore, improving the level of preparedness and risk awareness are essential to ensure a safe and enjoyable experience in slalom kayaking.

Key words: *kayaking, kayak safety, kayaker training, accident prevention in kayaking, kayak navigation techniques*

1. Introduction

Slalom kayaking navigation is a complex activity that not only involves mastering paddling techniques but also requires a high level of safety awareness (Hill et al., 2010). As kayaking is an Olympic discipline, athletes must be able to manoeuvre swiftly through fast-flowing watercourses, whether natural or artificial. Success in this discipline largely depends on the development of athletes' mechanical, physiological, and technical capabilities (Hill et al., 2010, p. 16).

An essential component of performance in slalom kayaking is the ability to navigate through slalom gates, whether upstream or downstream, while exerting intense efforts (Hill et al., 2010, p. 17). This aspect requires not only impeccable technique but also rapid and precise concentration and execution.

However, if kayakers do not master navigation techniques and take appropriate safety measures, there is an increased risk of encountering difficulties or even dangers on the water (Messias et al., 2018, p. 1). Lack of navigation skills can lead to loss of direction or deviations from the planned route, which can result in time loss or even getting lost (Messias et al., 2018, p. 3). Therefore, it is important for athletes to be well-prepared and to have a profound understanding of navigation techniques and safety measures to avoid such undesirable situations.

Thus, to excel in kayaking, athletes must develop both technical skills and awareness and respect for safety measures. Only through the integrated approach of

these aspects can they hope to achieve remarkable performances in this highly competitive and demanding discipline.

2. Material and method

This study aims to analyse various effective navigation techniques for kayakers, evaluate the risks associated with this activity, and identify the most efficient safety measures to prevent accidents and improve practitioners' preparedness. The study highlights the importance of an integrated approach in kayakers' training, combining advanced navigation techniques with robust safety strategies. Therefore, improving the level of preparedness and risk awareness are essential for ensuring a safe and enjoyable experience in slalom kayaking. The analysis was conducted based on a systematic review of specialized literature, focusing on scientific articles, case studies, and research reports published in the last ten years. Studies from the last decade were selected from Google Scholar, explicitly addressing techniques of navigation in slalom kayaking (208 results), risk assessment specific to slalom kayaking (1,110 results), and safety strategies adopted for preventing accidents in slalom kayaking (549 results). In total, 1867 articles were identified. The selection criteria for the articles included in the analysis were as follows: they had to be full papers, relevant, and non-duplicative. Finally, 17 articles were selected for analysis based on these criteria. The information obtained from the specialized literature was analysed and synthesized to identify the main trends and effective practices in the field.

3. Results and Discussions

Kayaking is an extremely diverse sporting activity that involves navigating the water using a kayak. To improve their skills and performance, kayakers must master a number of advanced techniques. These include paddling in a firm grip (Niu et al., 2019), slalom kayak handling in windy conditions (Aadland et al., 2015), and self-rescue techniques (Greenbaum, 2019). These techniques are essential for safe and efficient navigation in various water and weather conditions.

Paddling in a firm grip is one of the most fundamental techniques in kayaking, being essential to the control and propulsion of the kayak. Thus, the importance of a correct rowing technique in a firm grip has been demonstrated to maximize the efficiency of movement and minimize the risk of injury

The study by Niu et al. (2019) evaluated the water kayaking performance of female athletes using a custom paddle equipped with fiber optic sensors. The system measured handle loading and blade loading in real time. Thirty participants, split equally between competitive and recreational kayakers, sprinted across a 50-meter pool. Data showed that competitive rowers had shorter durations in the water phase and exerted higher grip and blade forces than their recreational counterparts, indicating a more efficient rowing technique (Niu et al., 2019, p. 11918).

Thus, the study highlighted the importance of correct paddle positioning, rowing angle and correct use of trunk muscles to achieve optimal propulsion.

Kayaking in windy conditions is an advanced aspect of the sport that requires specific skills and techniques. The study by Aadland et al. (2015) aimed to analyse sea kayaking incidents in Norway, focusing on weather conditions, especially wind, to determine their causes. The authors examined 49 media-reported incidents and found that most occurred in moderate to high wind conditions. Weather forecasts generally predicted wind conditions correctly. The study showed that prevention of future incidents could be improved by raising awareness and organizing context-relevant learning experiences (Aadland et al., 2015, pp. 131-145).

Techniques such as controlling the center of gravity (Kiss et al., 2018, p.367), using the paddles correctly to surf the waves (Forsyth et al., p.3003) and using the eskimo roll technique to get back into position quickly vertical in case of overturning (Spittler et al., 2020, p. 422) are key aspects in this regard.

Self-rescue is a vital skill for any kayaker, allowing them to manage emergencies and safely return to the water in the event of a capsize or other incident (Greenbaum, 2019, p.18).

Risks associated with slalom kayaking include hypothermia (Nathanson et al., 2015), collisions (Wickens et al., 2020), capsizing (Porathe et al., 2018), and losing contact with the group.

One of the main concerns in slalom kayaking is exposure to cold water and the possibility of hypothermia (Nathanson et al., 2015, p. 59). So cold water can lead to rapid loss of body heat, putting kayakers at risk of hypothermia, especially in cold weather or cold water. To prevent hypothermia, it is recommended to wear appropriate thermal equipment, as well as practice self-rescue techniques to get back into the kayak as quickly as possible in the event of a capsize.

Fast and precise navigation in kayak slalom involves passing through narrow gates and avoiding obstacles. However, the risk of collisions with other boats, rocks or floating objects is always present. The study by Wickens et al. (2020) showed the importance of attention and anticipation while sailing, as well as following priority rules and water traffic rules to minimize the risk of collisions (Wickens et al., 2020, p. 1304).

Kayak capsizing is one of the major risks associated with slalom kayaking, especially during fast and aggressive manoeuvres. Studies have looked at factors that contribute to kayak capsizing, such as loss of balance, mistakes in navigation technique (Porathe et al., 2018, p. 422) and rough water conditions (Zinke et al., 2018, 1763). To prevent capsizing, regular practice of balancing and self-rescue techniques is recommended, as well as the use of safety equipment such as life jackets (Viauroux and Gungor, 2016, p. 304).

Although I have not identified it in the specialized literature, as a professional in the field I have noticed another risk associated with slalom kayak sailing which consists of losing contact with the group.

Slalom kayaking can be practiced both individually and in groups. However, there

is a risk of losing contact with the group during the race or training. Thus, the importance of communication and coordination between group members, as well as establishing clear safety protocols to handle emergency situations or loss of contact, is very important.

Route planning is a fundamental aspect of kayaking that can significantly contribute to incident prevention. In this way, it is very important to select an appropriate route according to the skill level of the kayaker (Abelleira-Lamela et al., 2020, p. 8389) and the weather conditions (Hamacher et al., 2018, p. 491). Route planning must also consider factors such as current, wind and potential obstacles to minimize the risk of accidents (Aadland et al., 2017, p. 203).

Proper safety equipment plays a significant role in the prevention and management of kayaking incidents. Thus, it has been shown that wearing protective equipment such as life jackets and helmets can significantly reduce the risk of injury in the event of an accident (Quistberg et al., 2014). Also, the use of signalling devices, such as beacons and rescue whistles (Rosenbaum, 2016, p. 163), can make it easier for rescue teams to locate and assist the kayaker in an emergency.

Also, as a professional in the field I mention that knowledge of first aid techniques is essential for kayakers to be able to provide assistance in emergency situations. In this regard, first aid training is very important to effectively manage injuries, hypothermia, capsizing and other emergencies that may occur while kayaking.

Starting from the analysis of the specialized literature, I created Guide to Kayaking: Techniques, Safety, and Gear Essentials as follows (Table 1):

Table 1 *Guide to Kayaking: Techniques, Safety, and Gear Essentials*

Section	Details
1. Paddling techniques and kayak control	- Correct positioning of the paddles - Specific skills
2. Self-rescue and safety techniques	- Essential safety techniques. Thermal equipment to prevent hypothermia - Risks: hypothermia, collisions, overturning of the kayak. - Safety equipment, route planning
3. Risk and incident management	- The role of safety equipment, first aid techniques - Selecting the appropriate route. Group communication and coordination
4. Equipment and accessories	- Life jackets, helmets, signalling devices - Customized equipment, sensor technology
5. Training and development	- Specific training, relevant learning experiences - Essential first aid knowledge for kayakers

It is important to learn the correct paddling and kayak control techniques in order to navigate the water efficiently and safely. Learning self-rescue and safety techniques is essential to deal with emergencies such as capsizing or collisions. Risk and incident management requires adequate training in the use of safety equipment and the application of first aid. Proper equipment and accessories, such as life jackets and signalling devices, are crucial to ensuring safety while kayaking. Attending training and continuing to develop your skills is important to increase your confidence and competence in kayaking responsibly. By learning and applying these aspects, kayakers can enjoy enjoyable and safe experiences on the water. Practicing water sports, including kayaking, requires a responsible approach and adequate preparation to deal with the various situations that may arise on the water. Investing in the knowledge and skills necessary for navigation and safety is essential to ensure an enjoyable and incident-free experience for all involved.

Thus, the lack of skills in navigation techniques and ignoring safety measures in kayaking can have serious consequences and can endanger the lives of both athletes and other people involved in nautical activities. Sailing without adequate knowledge can lead to loss of direction or exposure to unpredictable weather conditions such as strong winds or eddy currents. These situations can create difficulty in controlling the kayak and increase the risk of capsizing or going astray.

In terms of safety, not wearing protective equipment such as life jackets or signalling equipment and ignoring navigational rules can contribute to an increased risk of accidents or collisions. Failure to take these precautions can leave athletes vulnerable to hazards such as improper kayak loading, adverse weather conditions, or interactions with another watercraft.

4. Conclusions

Paddling in a firm grip, handling the slalom kayak in wind and wave conditions and self-rescue techniques are three fundamental aspects of kayaking. Kayaking can be an adrenaline-filled and rewarding activity, but it comes with some safety risks. Understanding and being aware of these risks is essential to playing this sport safely. By taking the proper safety precautions and following recommended practices, kayakers can minimize the associated risks and still enjoy their passion for slalom kayaking. Preventing kayaking incidents requires a comprehensive approach that includes careful route planning, checking weather conditions, using the proper safety equipment, and knowing first aid techniques. By taking these preventative measures, kayakers can significantly reduce the risk of accidents and still enjoy their passion for kayaking in a safe and responsible manner.

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EFFICIENCY OF DISPLACEMENT OF SPEED DEVELOPMENT METHODS IN ARTISTIC GYMNASTICS

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Abstract

The gymnast is forced to control her body in unusual conditions, to overcome her own weight, her segments, her entire body, as well as gravity. Gymnastics is made up of natural and adapted means, contributing both to the formation of motor skills and habits, as well as to the development of motor qualities. Exercise structures must ensure a high level of effort, being designed to solicit the body through various exercises, alternating effort and their complexity. The experiment aims to improve the speed of movement of 11-12-year-old gymnasts by athletic means. It was assumed that the use of athletic means applied in the preparatory period can lead to an increase in training performance and to a shortening of the period of improvement of the gymnasts' displacement of speed, thus to an increase in the results obtained in competitions. The following tests were used in the experiment: 10 m running, 20 m running, Long jump from the spot, Explosive force. At the end of the experiment, the gymnasts obtained improved results in all the tests tested.

Key words: *displacement of speed, gymnastics, motor skills, athletics means, training*

1. Introduction

Gymnastics creates great benefits for harmonious physical development, for the enrichment of the degree of motor skills, for strengthening health, for the formation of correct attire, for the systematic and independent practice of exercises, for the prevention and treatment of physical deficiencies, for the aesthetic form of movements, for the ability to control the musculoskeletal system, for the development of courage, perseverance, self-control and discipline (Grigore V., 2001).

In her exercises, the gymnast presents special body movements, in a beautiful shape, executed with ease, amplitude and expressiveness (Potop V., 2008). Simple movements are combined with difficult ones, easy ones with particularly risky ones. Behind these exercises of high tenacity and precision hide thousands of repetitions, hours of preparation, an enormous amount of work and a lot of renunciations.

The goal of any workout is to improve skills for successful performance. In the training of gymnasts, attention will be paid equally to physical improvement through the high level of development of basic and specific motor qualities, optimal values of morpho-functional indicators, full mastery of the exercises used, artistic and psychological training (Grosu E.F., 2011).

At the beginning of the preparatory period it is necessary to make a good general and balanced preparation, in order to ensure the development of basic motor qualities

and increase the functional possibilities of the body in general (Ballesteros J.M., 1993).

General physical training is carried out with the help of general development exercises, with and without difficulties, with objects and without and, especially, with exercises borrowed from athletics. Exercises with direct influence are directly aimed at increasing physical training in gymnastics; for example: with the help of various types of running, the gymnast improves her speed of movement on the jumping momentum.

A major objective of general physical training is to improve the capacity for effort. The greater the work potential, the easier it is for the body to adapt to the continuous increase in physical and psychological training requirements (Teodorescu S., 2006). Similarly, the stronger is the general physical training, the higher the level of motor qualities that the gymnast can reach.

Artistic gymnastics exercises, jumping, acrobatics require a proper development of the strength of the muscles of the arms, abdomen, back and a very good relaxation. Also, good mobility and flexibility of the spine, scapulohumeral joint, coxofemoral joint and ankles are required (Stoica V.G., 2015). An appropriate speed, with an emphasis on the speed of reaction and execution, a specific resistance adequate to the complex effort determined by the requirements of the competition and, last but not least, good coordination and skill. All these are part of the motor qualities and are the object of physical training (Corlaci I., 2013).

As one advances in training, the share of general physical training decreases, leaving room for specific physical training.

2. Material and method

The purpose of the research is to continuously improve the speed of movement of 11-12-year-old gymnasts by means specific to athletics, in order to obtain superior results over two training mesocycles.

Research hypothesis. It was assumed that the use of athletic means applied in the preparatory period can lead to an increase in training performance and to a shortening of the period of improvement of the gymnasts' displacement of speed, thus to an increase in the results obtained in competitions.

The research methods used were: Bibliographic study method, Observation method, Registration method results, Graphic method and Statistical-mathematical method.

The experiment took place on a number of 10 gymnasts aged 11-12 years, from the School Sports Club no. 2 in Bucharest. The duration of the experiment was 3 months between September 15 and December 15, 2023, during which 2 mesocycles of 6 weeks each were carried out. The following tests were used in the experiment: 10 m running, 20 m running, Long jump from the spot, Explosive force. Throughout the experiment, the gymnasts had 3 workouts per week in which they worked on athletic exercises to develop speed, especially displacement of speed.

3. Results and Discussions

Speed represents the ability of the human body to perform motor acts and actions in compliance with the conditions of speed imposed by certain conditions (Dragnea A., 2006, p. 122).

The displacement of speed represents the individual's ability to travel as far as possible in the shortest possible time, and is expressed in seconds (Ungureanu A., 2013).

For the development and improvement of all forms of manifestation of speed, the method of repetitions is used. The resumption of the effort is done after the body has fully recovered. The variant often used is the one in which the speed of repetitions gradually increases until it reaches the maximum speed. Another variant is that the maximum speed is reached from the beginning (Neder F., 2022).

As a result of the experiment, the following results were obtained (Table 1):

Table 1. Initial and final results – girls 11-12 years old

No. crt.	Initial of name and first name	10 m Running (seconds)		20 m Running (seconds)		Long jump from the spot (centimetres)		Explosive force (centimetres)	
		T1	T2	T1	T2	T1	T2	T1	T2
1.	P.A.	1.98	1.95	3.81	3.75	173	179	20	24
2.	N.D.	2.00	1.97	3.89	3.83	174	178	20	23
3.	R.B.	1.98	1.94	3.73	3.68	172	180	18	20
4.	A.R.	2.12	2.06	3.86	3.83	162	165	17	19
5.	C.S.	1.95	1.91	3.50	3.45	181	187	24	30
6.	D.E.	2.14	2.09	3.91	3.85	161	167	17	21
7.	M.D.	2.02	1.98	3.87	3.85	166	169	18	20
8.	I.C.	2.00	1.98	3.84	3.78	169	172	19	21
9.	B.A.	2.05	2.02	3.88	3.80	173	178	18	22
10.	L.O.	2.11	2.08	3.89	3.81	165	173	17	21
11.	Average	2.035	1.998	3.818	3.763	169.6	174.8	18.8	22.1
12.	Standard deviation	±0.066708	±0.061788	±0.12318	±0.121568	±6.186006	±6.795423	±2.149935	±3.142893
13.	Coefficient of variability	3.28%	3.09%	5.58%	3.23%	3.65%	3.89%	11.44%	14.22%

At the 10 m speed running event (Fig. 1), the arithmetic average was 2.035 seconds at the initial moment and 1.998 seconds at the end, which shows an improvement in the final performance by 0.037 seconds. The standard deviation is ±0.066708 at the initial moment and ±0.061788 at the end, indicating a homogeneous sample. The coefficient of variability is between 3.09 -3.28, from which the high homogeneity of the group is observed.

Analysing the data in Table 1 and Fig. 2 for the 20 m running event, we notice that the difference between the final and initial arithmetic mean represents a decrease in time of 0.055 seconds. The standard deviation at the initial moment is ±0.12318,

and at the end it is ±0.121568, the value at the two moments being very close, therefore homogeneity of the group. From the analysis of the coefficient of variability, we observe the high homogeneity of the group, the coefficient at the initial test being 5.58% and at the final one of 3.23%.

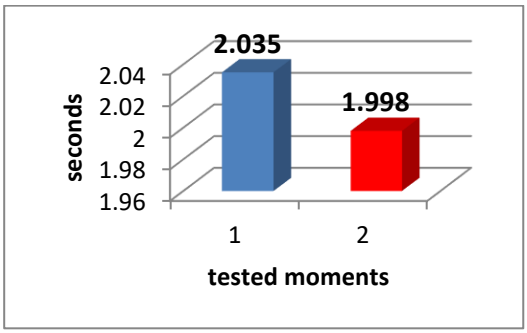

Fig.1. 10 m Running

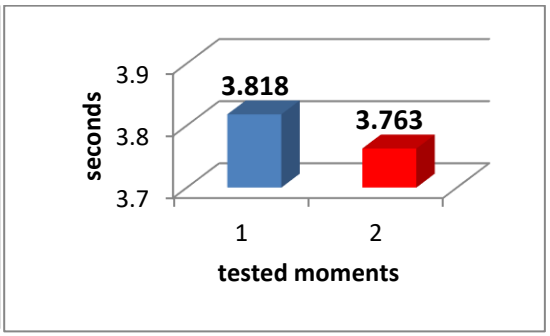

Fig. 2. 20 m Running

For the Long jump from the spot test (Fig. 3), in the initial moment the arithmetic average is 169.6 cm, and in the final moment it is 174.8 cm, which results in an improvement in the final average by 5.20 cm. The standard deviation is ±6.186006 at the initial test and ±6.795423 at the final test. The coefficient of variability has the value of 3.65% at the initial moment and 3.89% at the end, which results in a good homogeneity of the group.

In the Explosive force test (Fig. 4), at the initial moment the arithmetic average is 18.8 cm, and at the final moment it is 22.1 cm, resulting in an improvement of the final average by 3.30 centimetres. The standard deviation is ±2.149935 at the initial test and ±3.142893 at the final test. The coefficient of variability has the value of 11.44% at the initial moment, and 14.22% at the end, which results in an average homogeneity of the group.

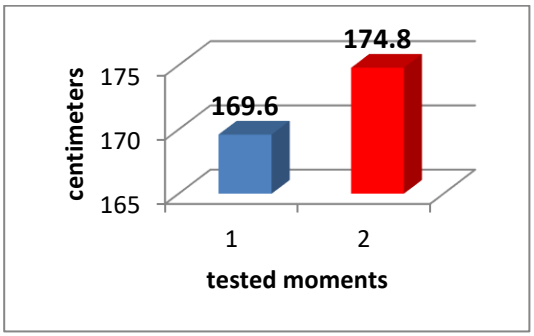

Fig. 3 Long jump from the spot

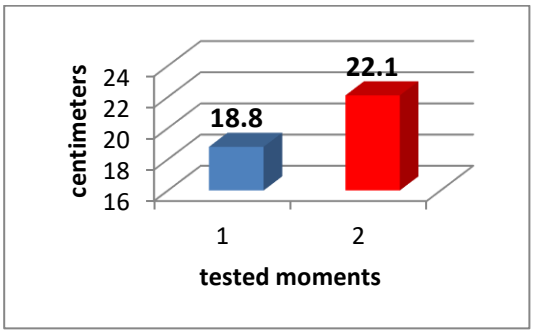

Fig. 4. Explosive force

In conclusion, at the end of the experiment, the gymnasts obtained improved results in all the tests tested.

4. Conclusions

As a result of the research, the following conclusions were reached:

1. The motor qualities necessary for gymnasts are: speed, strength of the muscles of the arms, abdomen, back and legs, mobility and specific endurance.
2. In the 10 m sprint event, the final result improved by 0.037 seconds, while in the 20 m run the final result was 0.055 seconds better than the initial one.
3. For the Long jump from the spot event, the final performance shows an improvement in the arithmetic mean by 5.20 cm. In the Explosive force test, the arithmetic media improved by 3.30 centimetres at the end of the experiment.
4. The hypothesis was confirmed. The use of athletic means that are applied in the preparatory period led to an increase in training performance and to a shortening of the period of improvement in the movement speed of gymnasts.

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OPINIONS ON ACTION STRATEGIES REGARDING THE PERFORMANCE CAPACITY OPTIMIZATION OF THE SPORTS WOMEN IN LUGE EVENTS

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Abstract

The *purpose of this study* is to analyze and evaluate the necessary action strategies for optimizing the performance capacity of female athletes in luge events. In this context, it was proposed that the responses obtained from winter sports specialists, by means of a questionnaire focused on training and competition methodologies in luge, serve as a starting point for identifying optimal strategies to enhance athletic performance in individual luge events.
Material and methods. To this end, a sociological study was conducted, applying the questionnaire to specialists in winter sports, particularly luge. The study involved 70 specialists from the country.
Results. The research results highlight that the majority of specialists consider winter sports in Romania to be at an average level, with significant potential for improvement. Athlete training is assessed as average, and the lack of adequate facilities and the insufficient media coverage are important limiting factors. The study identifies three main factors for optimizing luge performance: the quality of competition materials, adaptation to the specific characteristics of the track and the individual skills of the athletes. Effective strategies must integrate a detailed performance evaluation and equipment adaptation, taking into account the international conditions and successful models.
In *conclusion*, to improve the performances of the national team, it is essential to develop well-founded strategies tailored to the specific needs of the athletes. Strategies for optimizing luge performance in Romania should focus on improving competition materials, adaptation to the track characteristics and understanding competition requirements, with an emphasis on the effective interaction between strategy and tactics, reflecting both the specialized literature and the practical reality.

Key words: *optimization, performance, competition materials, track specifics, strategies*

1. Introduction

Sports performance in luge events has been the subject of increased attention in recent decades due to the complexity and specific challenges of the sport. Optimizing the performance capacity of luge athletes requires a comprehensive approach that combines detailed analysis of technical, physical and strategic aspects. Grigore et al. (2024) emphasize the importance of establishing a relationship between general and specific motor indices, showing that the development of effective strategies intended to improve luge performance should be based on evaluating and adjusting these parameters. In this respect, Lembert et al. (2011) highlight the need for developing

specific measurement and feedback tools to enhance luge technique, a crucial aspect for perfecting the skills of athletes.

On the other hand, studies by Fuss (2023) and Williams (2020) explore the influence of equipment and competition conditions on performance, underscoring that optimization strategies must consider these variables to ensure optimal results. Additionally, Bagińska et al. (2022) and Khoo et al. (2020) have demonstrated that nutrition and physical training are crucial components in the development of athletes, suggesting that action strategies should also integrate these aspects to maximize performance. In the international context, Baka (2006) and Rutty et al. (2015) provide valuable insights into successful models and risk management, highlighting the importance of adapting strategies to international standards and conditions.

The review of the literature emphasizes the need for well-founded strategies for optimizing luge athletes' performance, taking into account technical and physical aspects as well as external conditions and international successful models. By integrating these perspectives, the study aims to provide effective solutions tailored to the specific needs of luge athletes.

The *purpose of this study* is to analyze and evaluate the action strategies necessary for optimizing the performance capacity of sportswomen in luge events. The study aims to identify critical factors influencing performance in luge competitions, examine the effectiveness of current strategies and propose recommendations based on collected data to improve athletes' results. Specifically, the study focuses on aspects related to training of athlete athletes, selection and use of competition materials, adaptation to the characteristics of the track and understanding competition requirements, as well as the interaction between long-term strategies and short-term tactics.

2. Material and method

Research hypothesis: Responses obtained from winter sports specialists through a questionnaire centered on the methodologies of training and competing in luge events can serve as a starting point for identifying optimal strategies to enhance individual luge performance.

Research methodology: A sociological survey via questionnaire, combining both closed and open-ended questions, according to methodological recommendations from experts in the field, was used as research method. The survey investigated the opinions of specialists in order to obtain essential insights into performance optimization strategies in female luge athletes of Romania. The study involved 70 winter sports specialists, particularly in the field of luge.

3. Results and discussions

The results show that the majority of specialists surveyed (46%) consider the level of winter sports in Romania to be average. A percentage of 29% view the performance as low, while 17% consider it high. Only 6% of respondents rate the

level as very low, and just one specialist (3%) views it as very good. The general conclusion is that winter sports in Romania are at an average level, with potential for improvement, despite participation in major international competitions.

Most specialists (51%) believe that winter sports in Romania receive some attention, but the lack of adequate training facilities and limited media coverage restrict their support, with no respondent rating the attention given to winter sports as high.

The majority of specialists (46%) consider the training level of Romanian lugers to be average, while 43% view it as high. The general conclusion is that athletes are trained at an average level, with a focus on improving international performance.

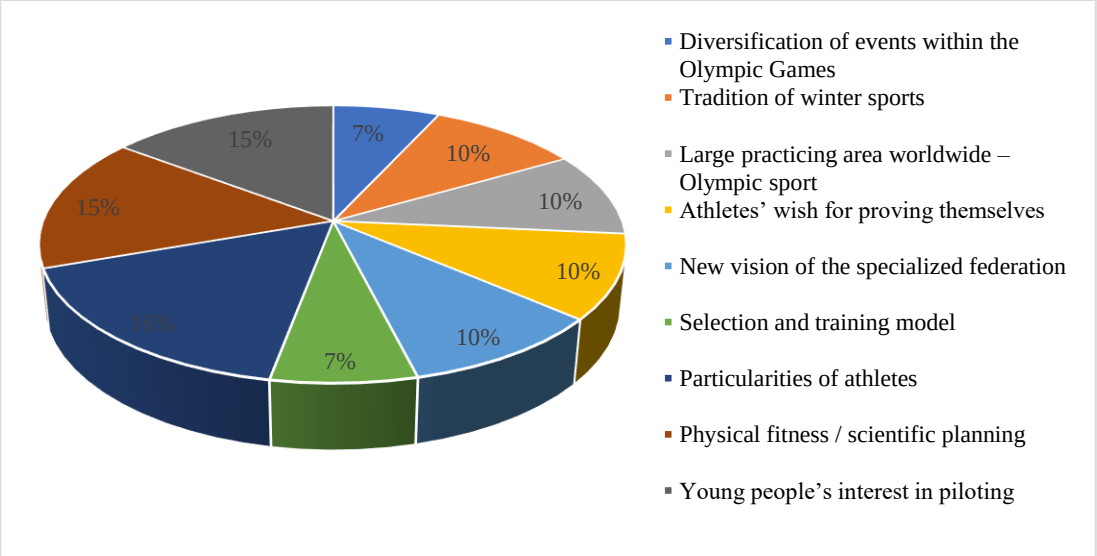

Fig. 1. *Factors favorable to sports performance in luge events*

The question in the sociological questionnaire shown in Figure 1 reveals that between 15% and 17% of specialists identified the following factors as favorable to performance in luge events: characteristics of athletes, scientific planning and youth interest. Meanwhile, 10% highlighted the vision of the federation, the desire for recognition and the tradition of winter sports, while 7% emphasized the diversification of events at the Olympic Games and the model of selection and training.

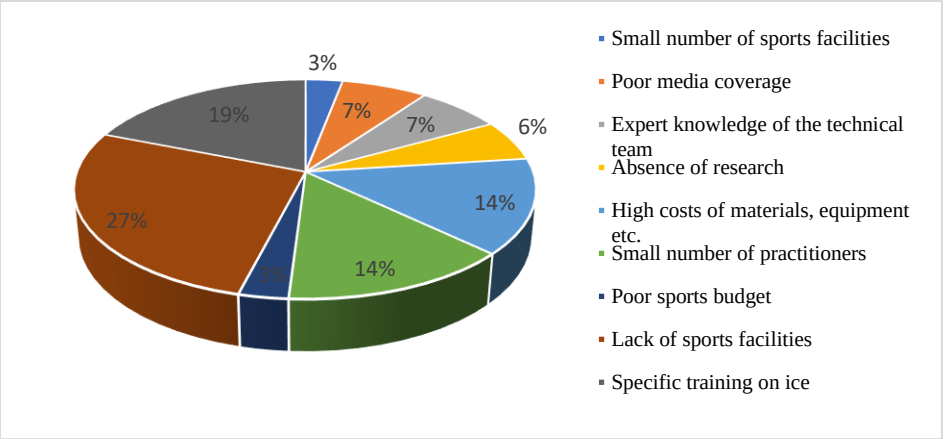

Fig. 2. *Factors limiting sports performance in luge events*

Regarding the limiting factors of sports performance in luge events (Fig. 2), 27% of respondents identified the lack of sports facilities as the main limiting factor, 19% mentioned specific ice training, 14% highlighted the costs of equipment and the small number of practitioners in Romania, and 21% included factors such as the absence of research, insufficient technical knowledge and poor media coverage. Additionally, three specialists noted inadequate funding and the limited number of sports sections.

The question about training strategy in luge events from the sociological questionnaire reveals that 30% of specialists emphasized the importance of competition materials and training, 20% indicated the planning of ice training and 14% mentioned planning performance goals over Olympic cycles. The conclusion is that the strategy should include ensuring competitive equipment, planning specific indicators and a multidisciplinary technical leadership for medium- and long-term objectives.

The question concerning the interaction between strategy and tactics reveals that 57% of specialists believe this interaction occurs to a very large extent and 40% to a large extent. The conclusion is that the interaction is essential for achieving performance goals, with specialists effectively combining means and goals to reach these objectives.

Through the analysis of the sociological questionnaire, several differences between strategy and tactics in the field of luge were identified (Fig. 3). 29% of specialists emphasized that strategy is long-term oriented, while tactics are adapted in the short term according to immediate goals. Another 29% mentioned that strategy aims at optimizing sports training, in contrast to tactics which are adapted and implemented based on competition conditions. Additionally, 14% of responses indicated that tactics are a component of strategy, with strategy responsible for planning goals and tactics for achieving them. 10% of specialists stated that the success of the strategy depends on the effective application of tactics, while 5% believe that the decisive factors are different.

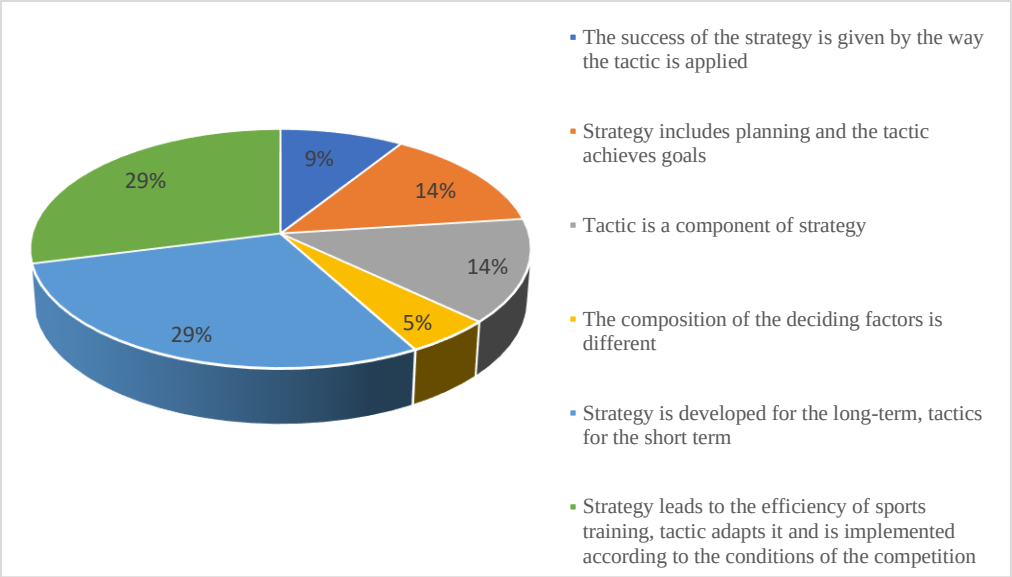

Fig. 3. Differences between strategy and tactics

The conclusion of this analysis is that in order to achieve strategic goals, it is essential to develop a long-term strategy and implement effective short-term tactics, adapting to competition conditions and ensuring optimal fulfillment of planned objectives.

The analysis of responses to the question regarding the existence of strategies for optimizing sports performance in luge events shows the following:

- 60% of specialists, namely 21 respondents, believe that the strategies developed for optimizing performance are well-defined to a large extent and have considerably contributed to these strategies;
- 29% of specialists, representing 10 respondents, estimate that the existing strategies are well-defined to some extent;
- Only 2% of respondents (two individuals each) consider that the strategies are well-defined to a small extent, while the same proportion considers them to a very large extent.

The conclusion of this analysis is that the majority of specialists believe that strategies for optimizing performance in luge events are well-defined and effective. Additionally, professional experience confirms that these strategies are regarded as suitable for improving the performance of the national team.

For optimizing performance in luge events, the three most important factors are:

- Preparation and setup of competition materials – 31% of specialists consider that using the best competition materials and appropriate settings are essential;
- Characteristics of the track and knowledge of competition effort – 24% of specialists emphasize the importance of adapting to the specifics of the track and understanding competitive requirements;
- Own skills of the athlete – 14% of specialists highlight the role of the athlete's individual skills in developing the strategy.

In conclusion, strategies for optimizing performance in luge events should be based on appropriate competition materials, adaptation to the specifics of the track and understanding competitive requirements.

The study on action strategies for optimizing the performance capacity of female luge athletes highlights the importance of a scientifically grounded and integrated approach in the training and development of athletes. Research conducted by Grigore et al. (2024) and Lembert et al. (2011) emphasizes the need to assess and improve specific motor and technical parameters for luge athletes, providing a solid foundation for developing effective strategies. Additionally, studies on the influence of equipment and competition conditions, such as those made by Fuss (2023) and Williams (2020), suggest that strategies must integrate both technical aspects and external conditions. Moreover, the evaluation of nutrition and physical training, as presented in the works of Bagińska et al. (2022) and Khoo et al. (2020), highlights the importance of a well-balanced training regime tailored to the individual needs of athletes. Lastly, strategies must consider international perspectives and successful models, as presented by Baka (2006) and Rutty et al. (2015). Therefore, an effective strategy for optimizing luge performance must combine detailed performance assessment, adaptation of equipment and competition conditions, and ensuring holistic support in athlete preparation.

In the context of the study on optimizing the performance of athletes in luge events, the studies of Kara and Kunt (2020) and Zanoletti et al. (2006) provide valuable additional perspectives, as shown hereby:

Kara and Kunt (2020) analyze the competitiveness of tourist destinations from the perspective of luge athletes, exploring the link between the tourist experience and the perceived competitiveness of the destination. This research suggests that performance optimization strategies should not ignore the competitive context and local attractions that can influence athletes' perceptions and performance. For example, the facilities and services available at the competition destination can affect both the training of athletes and their overall experience.

Zanoletti et al. (2006) focus on the analysis of the push phase in skeleton performance, highlighting the importance of this stage during races. This contributes to understanding the specific technical aspects of the luge sport, providing concrete data on the correlation between performance in the push phase and the final race time. This aligns with the need to evaluate and improve specific technical parameters, as mentioned in previous studies, adding detailed attention to the start technique and the initial phase of the race.

By integrating these perspectives, the strategy for optimizing performance in luge events should consider both external influences related to the competition destination and the detailed technical aspects of performance, ensuring a holistic and well-founded approach to athlete preparation.

4. Conclusions

Strategies for optimizing performance in luge events in Romania must be based

on improving competition materials, adapting to the specifics of the track and understanding competitive requirements. Despite average performances and existing limitations, there is significant potential for development and an effective interaction between strategy and tactics is essential for achieving long-term objectives.

The opinions of the surveyed specialists are in full agreement with the conclusions drawn from studying the specialized literature, but especially with the practical reality regarding the specific activities of luge events, which require special conditions and materials without which achieving performance would not be possible.

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CHARACTERISTICS OF THE GENERAL MOTRICITY OF THE SPORTSWOMEN IN LUGE EVENTS

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Abstract

The purpose of this study is to examine the general motor characteristics of female luge athletes, with a focus on identifying the fundamental motor skills that influence their performance. It is suggested that luge athletes with a higher level of general motor skills, particularly in explosive strength and coordination, will achieve superior results in competitions. The study involved 10 female luge athletes from the "Muscel" Sports Club in Argeș County, all with a competitive experience of minimum 3 years. The research methods included bibliographic study, testing methods and statistical-mathematical analysis. Various fitness tests were conducted to evaluate general motricity indices, including the weight throw test, 30m sprint test, pull-ups test, barbell bench press test, barbell hang clean test and consecutive standing long jumps test. The analysis of the obtained data revealed the following conclusions: in the weight throw test, the maximum performance was 12.60 m, with an average of 9.66 m and a coefficient of variation of 19.47%, indicating moderate dispersion. In the 30m sprint test, the best performance was 4.42 seconds, with a coefficient of variation of 4.11%, indicating that the group is homogeneous. In the pull-ups test, the maximum performance was 8 repetitions in 10 seconds, and the coefficient of variation of 30.88% reveals sub-optimal athletic condition. In the barbell bench press test, the best performance was 75 kg, but the high variability (CV of 30.56%) indicates significant differences between athletes. In the consecutive standing long jumps test, results varied between 9.00 m and 11.60 m, with a coefficient of variation of 8.26%, highlighting above-average leg explosiveness for the studied group. Following the analysis of the obtained results, the hypothesis is confirmed that luge athletes with a superior level of general motor skills, particularly in terms of explosive strength and coordination, tend to achieve better performances in competitions.

Key words: *motricity, explosive strength, coordination, performance, luge*

1. Introduction

Luge is a high-speed winter sport in which athletes slide down an ice track while controlling a sled in a supine position. This sport involves complex motor skills such as fine motor control, balance and reaction speed. In luge competitions, success depends on a unique combination of motor characteristics, which include strength, flexibility, coordination and speed. Moreover, performance is influenced by psychological factors such as concentration ability and stress management.

General motor skills refer to the set of fundamental motor abilities necessary to

perform various physical activities. In performance sports like luge, they include strength, speed, endurance, flexibility and coordination. These components are essential for developing the specific skills required in each sport (Williams, Hodges & Scott, 2004). In this context, Williams and Lacy (2018) highlight the importance of measurement and evaluation in physical education, while Baumgartner and colleagues (2006) offer a valuable framework for evaluating sports performance, crucial for analyzing the general motor skills of luge athletes and their influence on performance and specific abilities.

To understand motor skills in luge events, a biomechanical analysis of the sport is essential. According to studies, the biomechanical components involve both the ability of athletes to optimize body position on the sled to reduce aerodynamic drag and the ability to maintain control in high-speed turns. The optimal aerodynamic position requires not only body flexibility but also high isometric strength to maintain posture throughout the race (Kurpiers, McAlpine & Kersting, 2020). Roberts (2013) emphasizes that the interaction between the athlete and the sled is essential for ensuring stability and speed, while Jeffreys (2024) highlights the importance of developing speed and power in sliding sports to improve acceleration and control during competitions.

Luge athletes require a complex combination of physical qualities to perform at a high level. Explosive strength is essential in the starting phase, where athletes must reach maximum speed in a very short time. This aspect is revealed by Platzer, Raschner and Patterson (2009) in their study, which underscores the determining role of physiological factors at the start. In addition, anaerobic endurance is crucial for maintaining speed throughout the race, as discussed by Denny (2011), who analyzes the physics of winter sports. Moreover, precise sled control requires exceptional neuromuscular coordination, similar to the demands observed in related sports like snowboarding, according to research conducted by Wang, Zhong and Wang (2023) or by Yao and Niu (2024), who show the physical and physiological profiles necessary for elite performance in winter sports.

Over time, discussions have addressed the differences in motor skills between men and women in performance sports. According to research by Davids & Baker (2007), women tend to have lower aerodynamic resistance due to anthropometric differences, which can be an advantage in certain sports like luge. Additionally, body structure and muscle mass distribution influence the center of gravity, affecting performance in tight turns. Dabnichki and Avital (2006) investigated the influence of team members' positions on the aerodynamic performance of the two-man bobsleigh, highlighting the impact of team arrangement on efficiency and speed during bobsleigh competitions.

Another essential aspect is specific training, which contributes to improving both general and specific motor skills. Studies have shown that luge athletes must focus on strength and speed training, as well as developing excellent coordination and refined tactile sense, necessary to effectively control the sled at high speeds (Solli et al., 2018).

2. Material and method

The purpose of this study is to analyze the general motor characteristics of female athletes participating in luge events, identifying the fundamental motor skills that contribute to their performance.

The hypothesis of this study is that luge athletes with a higher level of general motor skills, especially in terms of explosive strength and coordination, will have a better performance in competitions.

The study involved 10 elite luge athletes selected from the "Muscel" Sports Club in Argeș County. All participants had a minimum experience of 3 years in luge competitions. Informed consent was obtained from all participants, and the study was approved by the Ethics Committee of the Doctoral School of Sport Science and Physical Education at the University of Pitești, part of the National University of Science and Technology "Politehnica" Bucharest.

Research methods used: bibliographic study, testing method and statistical-mathematical method (Thomas et al., 2022).

The following tests were used for evaluating *general motricity indices:*

Weight Throw Test: in women's category, this test involves throwing a 4 kg ball as far as possible from a standing position, facing away from the sector, with feet positioned at the edge of the throwing circle. Each athlete is allowed two attempts, and the best result is recorded as the longest throw.

30 m Sprint Test: conducted on a running track, this test begins with a standing start. An electronic timing system measures the time taken in seconds and hundredths of a second from the moment when the starting photocell is activated until the athlete crosses the finish line.

Pull-Ups Test: this test requires athletes to lift their upper body by bending their arms until their chin or chest reaches the level of a fixed bar. The number of successful repetitions is counted within a duration of 10 seconds.

Barbell Bench Press Test: performed while lying on a horizontal bench, this test involves executing controlled and explosive movements to assess upper body strength. The final result is determined by the maximum weight successfully pressed after 4-6 progressively heavier attempts.

Barbell Hang Clean Test: in this test, athletes lift and position a barbell on their shoulders by extending their hips and knees. After 4-6 attempts with progressively heavier weights, the maximum weight lifted is recorded as the final result.

Consecutive Standing Long Jumps Test: athletes perform five consecutive jumps starting from a squat position and landing in a sand pit. The total jump distance is measured from the start line to the first mark in the pit. Each athlete is allowed two consecutive attempts to record their best result.

3. Results and Discussions

For the evaluation of luge athletes' performance, specific general motor skill indices were used, enabling a detailed analysis of the fundamental motor abilities

that influence competition results.

Table 1 *Results of the general motor skills analysis*

Tests	mean	±SD	CV(%)	max	min
Weight Throw Test (m)	9.66	1.88	20.52	11.53	7.78
30 m Sprint Test (sec)	4.68	0.20	4.33	4.87	4.49
Pull-Ups Test (reps)	4.90	1.59	32.21	6	3
Barbell Bench Press Test (kg)	51.75	16.09	334.06	67.56	35.94
Barbell Hang Clean Test (kg)	47.25	16.09	34.06	67.56	35.94
Consecutive Standing Long Jumps Test (m)	10.46	0.91	8.71	11.32	9.60

The results of the study on the general motor skills characteristics of sportswomen in luge events provide a detailed insight into the fundamental motor abilities required for performance in this sport. Various testing methods were used in the analysis, including throwing, sprinting, pull-ups, bench press and consecutive jumps. These tests allowed the evaluation of essential aspects of general motor skills, as suggested by the literature.

The results of the throwing test, with an average of 9.66 m and a coefficient of variation of 19.47%, point out a moderate dispersion of performances (Baumgartner et al., 2006). This may reflect individual differences in strength and throwing technique, considering that the luge sport requires not only strength but also a well-developed technique for maximizing the efficiency of initial movements.

In the 30 m sprint test, the maximum result of 4.42 seconds, along with a coefficient of variation of 4.11%, indicates greater homogeneity in the performances of athletes (Denny, 2011). These data suggest that the athletes have similar physical training in terms of reaction speed and acceleration ability, essential skills for a quick start in competitions.

The pull-ups test revealed a maximum performance of 8 repetitions, and the coefficient of variation of 30.88% highlights a suboptimal form (Platzer et al., 2009). This may show that strength training has not been varied or intense enough to develop the upper body strength required. Additionally, in the bench press test, the various performances (75 kg vs. 30 kg) point out the differences between athletes in terms of strength capacity and physical fitness, which is supported by previous research that emphasizes the influence of these variables on performance in winter sports (McArdle, 2010).

The performances in the consecutive long jumps test, with an average of 10.46 m and a coefficient of variation of 8.26%, suggest above-average leg explosive power, which is crucial in luge (Solli et al., 2018). This ability to generate explosive power is vital for luge athletes, given that a fast start is essential for optimal performance.

The studies conducted by Dabnichki, Motallebi and Avital (2004) and Dabnichki and Avital (2006) explore the advanced design of the bobsleigh, focusing on body protection, injury prevention and performance improvement, as well as the influence

of crew members' positions on aerodynamic performance. Meanwhile, Haugen, Breitschädel and Seiler (2019) examine the mechanical variables of sprinting among elite athletes, revealing sport- or individual-specific force-velocity profiles. Mosey (2016) analyzes the application of common methods in unconventional winter sports, such as skeleton. Laing and Sleivert (2002) investigated the influence of clothing and textiles on human performance, highlighting the role of materials in optimizing comfort and functionality for athletes. Cappaert and colleagues (2008) presented a position statement by the National Athletic Trainers' Association regarding the prevention of cold-related injuries among athletes. McArdle (2010) provides an in-depth analysis of exercise physiology, emphasizing the role of nutrition and energy in human performance—very important aspects for luge athletes, who must optimize their diet and training plan to achieve peak results in competitions.

4. Conclusions

Analyzing the results, the hypothesis that luge athletes with a higher level of general motor skills, particularly in terms of explosive strength and coordination, tend to perform better in competitions is confirmed. The need for personalized training programs, which take into account individual variability in preparation and skills, is obvious for optimizing results in luge events. These findings are consistent with the specialized literature, which emphasizes the importance of systematic evaluation and the adjustment of training strategies to meet the specific needs of athletes.

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THE INFLUENCE OF ACTION END ZONES ON SOCCER GAME PERFORMANCE

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Abstract

The main aim of the study was to investigate to what extent the percentage of completion of actions executed from 3 main areas of the field (outside the large box, inside the large box and inside the small box) can be reflected on the performance level of football teams. The study started from the premise that teams with a high value level of performance have a more elaborate game that allows them to initiate and complete actions in a higher percentage with shots on goal from inside the large box and small box compared to the underperforming teams who base their actions to a greater extent on finishing outside the big box. The study revealed that teams with a high level of performance base their attacking completions mainly on shots sent from inside the box and small box, compared to teams with a lower value level, which base their attacking actions more on shots sent from outside the box. The purpose of the research is to give specialists in the field the opportunity to develop actions and game models, based on the information and conclusions drawn, which can contribute to increasing the performance of football teams.

Keywords: completion of actions, terrain areas, performance.

1. Introduction

Scoring a goal is dependent not only on the distance to the goal and the area where the ball is hit, but also on other variables such as: the type of game phase (fixed, dynamic); the type of action preceding the shot (long pass, short pass, height of the pass, etc.); the relationship of adversity (2 vs1; 1vs1 etc); the angle of the player's positioning in relation to the goal; the type of hitting the ball (with the head, with the foot, left, right or with another part of the body); the applied procedure (volleyball, demi volley, etc.); the position of the goalkeeper and opposing defenders; the quality of the players and especially the goalkeeper's reaction time; the number of defenders interposed between the goal and the attacker; the technique expressed by the control, precision, accuracy of the performer's procedure; biomechanics of body segments; other aspects that can be represented by the quality of the turf, the location of the game (matches played at home, neutral or away), other initiated actions that precede the completion (taking over, the number of touches of the ball, dribbling), the ability to quickly analyze and decision, other psychological aspects, etc. (Frățilă. 2023).

Research conducted by Ruan et al. (2022), concluded that a supernumerary defense, aggressive and capable of rationally covering the area in front of the goalkeeper, could lead to fewer errors and dangerous situations while contributing to a decrease in the number of goals scored. Also, the time to take a shot on goal without being attacked by opposing players is extremely limited (up to 2 sec), with

very few actions exceeding this duration. In addition, some research has shown that there are significant correlations between football teams in terms of the mentioned aspects. These ways of completing the actions are dependent on the number, area and duration of time offered by the opponent to shoot (Loutfi et al. 2023).

The completion of actions in certain areas of the field are also dependent on the individual value of the players, but they can also be correlated with a good team organization at the collective tactical level, the style and strategy of the game applied, both of the own team and of the opponents. A series of research undertaken in this direction, concluded that shots on goal and goals are good predictors for performance (Lago and Penas, 2010); (Machado Barreira and Garganta, 2011); (Pratas et al. 2012); (Clement et al. 2015). Other studies have revealed the importance of the following technical-tactical indicators in increasing performances, such as: shots sent towards the goal from inside the large box (Wright et al. 2011); (Harrop and Nevill. 2014); shots sent from inside the small box (Yiannakos and Armatas. 2006); (Armatas and Yiannakos. 2010); the part of the body used when scoring a goal (Muhamad, Norasrudin and Rahmat. 2013).

Summarizing what has been mentioned so far, it is noted that the efficiency of completing an action is conditioned by a multitude of variables and aspects: - the angular variation (the greater the angle formed by the ball striking area and the goal post, the higher the probability of scoring a goal); - completion areas (centrally located areas are more efficient compared to lateral areas); - the distance from the goal (a smaller distance from the goal has a positive influence on the success rate of scoring a goal); - the segment of the body engaged in completing the action (at identical distances from the goal, hitting the ball with the foot is more effective compared to hitting the ball with the head); - interaction, balance between skills and training components.

2. Material and method

The object of the research consisted of the comparative analysis of the percentage of shots on goal from outside the big box, inside the big box and inside the small box. A total of four Premier League teams in the 2022-2023 season were studied. Data was collected from a total of 152 games, with each team playing 38 games. In order to highlight more details, the statistical interpretation was carried out cumulatively, at the level of all the games played in the competitive season, as well as separately for the games played away and at home. The teams under analysis were represented by the champion and vice-champion of England (Manchester City and Arsenal London) and the last two runners-up (Leeds United and Southampton FC). The methods used were: the bibliographic method, the case study method, the comparative method and the statistical-mathematical method. For the inferential statistics part, we used the one-way ANOVA test, which aimed to determine the existence of possible significant differences between the groups, we set the threshold α ($p < 0.05$), and in order to accurately identify the team/teams that can present these

differences, we resorted to a post hoc multiple comparison procedure using Tukey's test (HSD).

3. Results and Discussions

The application of the one-way Anova test revealed the following results: regarding the percentage of completed actions outside the large square (F=3.48); completed actions inside the large square (F=1.37); for the completed actions inside the small box (F=1.15), of the four teams under investigation throughout the 38-game contest. Applying the post hoc test for actions completed outside the 16m box, the following results were obtained: T1 (Manchester City)-T2 (Arsenal London) Q=0.54; T1 (Manchester City)-T3 (Leeds United) Q=0.45; T1 (Manchester City)-T4 (Southampton FC) Q=3.61; T2 (Arsenal London)-T3 (Leeds United) Q=0.99; T2 (Arsenal London)-T4 (Southampton FC) Q=4.15 (statistically significant); Q3 (Leeds United) - Q4 (Southampton FC) Q=3.16. Analyzing the averages of the four teams regarding the completion of actions outside the box, it can be seen that the lowest averages of shots sent from this area of the field were had by the teams ranked on the podium, respectively Manchester City and Arsenal London, while the teams ranked on the last two places at the end of the championship (Leeds United and Southampton FC), have higher averages, aspects that are revealed with the help of figure no. 1.

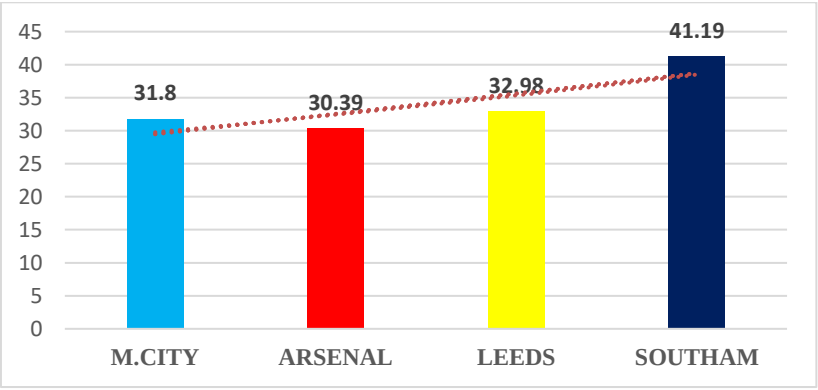

Figure 1. Average shots on goal from outside the 16m box

The post-hoc test applied to the recorded data regarding the ball shooting area inside the 16 m box revealed the following results: T1 Manchester City-T2 Arsenal London (Q=0.03); T1 Manchester City-T3 Leeds United (Q=0.55); T1 Manchester City-T4 Southampton FC (Q=2.48); T2 Arsenal London-T3 Leeds United (Q=0.52); T2 Arsenal London-T4 Southampton FC (Q=2.45); T3 Leeds United- T4 Southampton FC (Q=1.93). From the analysis of the averages regarding the ball hitting area inside the 16 m box (figure 2), it can be seen that the teams ranked in the first two places have higher averages compared to the other two teams ranked in the last two places.

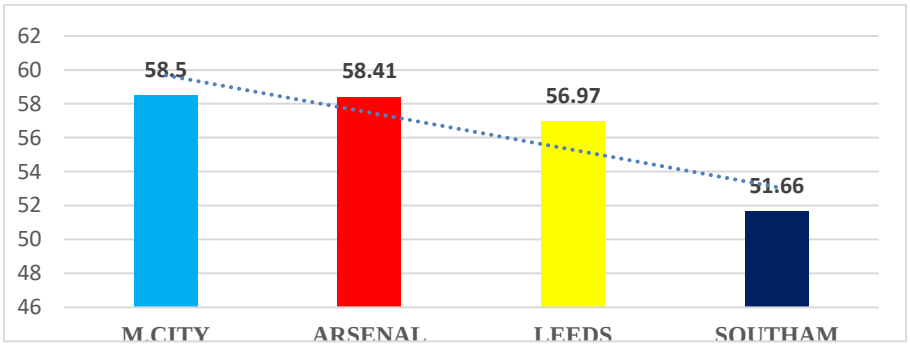

Figure 2. Average shots on goal from inside the 16m box

Looking at the shooting area of the ball inside the 6m box, the following results were highlighted: T1 Manchester City-T2 Arsenal London (Q=0.80); T1 Manchester City-T3 Leeds United (Q=0.19); T1 Manchester City-T4 Southampton FC (Q=1.71); T2 Arsenal London-T3 Leeds United (Q=0.61); T2 Arsenal London-T4 Southampton FC (Q=2.50); T3 Leeds United-T4 Southampton FC (Q=1.89). From the analysis of the averages regarding the ball hitting area inside the 6 m box (figure 3), it can be seen that the teams ranked in the first two places and the penultimate team have higher averages compared to the last ranked team.

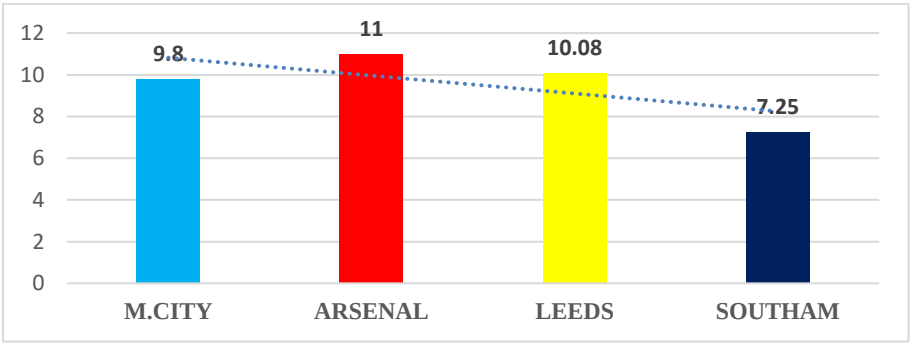

Figure 3. Average shots on goal from inside the 6m box

In order to obtain detailed data on the aspects related to the 3 main areas for completing the actions, we analyzed, apart from the general percentages, the percentages obtained both in the matches played at home and in the matches played away, obtaining the following results: Statistics regarding away games, the area outside the big square: one-way Anova test (F=1.24); T1-T2 (Q=0.70); T1-T3 (Q=1.05); T1-T4 (Q=1.46); T2-T3 (Q=0.36); T2-T4 (Q=2.16); T3-T4 (Q=2.52). From the analysis of the means, it can be seen from the figure. 4, that in away games

the team ranked last has a high average of actions completed outside the big box compared to the other teams.

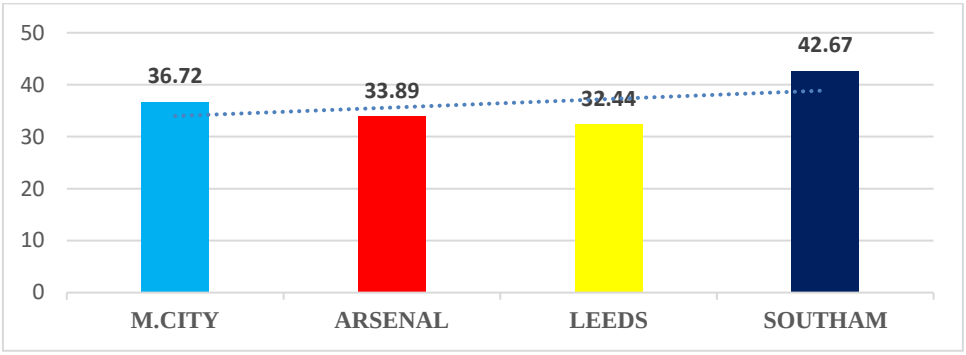

Figure 4. Average shots on goal from outside the 16m box (travel)

Statistics regarding away games with the completion of actions in the area inside the big square: one-way Anova test (F=0.72); T1-T2 (Q=0.36); T1-T3 (Q=0.54); T1-T4 (Q=1.35); T2-T3 (Q=0.18); T2-T4 (Q=1.70); T3-T4 (Q=1.89). From the analysis of figure no. 5, there is a clear difference regarding the average between the last ranked team and the averages of the other three teams.

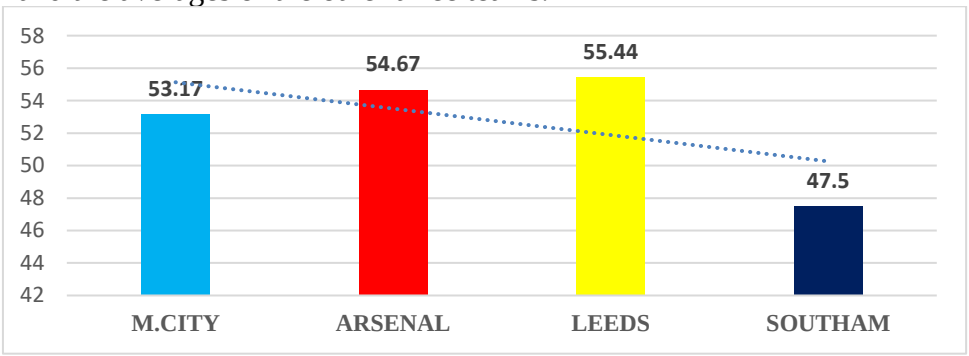

Figure 6. Average shots on goal from inside the 6m box (displacement)

Statistics regarding the matches played on home ground, the area outside the big square: one-way Anova test (F=4.15); T1-T2 (Q=0.40); T1-T3 (Q=2.47); T1-T4 (Q=4.41); T2-T3 (Q=2.07); T2-T4 (Q=4.01); T3-T4 (Q=1.95). From the figure. 7, it can be clearly seen that the teams on the podium have a much lower percentage of completing actions outside the big square, compared to the last two ranked.

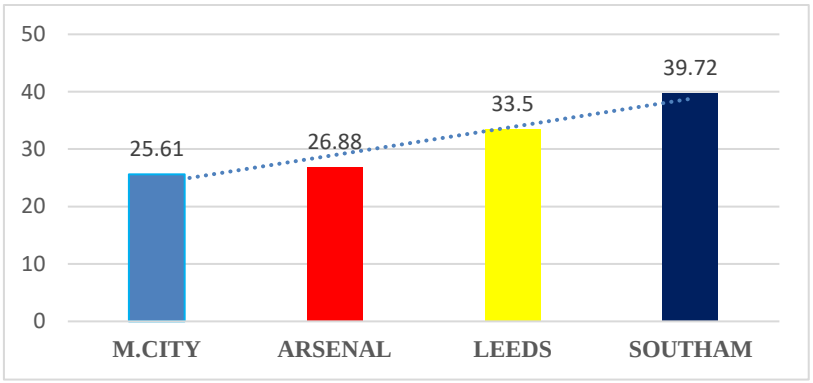

Figure 7. Average shots on goal from outside the 16m box (home)

Statistics regarding the games played on home ground, the area inside the large square: one-way Anova test (F=1.48); T1-T2 (Q=0.93); T1-T3 (Q=2.00); T1-T4 (Q=2.78); T2-T3 (Q=1.07); T2-T4 (Q=1.85); T3-T4 (Q=0.78).
The averages of shots on goal sent from inside the big box exposed with the help of figure no. 8, highlight the fact that in the matches played at home, the teams ranked in the first two places have a higher percentage of actions completed in this area compared to the last ranked.

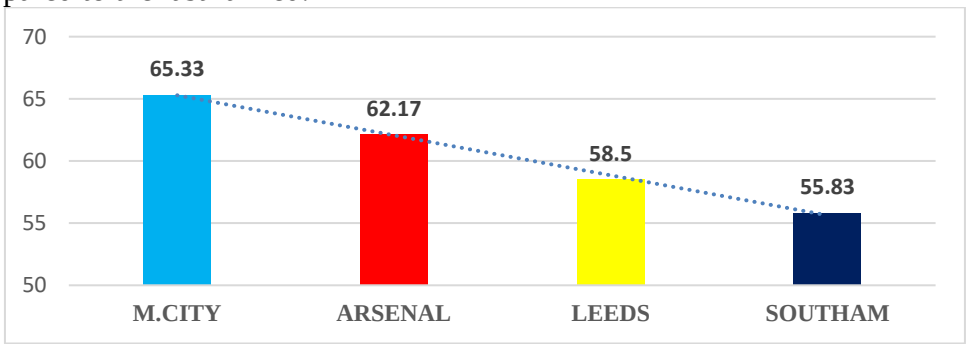

Figure 8. Average shots on goal from inside the 16m box (home)

Regarding the results of the statistical data obtained in the matches played on the own ground, in relation to the completed actions inside the small box, they are: one-way Anova test (F=2.04); T1-T2 (Q=0.87); T1-T3 (Q=0.60); T1-T4 (Q=2.50); T2-T3 (Q=1.48); T2-T4 (Q=3.37); T3-T4 (Q=1.90). It can be seen by analyzing figure no. 9, the fact that the teams on the podium have much higher averages of the percentage of actions completed inside the small box compared to the last ranked.

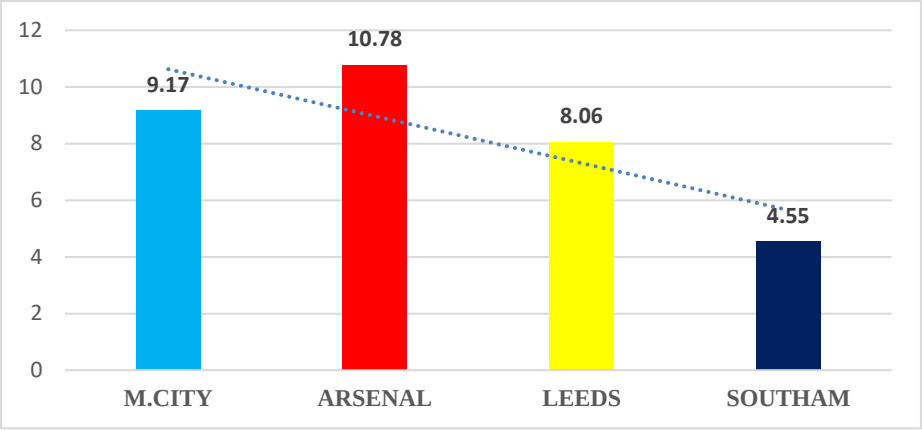

Figure 9. Average shots on goal from inside the 6m box (home)

4. Conclusions:

Following the research carried out, we can draw the following conclusions: There is a statistically significant difference between the podium teams and the bottom ranked teams in terms of the 3 research variables. From the analysis of the data it can be concluded that teams with a high value level tend to complete more actions inside the large and small box compared to teams with a lower value level that tend to use a higher percentage great completion of actions by shots from outside the large box; Based on the analysis of the statistical data, it was highlighted that there are no significant differences in terms of away games and home games, in the sense that teams with a lower value level, located in the lower part of the ranking, tend to complete more actions outside the 16m box compared to the teams on the podium.

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THE IMPACT OF COMMUNICATION BETWEEN COACH AND ATHLETE ON THE TECHNICAL-TACTICAL ACTIONS OF 12-13-YEAR-OLD FOOTBALL PLAYERS

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Abstract
Communication between the coach and the football player, at the team level, in general and, in particular, in the case of junior footballers, is intensively studied in the specialized literature, precisely from the perspective of the serious impact that this phenomenon has on the athlete´s football career, but also on team cohesion. The study aims to investigate some football coaches, from junior clubs in Argeș county, both from rural and urban areas, regarding their perspective on the importance of communication between coach and athlete, in order to optimize technical and tactical actions. *Methods*: 20 football coaches from children´s and junior clubs in Argeș county, both from urban and rural areas, with different seniority, were investigated. As a research method, I used a self-administered, written questionnaire based on 10 precoded questions. *Results*: For all 10 questions asked, participants present various assessments, from the point of view of the content, starting from the qualifier „Insufficient", to the one of „Very good", referring to different aspects of communication and the way in which some technical-tactical actions, in the targeted junior footballers, could have been impacted by the level of coach-athlete communication. *Conclusions*: Most of those questioned considered communication between the coach and the footballer to be desirable, throughout the training process, this having a real impact on the technical-tactical actions of the 12-13-year-old junior footballers.
Key words: communication, football, junior, technical-tactical actions

1. Introduction

According to the Explanatory Dictionary of the Romanian Language, DEX, the term „communication" is defined as „oral or written information/notice, news, report/contact, relationship, connection/presentation in a specialized circle of a personal contribution, in a scientific problem, work that is the subject of such a presentation„ (DEX, 2007).

From an etymological point of view, the word „communication", according to Gh. Guțu, 1993, is a derivative of the word „common" (communico, -are, -avi, -atum, which belongs to several or all) < lat. communis, originating from the Latin verb communicare (18th century), and being, in Romanian, a doublet (as a later loan), signifies the action of doing something common, of sharing with someone, of sharing, in general.

From the perspective of historical dating, Simona Iovănuț, in a communication course intended for social workers in rural areas, states that the first information in this vast field would have been delivered in the 5th century BCE, when Corax from Syracuse introduces the first elements in the book "The Art of Rhetoric", a work of

that time (Iovănuț, 2001). According to the same source, the first real model of a communication system is elaborated, around 100 BC, by Cicero, Roman philosopher, theorist and orator.

According to Wilson E., communication is "an action of an organism or a cell, which modifies the probable behaviour patterns of another organism or another cell, in an adaptive manner for one or both participants ".

In an article about the need for the presence of appropriate communication in the sports environment, Emilia Grosu said, regarding this aspect, the following:

"It is known that the effect of good communication in a team leads to its consolidation, and this effect is based on the individualization of communication on each person by using specific techniques, thus obtaining maximum results with the minimum possible effort". (Grosu, E., F., 2009).

In an article written in 1999, *La tyrannie de la communication*, Ignacio Ramonet, French journalist and writer, founder of Attac magazine, speaking about the valences that communication has acquired, states that it „should be considered as a simple service and, therefore, governed by the laws of commerce". (Ramonet, 1999).

Communicating, at the level of football teams and in all the environments that surround such a team, becomes fundamental, and the types of communication are extremely diverse and in a continuous dynamic. Currently, football has become a favourite subject of studies in communication, mass-media and is considered a world phenomenon, as the „supreme stage of globalization" (Boniface, P., 2002,).

Also related to the extremely serious impact that communication, generically speaking, has when we talk about football, F. Antonelli and A. Salvini (1978), cited in the work of R. Manno (1996), point out the role of the coach in increasing the efficiency of a sports teams. According to them, efficiency depends on the following factors:

- factors that ensure the achievement of performance objectives, competitiveness, sports discipline, rigidity of roles, utilitarian relationships, formal communication, vertical decisions, hierarchy and;
- factors that maintain cohesion – collaboration, collaboration, participation and spontaneous communication, affective relationships, group decisions, the collective and democracy (Manno, R., 1996).

2. Materials and methods

We applied, during the competitive period, using a questionnaire-based survey as a method, such a tool, collecting and subsequently analysing the responses generated. The questionnaire included a number of 10 questions, with answers in the range 1-5, where 1 means "insufficient", and 5 - „very good", wanting to find out an insight into the importance that coaches give to communication at the level of the team, both between athletes, but also between the coach and the junior footballers.

3. Results

This questionnaire was applied to a number of 20 coaches, from children´s and junior

clubs, both from rural and urban areas, from Argeș county.

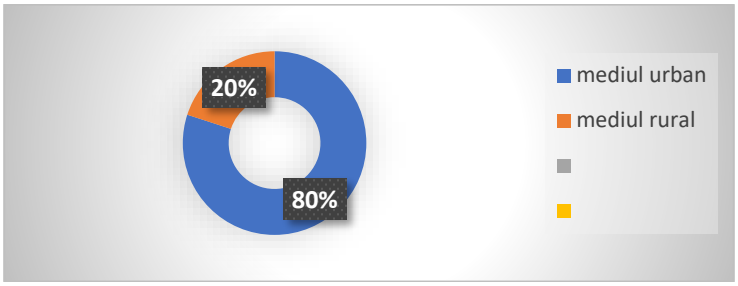

Fig. 1. *Where do you train as a football club?*

According to the answers to question number 1, it can be seen that 80% of those questioned carry out their activity, together with the athletes, in some clubs in the urban environment, while only 20 percent are in the rural environment.

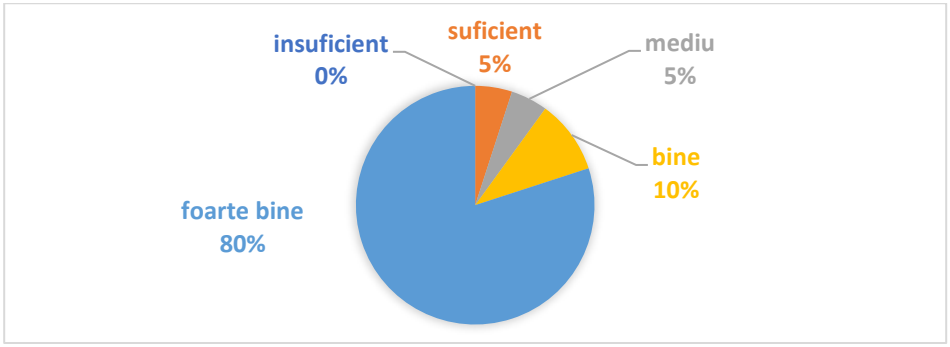

Fig. 2. *How important is communication between coach and athlete?*

For the question regarding the importance of communication between the coach and the athlete, no coach considered that the act of communication is unimportant, one of them generated the answer 2 (sufficient), one also considered the answer 3 (medium), 2 coaches gave the answer 4 (good), while the rest of 16, the majority, generated the answer 5 (very good), resulting in the idea that most of the coaches perceive communication between then and the athletes as a very important.

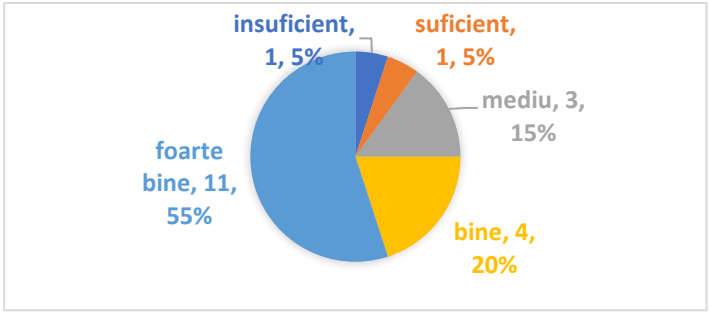

Fig. 3. *To what extent the communication between the coach and the athlete influences the technical actions of the athletes?*

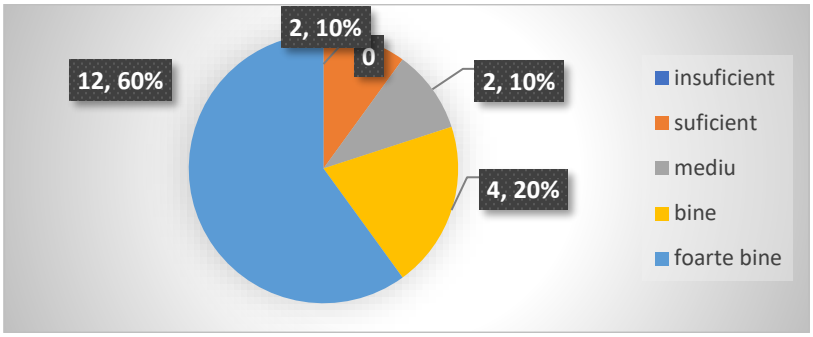

Fig. 4. *Communication between athletes during the game*

Following the answers generated by this question, 10% of those surveyed agreed that it is not very important for athletes to communicate with each other during the game, while 60% considered this aspect of communication between soccer players to be very important.

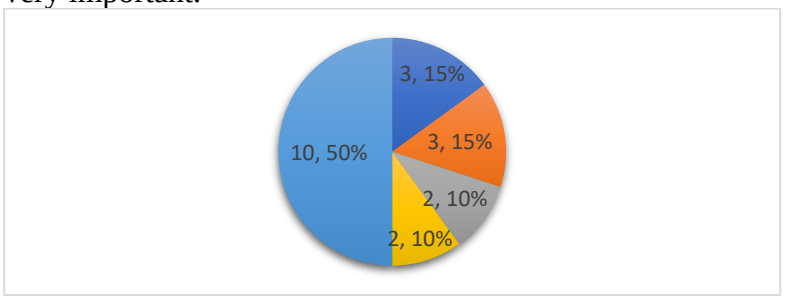

Fig. 5. *The relevance of verbal communication between field players and the goalkeeper*

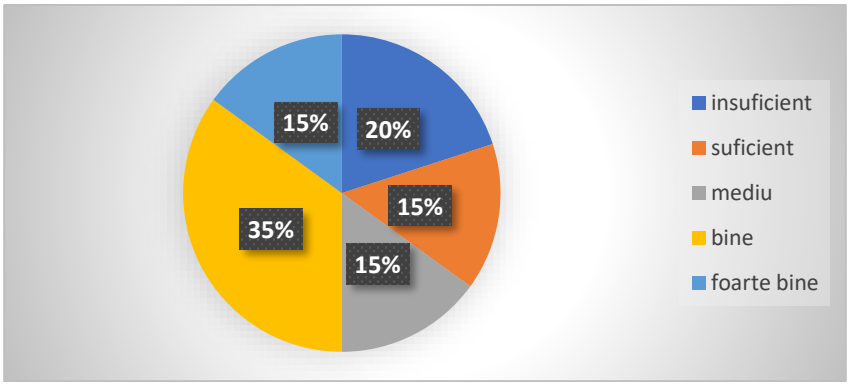

Fig. 6. *How much emphasis do you put on adapting coach communication and footballer, depending on the position the latter occupies on the field?*

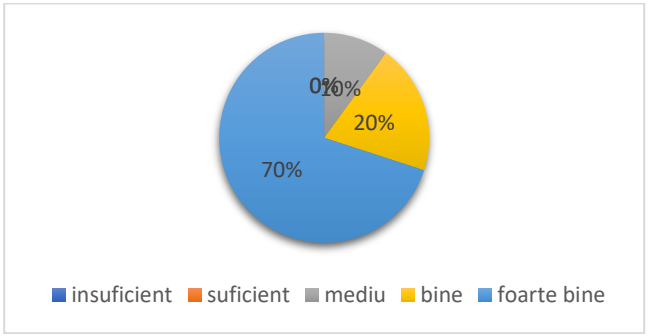

Fig.7. The *Importance of communication between the coach and the footballer, outside the sports environment*

For question number 7, following the collection and interpretation of the answers, most of the respondents rated the aspect related to communication as very important, even outside the sports environment, in order to improve coach-footballer relations.

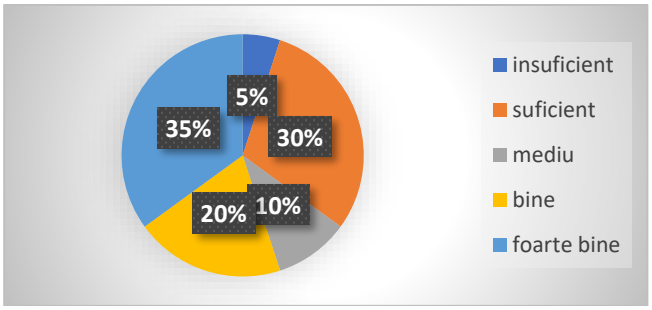

Fig. 8. *How high do you consider the level of communication between the coach and the family?*

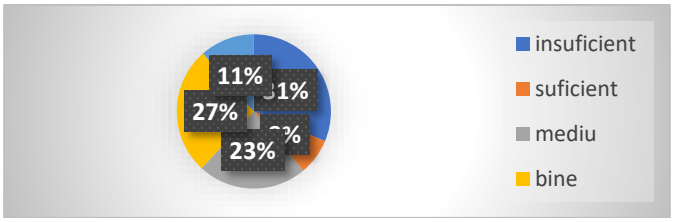

Fig. 9. *To what extent do young footballers integrate the coac´s advice?*

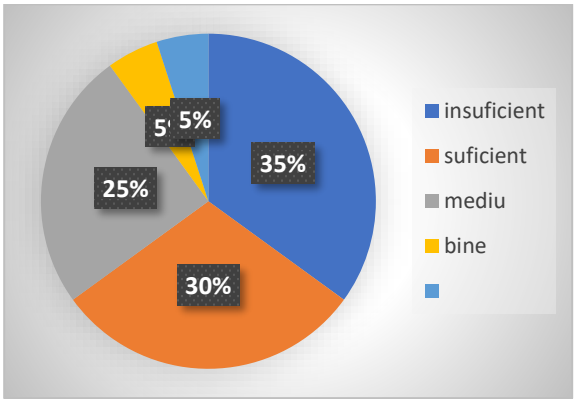

Fig. 10. *How often you attend, in what capacity as a coach, at courses/trainings/events of communication in the sports?*

The last question, no. 10, regarding the coaches 'concern for events intended for communication in the sports environment, 35% of them answered that they participate very often, 30 percent participate often enough, while only 5% answered that not often enough take part in such events.

4. Conclusions

In any kind of activity, in order to normalize and make it more efficient, a special role will be occupied by communication, the phrase „lack of communication„ becoming extremely present in discussions about failure, either within an organization, of some activity or even in case of relationships of any kind. Therefore, sports activity, at every level, requires the existence of communication, as a sine qua non condition.

Following the survey based on the questionnaire, through the questions launched and, especially following the answers generated by those surveyed, percentages are observed that show that the coaches are aware of the need for communication at the team level, in football, in the current situation, both between these and the athletes they train, but also between footballers, during training or even the game.

Also, more than a third of those surveyed believe that participating in events that could support communication in the sports environment is one of the concerns. So,

taking into account both what is provided in the specialized literature, but also aspects generated by surveys such as the one above, it can be deduced that aspects of communication find their effectiveness both from the point of view of the objectives related to the sports performance of football players, but also of the way group cohesion is achieved, of the team.

All the actors involved in this type of activity, namely the one centred on the football team, have common interests and goals, share the same meanings, make strategies and the right option to find the path to success, no matter how this success is translated, it would be that of communication, seen by A. Mucchielli, in „the art of communicating", as „an opening at all levels, breaking through obstacles, denying walls, overcoming opacities, abolishing distance, an attitude of understanding, based on certain values humanistic, wich indicates trust in the other. Through an inductive feed-back effect, this trust in turn generates trust" (Mucchielli, 2003).

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PSYCHOPHYSIOLOGICAL STATES AND PHYSICAL LOAD IN ELITE ATHLETES

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Abstract

The features of the psychophysiological state of elite athletes under physical laboratory load and real training conditions were studied. The laboratory diagnosed the level of emotional anxiety and volitional activation during intense muscular load of athletes. 33 elite athletes involved in practical wrestling (age 19-28) were examined. Heart rate variability and galvanic skin response were assessed. At the training camp itself, 26 elite wrestlers (age 20-27) were examined. The psychophysiological state was studied according to three main components: sensory-motor response, emotional activity and heart rate variability. The results were revealed that volitional activation is associated with different levels of psychophysiological state of athletes under conditions of high physical activity. The results show that three components of psychophysiological state change during training. The sensory-motor component tended to increase the dynamics of the training process. Emotional activity was beginning to increase from the middle of the training camp. Heart rate variability increases more slowly than other components of the psychophysiological state.

Key words: *psychophysiological states, physical load, athletes*

1. Introduction

Physical strain associated with competitive and training activities is supported by the activation of psychophysiological mechanisms of elite athletes (Tanguy et al., 2018). Physiological mechanisms associated with sports activities and supporting mental and regulatory processes of the body (Sametovich et al., 2023). During physical and psycho-emotional stress, the predominant focus of excitation of the brain is of great importance (Hatfield et al., 2020).

The dominant is the main mechanism for building a functional system that ensures sports activities (Yongtawee et al., 2022). But the dominant focus also has some negative sides. The main thing is the inertia of the dominant excitation center, which inhibits the adaptive capabilities of the athlete in pre-launch conditions (Korobeynikov et al., 2023).

One of the effective ways to optimize pre-launch reactions is to regulate the emotional state of athletes (Bird et al., 20221). As know, emotion is truly a mental reaction to environmental stimuli. In sports activities, emotional regulation may correlate with an athlete's desire to achieve high results in competitive conditions. The manifestation of emotions caused by mobilization adds reserves due to regulatory mechanisms (Sardorxon et al., 2023).

The purpose was to study the psychophysiological state and physical activity of elite athletes.

2. Material and method

The research was conducted in laboratory conditions and in really training camp among elite wrestlers.

In laboratory condition was diagnostic level of emotional anxiety and volitional activation in athletes with physical load performance. 33 elite athletes involved in practical wrestling (age 19-28) were examined. The heart rate variability and galvanic skin response were assessed. At the training camp itself, 26 elite wrestlers (age 20-27) were examined. The psychophysiological state was studied according to three main components: sensory-motor response, emotional activity and heart rate variability. For asses of sensory-motor apparatus-program psycho-diagnostic complex «Multipsychometr -05» were used. Emotional stability and anxiety was determined by Spielberger questionnaire. Heart rate variability was studied by cardiac monitor «Polar RS800CX». The parameters of heart rate variability calculated via support of statistical program «Kubios HRV».

Based on the results of the studies, an integral indicator of the psychophysiological state was determined on a five-point scale (the average score for both indicators) for each of the components.

The study was conducted in accordance with the recommendations of biomedical research ethics committees. From all participants was obtained informed consent.

3. Results and Discussions

The dynamics of HR, SDNN and galvanic skin response in elite wrestlers with stepwise increasing physical load presented in Figure 1. According to this result, level of physical load 120 Watt corresponds with reduction of SDNN and galvanic skin.

As know, galvanic skin is efficacy indicator of adaptation influence from sympathetic nervous system. This process related with anxiety and emotional strain. SDNN is characteristic of level of tension autonomy nervous system for reason of sympathetic tone.

Thus, the reduction of galvanic response and SDNN associated with volitional activation of athletes.

According to conception of general adaptation syndrome, stress reaction developed on certain dynamics: anxiety reactions, phases of resistance and fatigue. The phase of resistance forms adaptive changes in human body.

But the third phase, associated with fatigue and disadaptation, is usually absent in elite athletes.

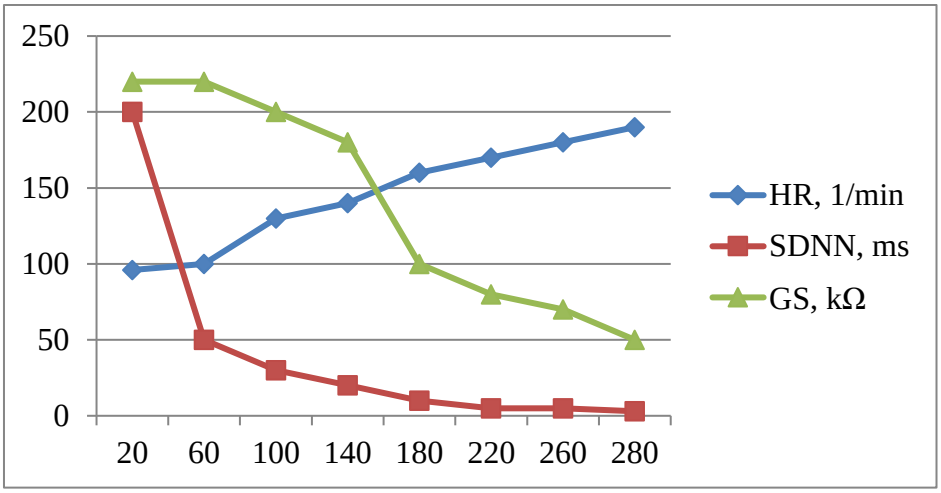

Figure 1. *Dynamics of HR, SDNN and galvanic skin response in elite wrestlers with stepwise increasing physical load*

Figure 2 shows the dynamics of various components of the psychophysiological state of elite wrestlers in the training camp.

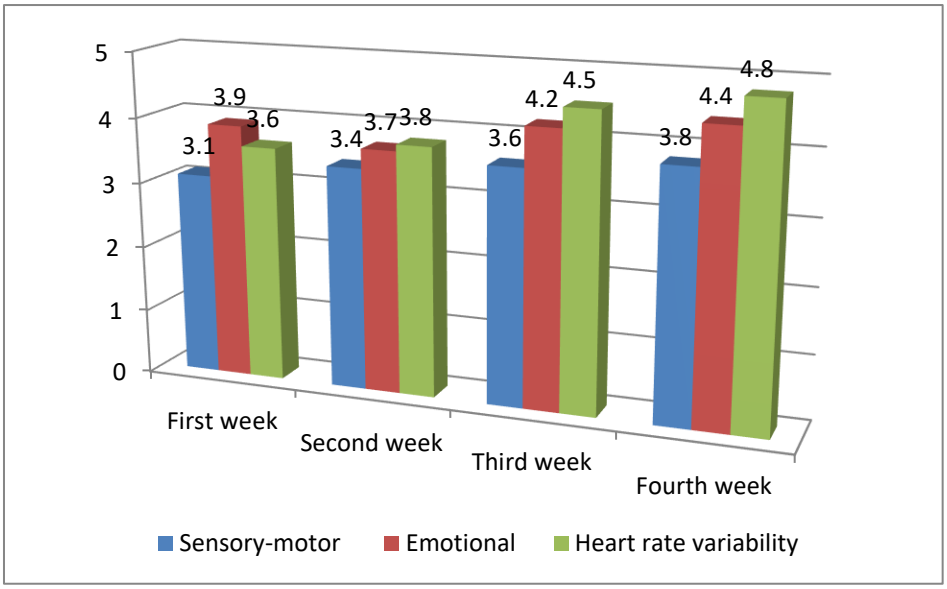

Figure 2. *Dynamics of various components of the psychophysiological state of elite wrestlers in the training camp*

On the first week observed the presents of low level of sensory-motor, higher level of emotional and heart rate variability components of psychophysiological state in elite wrestlers.

On the second week the sensory-motor component of psychophysiological state increased. Moreover, emotional and heart rate variability components of

psychophysiological state have not changed.

The third week of training camp characterized on improvement of sensory-motor, emotional and heart rate variability component of psychophysiological state for concerning to the first week.

The fourth week of training camp show of slowly grows emotional and heart rate variability components of psychophysiological state in elite wrestlers.

Thus, dynamic of training camp in elite wrestlers observed about tendency to grow of level of psychophysiological state by three components: sensory-motor response, emotional activity and heart rate variability.

4. Conclusions

The data obtained indicate the development of adaptive dynamics during physical activity in elite athletes: anxiety reactions, phases of resistance and fatigue. The resistance phase forms adaptive changes in the human body. At the same time, elite athletes usually do not have a disadaptation phase.

The results were revealed that volitional activation is associated with different levels of psychophysiological state of athletes under conditions of high physical activity. The results show that three components of psychophysiological state change during training. The sensory-motor component tended to increase the dynamics of the training process. Emotional activity was beginning to increase from the middle of the training camp. Heart rate variability increases more slowly than other components of the psychophysiological state. In fact, our studies have shown the mechanisms of short-term and long-term adaptation to physical activity in elite athletes.

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FEATURES OF PHYSICAL PERFORMANCE OF FOOTBALL PLAYERS WITH DIFFERENT PROPERTIES OF THE NERVOUS SYSTEM

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Abstract
Peculiarities of the physical performance of 37 elite football players during a test with a gradual increase in running speed, the levels of maximum oxygen consumption ($VO_{2\ max}$) and anaerobic threshold (AnTh) were studied. We determined such parameters as test duration (T, min), work power (W, $W \cdot kg^{-1}$) and average running speed (V, $km \cdot h^{-1}$) depending on the typological properties of the nervous system (NS). The typological property of the functional mobility of nervous processes (FMNP) was determined using the "Diagnost-1M" computer system; the indicators of the cardiorespiratory system (CRS) were determined using the Oxycon Mobile gas analyzer of the Jaeger company. The dependence of physical capacity on FMNP when performing shuttle running at the VO^2 max level was established. A high level of FMNP was correlated with statistically significantly higher indicators of physical performance than in persons with a low typological property under investigation (p=0.033-0.045). During the test with a gradual increase in running speed at the level of AnTh, no correlation was found between the indicators of physical performance of football players and the typological properties of NS. Regardless of the level of FMNP, the values of physical performance at the level of AnTh were the same. It has been proven that athletes with a high level of FMNP achieved a high level of physical performance in a test with a gradual increase in running speed due to the use of aerobic reactive capabilities of the CRS.

Key words*:* physical performance, shuttle test, cardiorespiratory system, typological properties of the nervous system.

Introduction

Nowadays in the world of sports there are big competitions such as Gymnasiade, Youth Olympic Games, etc. in which athletes between 15 and 18 years of age participate. It is known that it takes an average of 6.5-7.5 years of hard training to achieve high results and successful participation in competitions at this level, so most coaches want to make an earlier selection of children in sports sections. Existing age standards for sports activities are based on the passport age, but due to the phenomenon of acceleration, there are cases of discrepancy between the passport age and the biological age, when a child is 1-2 years ahead or behind his or her peers [16]. For example, children from the age of 7 are admitted to the initial training groups of children's and youth sports schools in gymnastics, artistic gymnastics, swimming, figure skating, tennis and table tennis. In such cases, during the initial medical examination, the sports physician encounters features of the ECG of young

athletes in the form of a juvenile ECG pattern, better known as the "T-infantile" phenomenon.

"T-infantile" phenomenon is a reflection of epicardial repolarisation of the right ventricle [13]. The "T-infantile" is characterized by the following features: 1) the negative T-wave or the negative phase of the biphasic T wave progressively decreases from lead V1 to lead V4; 2) the peaks of the negative T waves or the peaks of the negative phases of the biphasic T-waves in the right thoracic leads coincide with or slightly precede the peaks of the positive T-waves in the left thoracic leads; 4) the ST segment in the right thoracic leads is on the isoelectric line and does not have an upward convex arc shape.

Sandrucci & Bono [13] found "T-infantile" in 30% of healthy children and adolescents aged up to 14 years, and Shiyan [14] found this phenomenon in 21.7% of children aged 7-9 years and in only 1.5% of children aged 13-15 years. Attisani et al [3] found "T-infantile" in 132 (7.1%) of 1858 adolescents aged 6-18 years, and Basu et al [4] found it in 430 (6.0%) of 7162 adolescents aged 13-16 years.

Migliore et al [10], in a study of 2765 children (1914 males and 851 females) aged between 8 and 18 years (mean age 13.9±2.2 years), found T-wave inversion localized in the right precordial leads in 131 of the subjects studied, i.e. 4.7%. According to their results, the prevalence of "T-infantile" decreased significantly with increasing age (8.4% of children younger than 14 years compared to 1.7% of those older than 14 years, $p<0.001$). Of 158 children with T-wave inversion, 4 individuals (2.5%) were diagnosed with cardiomyopathy, including arrhythmogenic right ventricular cardiomyopathy in 3 children and hypertrophic cardiomyopathy in 1 child. The authors believe that T-wave inversion is a common ECG abnormality in inherited cardiomyopathies such as hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy, which are the leading causes of sudden cardiac death in young athletes. These cardiomyopathies are genetically determined and show age-related phenotypic expression. As early manifestations of the disease usually occur after puberty, the persistence of T-wave inversion in post-pubertal age raises the problem of differential diagnosis between developing myocardial disease and benign juvenile repolarisation type. In this age group, T-wave inversion, localized predominantly in the right precordial leads, was documented in 5.7% of cases, decreased significantly with increasing age and pubertal maturation and, most importantly, reflected the primary cardiomyopathy, such as arrhythmogenic right ventricular cardiomyopathy and hypertrophic cardiomyopathy in 2.5% of cases. These results suggest that T-wave inversion is much less common after full pubertal development than previously thought, and its persistence may indicate myocardial disease at risk of sudden cardiac death. Consequently, the demonstration of post-pubertal persistence of T-wave inversion in athletic children justifies an echocardiographic study that may lead to the presymptomatic detection of early cardiomyopathy.

The incidence of T-wave inversion in the anterior leads V1-V3 varies widely not only in non-athletic children and adolescents, but also in athletes. For example,

according to Abramova [2], in young athletes "T-infantile" is observed in 25% of girls aged 11-12 years, and in boys in two age groups: 11–12 years — in 16.6% and 13–14 years — in 12.5%. Calò et al [7], in a study of 2,261 football players aged 8-18 years, found this phenomenon in 136 (6.0%) players. Abela et al [1] found this phenomenon in 5.0% of Maltese adolescents examined, with an average age of 15 years. McClean et al [9] found "T-infantile" in 418 Arab and 314 African athletes aged 11-18 years, representing 15.8% of the total number of athletes studied.

Analysis of ECGs with similar phenomena performed on young athletes shows that they can develop cardiomyopathy. In these cases, according to Butchenko [6], the ECG shows the following changes 1) there is no progressive decrease in the negative T-wave or the negative phase of the biphasic T-wave from lead V1 to lead V4, but there is an increase in the negative T-wave or the negative phase of the biphasic T-wave up to lead V3; 2) there is a negative or flat positive T waveform in one of the leads, usually in V3, V4; 3) there is a terminal negative T-waveform; 4) the ST segment is shifted above the isoelectric line and becomes an upwardly curved arc. These signs of cardiomyopathy in young athletes may occur in different combinations.

Skuratova [15] reports that "T-infantile" is characterized by: 1) coincidence (or slight advance) of the peaks of the negative T-wave in the right thoracic leads and the positive T-wave in the left thoracic leads; 2) decrease in the depth of the negative phase of the T-wave from V1 to V4; 3) coincidence of the central depression of the T-wave (at the bicuspid) in the right thoracic leads with the peak of TV5 and TV6; no arc-shaped ST-segment elevation in the thoracic ECG leads. The described ECG changes in young athletes are a normal variant and have nothing in common with the ECG manifestations of cardiomyopathy due to chronic physical overexertion [2, 6].

Papadakis et al [12] studied 1710 adolescent athletes and 400 non-athletic children. There were no significant differences in the overall prevalence of T-wave inversion between athletes and controls. T-wave inversion in leads V1-V3 was mostly limited to the age of the subjects (older than 16 years) in both groups. Only 0.1% of athletes aged 16 years and older showed T-wave inversion outside V2. T-wave inversions in the inferior and/or lateral leads and deep T-wave inversions were rare in athletes (1.5 and 0.8%, respectively) and were associated with a high prevalence of left ventricular hypertrophy or congenital heart disease. Despite intensive further investigation, no athlete was diagnosed with cardiomyopathy.

The aim of the study was to quantify the incidence of the juvenile ECG pattern in athletic individuals aged between 6 and 17 years, and to elucidate the role of autonomic regulation in this electrocardiographic phenomenon.

Materials and Methods. Electrocardiographic recording of heart rate variability were performed in 3720 children and adolescents aged 6–17 years, including 74.6% (n=2774) boys and 25.4% (n=946) girls, involved in various sports. Of the total number of athletes, the "T-infantile" phenomenon was detected in 56 people, or 1.5%, including 40 (1.44%) boys and 16 (1.69%) girls.

The state of the neurohumoral regulatory mechanisms of the heart, the activity of segmental and suprasegmental divisions of the autonomic nervous system (ANS) were assessed using mathematical and spectral methods of heart rate variability (HRV) analysis [11]. Short (5-minute) recordings were used for HRV analysis [8]. ANS parameters were analyzed using an integral index of HRV, the stress index (SI). According to Bayevskiy [5], the vagotonic state is observed when the SI is less than 50 conventional units (c.u.), the eutonic state — in the range of 51–199 c.u., and the sympathicotonic state — when the SI is more than 200 c.u.

Statistical analysis of the data was performed using Statistica 6.0 (StatSoft Inc.) using parametric methods. Values are expressed as mean (M) ± standard error of the mean (SE). Differences in values were considered statistically significant at a significance level $p<0.05$.

Results and discussion. There were ten (25%) boys at age 9, eight (20%) at age 10, six (15% each) at ages 8 and 11, four (10%) at age 7, three (7.5%) at age 12, two (5%) at age 6, and one (2.5%) at age 15. There were four (25%) girls at age 11, three (18.8% each) at ages 9 and 12, and one (6.25% each) at ages 7, 8, 10, 13, 16 and 17. Boys were involved in martial arts (karate, taekwondo, jujitsu, kickboxing, hand-to-hand combat) — 22 (55%), sports games (football, hockey, table tennis) — 8 (20%), horting — 4 (10%), diving — 3 (7.5%), swimming — 2 (5%), fencing — 1 (2.5%). Girls were involved in sports games (basketball, handball, volleyball) — 5 (31.3%), swimming — 5 (31.3%), martial arts (wushu, karate) — 2 (12.5%) and one (6.25%) each in diving, sports aerobics, rhythmic gymnastics and archery.

The highest number of young athletes with this ECG phenomenon was found in boys at the ages of nine and ten years, and in girls at the ages of nine, eleven and twelve years.The sports most commonly engaged in by both boys and girls were predominantly martial arts and athletic games, though in recent times, an earlier initiation into sports is common for all forms of gymnastics (artistic, competitive, aesthetic), figure skating, tennis, swimming, and diving. Some variations in the presence of "T-infantile" in youthful sportspeople, when contrasted with the findings of other researchers, might be attributed to the examination of different sports that the scrutinized athletes partake in, as well as elements that consider the child's gender.

The next stage of our research was to analyze the ECG characteristics of young athletes with the "T-infantile" phenomenon. In boys with "T-infantile" (n=40), normal sinus rhythm was found in 80% (n=32) and right atrial rhythm in 20% (n=8). Regular rhythm was found in 80% (n=32) and sinus respiratory arrhythmia in 20% (n=8). Normal ECG amplitude was recorded in all boys. In the boys with "T-infantile" in 30% (n=12) the electrical axis of the heart was not deviated and was in a semi-vertical position, in 25% (n=10) it was vertical, in 7.5% (n=3) the axis was deviated to the right, in 5% (n=2) it was semi-horizontal and in one (2.5%) the heart axis was deviated to the left. Bradycardia was detected in 15% of the examined athletes (n=6), 42.5% (n=17) had heart rate in the range 61–79 bpm^{-1} and the remaining 42.5% (n=17) had heart rate 80 bpm^{-1} or more. ECG changes were present

in 49 cases, i.e. in addition to T-infantile in 5 (10.2%) athletes in combination with incomplete right bundle branch block, in 3 (6.1%) with shortened PQ syndrome and in one (2.0%) with early ventricular repolarization syndrome.

In girls with T-infantile (n=16), normal sinus rhythm was found in 87.5% (n=14) and right atrial rhythm in 12.5% (n=2). Regular rhythm was found in 75% (n=12) and respiratory sinus arrhythmia in 25% (n=4). Normal ECG amplitude was recorded in all girls. In 43.8% (n=7) of the young female athletes the electrical axis of the heart had a semi-vertical position, in 25% (n=4) the electrical axis of the heart was not deviated and had a vertical position and in one (6.25%) the electrical axis of the heart was deviated to the right. Bradycardia was detected in 12.5% (n=2), heart rate in the range of 61-79 bpm^{-1} in 50% (n=8) and in 37.5% (n=6) heart rate was 80 bpm^{-1} or more. ECG changes were observed in 20 cases, i.e., in addition to "T-infantile", three girls (18.8%) additionally had incomplete right bundle branch block and one (6.3%) had shortened PQ syndrome.

A comparative analysis of HRV indices in boys and girls with the "T-infantile" phenomenon showed that boys, who were younger than girls (9.3±0.27 years vs. 11.1±0.68 years, p=0.02), had a significantly higher D value, reflecting the activity of vagus regulation of heart rate (0.403±0.028 s vs. 0.311±0.025 s, p=0.019). They also showed a tendency to decrease the following indices AMo, a measure of the mobilising influence of the sympathetic arm of the autonomic nervous system (36.321±2.059% vs. 40.20±4.465%, p=0.425), AMo/D, an index of the ratio between sympathetic and parasympathetic activity (122. 80±16.18%/s vs. 167.97±37.58%/s, p=0.269), autonomic rhythm index (ARI), indicating the balance of autonomic regulation of the sinus node (4.363±0.376 $1/s^2$ vs. 5.307±0.761 $1/s^2$, p=0.265), adequacy of regulation processes (ARP) — reflecting the correspondence between the activity of the sympathetic arm of the ANS and the leading level of sinus node function (52.869±3.577 %/s vs. 58.814±8.566 %/s, p=0.517), SI — stress index indicating the degree of centralisation of heart rate control (90.835±12.904 c.u. vs. 127.226±32.763 c.u., p=0.300) and LF/HF-sympatho-vagal index (1.159±0.188 c.u. vs. 1.413±0.282 c.u., p=0.450). The data obtained indicate a trend in the prevalence of parasympathetic influences of the ANS in boys.

T-wave inversion in two adjacent anterior leads (V1-V3) in individuals younger than 16 years of age is associated with electrical right ventricular predominance in infancy, which gradually resolves with T-wave normalization after puberty [1, 3, 4], is more common in females [1, 4], and is statistically more frequent according to [4].

According to Calò et al [7], T-wave inversion is associated with mild cardiac pathology in 4.8% of cases and persists in only 0.2% of cases in 16-year-olds [1], and according to Papadakis [12] in only 0.1% of cases. 1% of cases, and its persistence after 16 years of age should raise suspicion of underlying cardiac disease, warrant second-level diagnostic evaluation and annual surveillance [3], and be a hallmark of arrhythmogenic cardiomyopathy [4, 7]. Recent international guidelines for interpreting the electrocardiographic pattern in athletes recommend against

further evaluation of the juvenile ECG in the absence of symptoms or a significant family history of heart disease [4].

Analysis of the autonomic nervous system tone according to the classification of Bayevskiy [5] showed that there were 16 (40%) boys with vagotonia, 20 (50%) with eutonia and 4 (10%) with sympathicotonia, showing a tendency for eutonia to predominate compared to vagotonia (p=0.549) and sympathicotonia (p=0.140). In girls, there were 5 (31.3%), 8 (50%) and 3 (18.8%) athletes, respectively, indicating a tendency for eutonia to predominate compared to vagotonia (p=0.506) and sympathicotonia (p=0.348), i.e. there were more individuals with eutonia (50% each) in the groups studied, corresponding to an SI value between 51–199 c.u.

Conclusions

1. The "T-infantile" phenomenon was observed in 1.4% of male and 1.7% of female young athletes aged between 6 and 17 years, showing no significant gender difference (p=0.945).
2. The peak prevalence of the "T-infantile" phenomenon among young athletes was identified in boys of 9 and 10 years old, and girls of 9, 11, and 12 years old.
3. Predominantly, boys engaged in oriental martial arts and sports games, whereas girls were more involved in sports games and swimming.
4. The occurrence of the T-infantile phenomenon in both boys and girls was linked with incomplete right bundle branch block and short QT syndrome.
5. HRV analysis indicated a trend towards parasympathetic ANS influences being more common in boys, and a state of eutonia was identified in 50% of cases for both genders.

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FEATURES OF AUTONOMOUS REGULATION OF CARDIAC ACTIVITY IN YOUNG ATHLETES WITH JUVENILE ECG PATTERN

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Abstract.
The aim of the work is to study the occurrence of juvenile ECG pattern and characteristics of autonomous regulation of cardiac activity in young athletes with this ECG feature.

Materials and methods. Electrocardiographic study and recording of heart rate variability (HRV) in children and adolescents of both genders engaged in various sports were carried out. Mathematical and spectral methods of HRV analysis were used to assess the state of mechanisms of neurohumoral regulation of the heart, activity of segmental and suprasegmental parts of the autonomous nervous system (ANS).

Conclusions. Juvenile ECG pattern in the sample of examined young athletes was found almost equally in both boys and girls. In certain age groups, the largest number of young athletes with juvenile ECG pattern was registered. This ECG feature was combined with incomplete blockade of the right bundle branch of Gis and shortened QT interval syndrome. The analysis of HRV indicates a tendency to predominance of parasympathetic influences of ANS in boys, and a certain number of examined boys and girls had the indices of vegetative tone corresponding to normotonia.

Keywords: juvenile ECG pattern, young athletes, heart rate variability, age groups

1. Introduction.

Nowadays in the world of sports there are big competitions such as Gymnasiade, Youth Olympic Games, etc. in which athletes between 15 and 18 years of age participate. It is known that it takes an average of 6.5-7.5 years of hard training to achieve high results and successful participation in competitions at this level, so most coaches want to make an earlier selection of children in sports sections. Existing age standards for sports activities are based on the passport age, but due to the phenomenon of acceleration, there are cases of discrepancy between the passport age and the biological age, when a child is 1-2 years ahead or behind his or her peers [16]. For example, children from the age of 7 are admitted to the initial training groups of children's and youth sports schools in gymnastics, artistic gymnastics, swimming, figure skating, tennis and table tennis. In such cases, during the initial medical examination, the sports physician encounters features of the ECG of young

athletes in the form of a juvenile ECG pattern, better known as the "T-infantile" phenomenon.

"T-infantile" phenomenon is a reflection of epicardial repolarisation of the right ventricle [13]. The "T-infantile" is characterized by the following features: 1) the negative T-wave or the negative phase of the biphasic T wave progressively decreases from lead V1 to lead V4; 2) the peaks of the negative T waves or the peaks of the negative phases of the biphasic T-waves in the right thoracic leads coincide with or slightly precede the peaks of the positive T-waves in the left thoracic leads; 4) the ST segment in the right thoracic leads is on the isoelectric line and does not have an upward convex arc shape.

Sandrucci & Bono [13] found "T-infantile" in 30% of healthy children and adolescents aged up to 14 years, and Shiyan [14] found this phenomenon in 21.7% of children aged 7-9 years and in only 1.5% of children aged 13-15 years. Attisani et al [3] found "T-infantile" in 132 (7.1%) of 1858 adolescents aged 6-18 years, and Basu et al [4] found it in 430 (6.0%) of 7162 adolescents aged 13-16 years.

Migliore et al [10], in a study of 2765 children (1914 males and 851 females) aged between 8 and 18 years (mean age 13.9±2.2 years), found T-wave inversion localized in the right precordial leads in 131 of the subjects studied, i.e. 4.7%. According to their results, the prevalence of "T-infantile" decreased significantly with increasing age (8.4% of children younger than 14 years compared to 1.7% of those older than 14 years, $p<0.001$). Of 158 children with T-wave inversion, 4 individuals (2.5%) were diagnosed with cardiomyopathy, including arrhythmogenic right ventricular cardiomyopathy in 3 children and hypertrophic cardiomyopathy in 1 child. The authors believe that T-wave inversion is a common ECG abnormality in inherited cardiomyopathies such as hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy, which are the leading causes of sudden cardiac death in young athletes. These cardiomyopathies are genetically determined and show age-related phenotypic expression. As early manifestations of the disease usually occur after puberty, the persistence of T-wave inversion in post-pubertal age raises the problem of differential diagnosis between developing myocardial disease and benign juvenile repolarization type. In this age group, T-wave inversion, localized predominantly in the right precordial leads, was documented in 5.7% of cases, decreased significantly with increasing age and pubertal maturation and, most importantly, reflected the primary cardiomyopathy, such as arrhythmogenic right ventricular cardiomyopathy and hypertrophic cardiomyopathy in 2.5% of cases. These results suggest that T-wave inversion is much less common after full pubertal development than previously thought, and its persistence may indicate myocardial disease at risk of sudden cardiac death. Consequently, the demonstration of post-pubertal persistence of T-wave inversion in athletic children justifies an echocardiographic study that may lead to the presymptomatic detection of early cardiomyopathy.

The incidence of T-wave inversion in the anterior leads V1-V3 varies widely not only in non-athletic children and adolescents, but also in athletes. For example,

according to Abramova [2], in young athletes "T-infantile" is observed in 25% of girls aged 11-12 years, and in boys in two age groups: 11–12 years — in 16.6% and 13–14 years — in 12.5%. Calò et al [7], in a study of 2,261 football players aged 8-18 years, found this phenomenon in 136 (6.0%) players. Abela et al [1] found this phenomenon in 5.0% of Maltese adolescents examined, with an average age of 15 years. McClean et al [9] found "T-infantile" in 418 Arab and 314 African athletes aged 11-18 years, representing 15.8% of the total number of athletes studied.

Analysis of ECGs with similar phenomena performed on young athletes shows that they can develop cardiomyopathy. In these cases, according to Butchenko [6], the ECG shows the following changes 1) there is no progressive decrease in the negative T-wave or the negative phase of the biphasic T-wave from lead V1 to lead V4, but there is an increase in the negative T-wave or the negative phase of the biphasic T-wave up to lead V3; 2) there is a negative or flat positive T waveform in one of the leads, usually in V3, V4; 3) there is a terminal negative T-waveform; 4) the ST segment is shifted above the isoelectric line and becomes an upwardly curved arc. These signs of cardiomyopathy in young athletes may occur in different combinations.

Skuratova [15] reports that "T-infantile" is characterized by: 1) coincidence (or slight advance) of the peaks of the negative T-wave in the right thoracic leads and the positive T-wave in the left thoracic leads; 2) decrease in the depth of the negative phase of the T-wave from V1 to V4; 3) coincidence of the central depression of the T-wave (at the bicuspid) in the right thoracic leads with the peak of TV5 and TV6; no arc-shaped ST-segment elevation in the thoracic ECG leads. The described ECG changes in young athletes are a normal variant and have nothing in common with the ECG manifestations of cardiomyopathy due to chronic physical overexertion [2, 6].

Papadakis et al [12] studied 1710 adolescent athletes and 400 non-athletic children. There were no significant differences in the overall prevalence of T-wave inversion between athletes and controls. T-wave inversion in leads V1-V3 was mostly limited to the age of the subjects (older than 16 years) in both groups. Only 0.1% of athletes aged 16 years and older showed T-wave inversion outside V2. T-wave inversions in the inferior and/or lateral leads and deep T-wave inversions were rare in athletes (1.5 and 0.8%, respectively) and were associated with a high prevalence of left ventricular hypertrophy or congenital heart disease. Despite intensive further investigation, no athlete was diagnosed with cardiomyopathy.

The aim of the study was to quantify the incidence of the juvenile ECG pattern in athletic individuals aged between 6 and 17 years, and to elucidate the role of autonomic regulation in this electrocardiographic phenomenon.

2. Materials and Methods.

Electrocardiographic recording of heart rate variability were performed in 3720 children and adolescents aged 6–17 years, including 74.6% (n=2774) boys and 25.4% (n=946) girls, involved in various sports. Of the total number of athletes, the

"T-infantile" phenomenon was detected in 56 people, or 1.5%, including 40 (1.44%) boys and 16 (1.69%) girls.

The state of the neurohumoral regulatory mechanisms of the heart, the activity of segmental and suprasegmental divisions of the autonomic nervous system (ANS) were assessed using mathematical and spectral methods of heart rate variability (HRV) analysis [11]. Short (5-minute) recordings were used for HRV analysis [8]. ANS parameters were analyzed using an integral index of HRV, the stress index (SI). According to Bayevskiy [5], the vagotonic state is observed when the SI is less than 50 conventional units (c.u.), the eutonic state — in the range of 51–199 c.u., and the sympathicotonic state — when the SI is more than 200 c.u.

Statistical analysis of the data was performed using Statistica 6.0 (StatSoft Inc.) using parametric methods. Values are expressed as mean (M) ± standard error of the mean (SE). Differences in values were considered statistically significant at a significance level $p<0.05$.

3. **Results and discussion**.

There were ten (25%) boys at age 9, eight (20%) at age 10, six (15% each) at ages 8 and 11, four (10%) at age 7, three (7.5%) at age 12, two (5%) at age 6, and one (2.5%) at age 15. There were four (25%) girls at age 11, three (18.8% each) at ages 9 and 12, and one (6.25% each) at ages 7, 8, 10, 13, 16 and 17. Boys were involved in martial arts (karate, taekwondo, jujitsu, kickboxing, hand-to-hand combat) — 22 (55%), sports games (football, hockey, table tennis) — 8 (20%), horting — 4 (10%), diving — 3 (7.5%), swimming — 2 (5%), fencing — 1 (2.5%). Girls were involved in sports games (basketball, handball, volleyball) — 5 (31.3%), swimming — 5 (31.3%), martial arts (wushu, karate) — 2 (12.5%) and one (6.25%) each in diving, sports aerobics, rhythmic gymnastics and archery.

The highest number of young athletes with this ECG phenomenon was found in boys at the ages of nine and ten years, and in girls at the ages of nine, eleven and twelve years.The sports most commonly engaged in by both boys and girls were predominantly martial arts and athletic games, though in recent times, an earlier initiation into sports is common for all forms of gymnastics (artistic, competitive, aesthetic), figure skating, tennis, swimming, and diving. Some variations in the presence of "T-infantile" in youthful sportspeople, when contrasted with the findings of other researchers, might be attributed to the examination of different sports that the scrutinized athletes partake in, as well as elements that consider the child's gender.

The next stage of our research was to analyze the ECG characteristics of young athletes with the "T-infantile" phenomenon. In boys with "T-infantile" (n=40), normal sinus rhythm was found in 80% (n=32) and right atrial rhythm in 20% (n=8). Regular rhythm was found in 80% (n=32) and sinus respiratory arrhythmia in 20% (n=8). Normal ECG amplitude was recorded in all boys. In the boys with "T-infantile" in 30% (n=12) the electrical axis of the heart was not deviated and was in a semi-vertical position, in 25% (n=10) it was vertical, in 7.5%

(n=3) the axis was deviated to the right, in 5% (n=2) it was semi-horizontal and in one (2.5%) the heart axis was deviated to the left. Bradycardia was detected in 15% of the examined athletes (n=6), 42.5% (n=17) had heart rate in the range 61–79 bpm^{-1} and the remaining 42.5% (n=17) had heart rate 80 bpm^{-1} or more. ECG changes were present in 49 cases, i.e. in addition to T-infantile in 5 (10.2%) athletes in combination with incomplete right bundle branch block, in 3 (6.1%) with shortened PQ syndrome and in one (2.0%) with early ventricular repolarization syndrome.

In girls with T-infantile (n=16), normal sinus rhythm was found in 87.5% (n=14) and right atrial rhythm in 12.5% (n=2). Regular rhythm was found in 75% (n=12) and respiratory sinus arrhythmia in 25% (n=4). Normal ECG amplitude was recorded in all girls. In 43.8% (n=7) of the young female athletes the electrical axis of the heart had a semi-vertical position, in 25% (n=4) the electrical axis of the heart was not deviated and had a vertical position and in one (6.25%) the electrical axis of the heart was deviated to the right. Bradycardia was detected in 12.5% (n=2), heart rate in the range of 61-79 bpm^{-1} in 50% (n=8) and in 37.5% (n=6) heart rate was 80 bpm^{-1} or more. ECG changes were observed in 20 cases, i.e., in addition to "T-infantile", three girls (18.8%) additionally had incomplete right bundle branch block and one (6.3%) had shortened PQ syndrome.

A comparative analysis of HRV indices in boys and girls with the "T-infantile" phenomenon showed that boys, who were younger than girls (9.3±0.27 years vs. 11.1±0.68 years, p=0.02), had a significantly higher D value, reflecting the activity of vagus regulation of heart rate (0.403±0.028 s vs. 0.311±0.025 s, p=0.019). They also showed a tendency to decrease the following indices AMo, a measure of the mobilising influence of the sympathetic arm of the autonomic nervous system (36.321±2.059% vs. 40.20±4.465%, p=0.425), AMo/D, an index of the ratio between sympathetic and parasympathetic activity (122. 80±16.18%/s vs. 167.97±37.58%/s, p=0.269), autonomic rhythm index (ARI), indicating the balance of autonomic regulation of the sinus node (4.363±0.376 $1/s^2$ vs. 5.307±0.761 $1/s^2$, p=0.265), adequacy of regulation processes (ARP) — reflecting the correspondence between the activity of the sympathetic arm of the ANS and the leading level of sinus node function (52.869±3.577 %/s vs. 58.814±8.566 %/s, p=0.517), SI — stress index indicating the degree of centralisation of heart rate control (90.835±12.904 c.u. vs. 127.226±32.763 c.u., p=0.300) and LF/HF-sympatho-vagal index (1.159±0.188 c.u. vs. 1.413±0.282 c.u., p=0.450). The data obtained indicate a trend in the prevalence of parasympathetic influences of the ANS in boys.

T-wave inversion in two adjacent anterior leads (V1-V3) in individuals younger than 16 years of age is associated with electrical right ventricular predominance in infancy, which gradually resolves with T-wave normalization after puberty [1, 3, 4], is more common in females [1, 4], and is statistically more frequent according to [4].

According to Calò et al [7], T-wave inversion is associated with mild cardiac pathology in 4.8% of cases and persists in only 0.2% of cases in 16-year-olds [1], and according to Papadakis [12] in only 0.1% of cases. 1% of cases, and its

persistence after 16 years of age should raise suspicion of underlying cardiac disease, warrant second-level diagnostic evaluation and annual surveillance [3], and be a hallmark of arrhythmogenic cardiomyopathy [4, 7]. Recent international guidelines for interpreting the electrocardiographic pattern in athletes recommend against further evaluation of the juvenile ECG in the absence of symptoms or a significant family history of heart disease [4].

Analysis of the autonomic nervous system tone according to the classification of Bayevskiy [5] showed that there were 16 (40%) boys with vagotonia, 20 (50%) with eutonia and 4 (10%) with sympathicotonia, showing a tendency for eutonia to predominate compared to vagotonia (p=0.549) and sympathicotonia (p=0.140). In girls, there were 5 (31.3%), 8 (50%) and 3 (18.8%) athletes, respectively, indicating a tendency for eutonia to predominate compared to vagotonia (p=0.506) and sympathicotonia (p=0.348), i.e. there were more individuals with eutonia (50% each) in the groups studied, corresponding to an SI value between 51–199 c.u.

4. Conclusions

1. The "T-infantile" phenomenon was observed in 1.4% of male and 1.7% of female young athletes aged between 6 and 17 years, showing no significant gender difference (p=0.945).
2. The peak prevalence of the "T-infantile" phenomenon among young athletes was identified in boys of 9 and 10 years old, and girls of 9, 11, and 12 years old.
3. Predominantly, boys engaged in oriental martial arts and sports games, whereas girls were more involved in sports games and swimming.
4. The occurrence of the T-infantile phenomenon in both boys and girls was linked with incomplete right bundle branch block and short QT syndrome.
5. HRV analysis indicated a trend towards parasympathetic ANS influences being more common in boys, and a state of eutonia was identified in 50% of cases for both genders.

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AN INTEGRATIVE APPROACH OF YOUNG ATHLETES' FUNCTIONAL QUALITY EVALUATION

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Abstract

The study of physical performance, as well as functional readiness of young athletes is an urgent task of mass health-improving physical culture. To implement this task, sports medicine specialists use dynamic medical control in the study of adaptive reserves and characteristics of the functional state of athletes. This article presents data on the body functional state assessment of young athletes by researching remote variational heart rate monitoring and heart rate variability. This study indicates appropriateness of using heart rate variability study method for personal monitoring of athletes' functional state level and their readiness for training activity and competitions. The vegetative balance and the functional state indicators of the cardiovascular system in young athletes engaged in martial art. The energy mobilization and metabolic reserves during physical and psychoemotional loads was diagnosed in 80% of the examined athletes. Thus, express definitions of the vegetative regulation type have the greatest variability in the acute test with physical activity.
Key words: physical development, functional state, cardiovascular system, heart rate variability, youth sports.

1. Introduction

Dynamical overall control under physical and functional conditions is needed for the best outcomes of young athlete's trainings that will be a certain guarantee [1,2]. One of the pressing problems of global health is cardiovascular system maladaptive states early diagnosis [3,4]. Thus, according to a meta-analysis on the prevalence of maladaptive states, more than 70% of athletes have signs of overexertion and overtraining during annual cycle of the training process. Regardless of the fact there are no statistical data on overtraining in the Republic of Kazakhstan, early diagnosis of maladaptive states' predictors becomes is an urgent task for domestic healthcare.

Today, dynamic monitoring of the athletes' functional state makes it possible to ensure their high physical performance and a strong health development [5]. That also will allow a high physical performance and will increase the training process efficiency for the best sports results.

For an adequate studying of the athlete's functional state, we need use the latest diagnostic tools that will help to select the right functional samples and tests for the high-level physical trainings. Supposed it is necessary to reveal the relevance of using hardware and software complexes at rest and also during training loads for an objective assessment of the athlete's health.

The aim of the study: to assess the young athletes functional state by assessing body's adaptive reserves by cardiac monitoring of remote variation pulsometry and heart rate variability.

2. Material and method

The study methods and organization: for the dynamical evaluation of the health condition, we recorded heart rate variability during the examination of 20 junior athletes aged 8–14 years at the Center for Sports Medicine, Rehabilitation and Training "PROSPORT" in Almaty.

For the best personal training plan, the cardiovascular system functional state should be determined. The study of heart rate variability (HRV) is indispensable tool to reveal the adaptation reserve, predicting sports results, and in the selection of athletically gifted individuals.

Before the HRV, the athletes were in a horizontal position for 3-5 minutes to adapt to environmental conditions; in addition, the study was carried out in the morning at an air temperature of at least 22°C. This examination was performed using a Poly-SPECTR electrocardiograph from Neurosoft (Figure 1).

Figure 1. *Device for determining heart rate variability "Poly-SPECTRUM" from Neurosoft*

The method is based on recognizing and measuring time intervals between R-R intervals of an electrocardiogram, and constructing dynamic series of cardiointervalograms. Afterwards, we used various mathematical methods for the subsequent analysis of the resulting number series.

After recording the cardiogram in a horizontal position, the subject took a vertical position and stayed calmly for 5 minutes continuing recording. The transient

process during the analysis of a functional sample was isolated and excluded from the processing of results, since it must be analyzed by special methods. The following indicators were assessed: the R-R intervals variation coefficient (CV, %), standard deviation of the RR interval (SDNN, ms), the proportion of consecutive intervals differing by more than 50 ms (pNN50, %), total spectrum power (TP, ms2), IN (SI) - voltage index characterizing the activity of the force sympathetic regulation mechanisms, high-frequency spectrum (HF, ms2), wave power in normalized units (HF norm and LF norm). Indicators were assessed in accordance with the standards for the heart rate variability analysis adopted at a joint meeting of the European Society of Cardiology and the North American Society of Electrical Stimulation and Electrophysiology in 1996 [6].

3. Results and Discussions

This chapter is the most important in the paper, aiming to detail and prove the statements made in the previous chapters. With this purpose in mind, tables and figures can be used to support the information, and add more clarity to the demonstration.

Tables

Results: the study of the time intervals variability between heart beats makes it possible to judge the body's capabilities and adaptation to the constantly changing conditions of sports and competitive activity for the present and prospect.

Thus, with the help of spectral analysis of HRV results, pre- nosological diagnosis of the body maladaptive states is possible.

By comparative analysis of the average HRV values results among young athletes the following indicators were identified. (Table 1).

Table 1. *Comparative characteristics of HRV results in young athletes*

Parameters	**Background**	**Orthostatic**	**Parameters**	**Background**	**Orthostatic**
HR (уд./мин)	498	338	**TP (мс²)**	2408	2112
R-R min (мс)	824	737	**L (Гц)**	0,397	0,397
R-R max (мс)	620	546	**TPav (мс²/Гц)**	6	5
RRNN (мс)	50	47	**VLF (мс²)**	1283	923
SDNN (мс)	83	39	**LF (мс²)**	941	903
RMSSD (мс)	7,9	2,5	**HF (мс²)**	183	285
pNN50 (%)	8,08	8,54	**LFnorm**	83,7	76,0
CV (%)	-162	-301	**HFnorm**	16,3	24,0
RM min (мс)	105	250	**LF/HF**	5,13	3,17
RM max (мс)	507	451	**HFmx (мс²/Гц*1000)**	3,0	4,5
R-R avg min (мс)	806	678	**HFt (с)**	0,4	0,2
HR (уд./мин)	96,7	109,8	**HFav (мс²/Гц)**	0,7	1,1
Mo (с)	0,625	0,549	**LFmx (с)**	42,4	35,0

AMo (%)	46,4	38,8	**LFt (c)**	0,0	0,1
Me (c)	0,621	0,547	**LFav (мс²/Гц)**	8,6	8,2
MxDMn (c)	0,299	0,284	**VLFmx (мс²/Гц*1000)**	99,0	75,3
MxRMn	1,60	1,64	**VLFt (c)**	0,0	0,0
SI	75	186	**VLFav (мс²/Гц)**	34,7	25,0
BP (c)	0,327	0,399	**RR 30 (c)**	-	0,499

We assessed the total effect of autonomic regulation in young athletes by the SDNN indicator, as well as the SI indicator, which indicates the stress level and the regulatory system's tension index. The subjects were divided into 3 groups depending on the circulatory apparatus regulation type (Table 2).

Table 2 *The autonomic regulation types of the highly qualified athletes.*

Autonomic regulation among young athletes		
Eutonic SDNN 40-80 мs	**Sympathicotonic SDNN >40 мс**	**Parasympathicotonic SDNN > 80 мс**
7(38,8%)	3(16,6%)	8 (44,4%)

We found the median value with the interquartile range SDNN was within 27 ms by HRV spectral values analysis in three athletes, which indicates increased tension in the regulatory systems and signs of maladaptation of autonomic regulation (Figure 2).

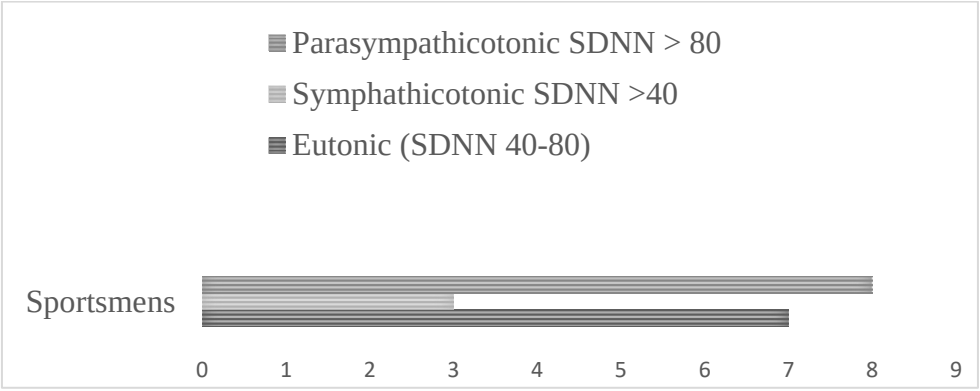

Figure 2. *Predominance of autonomic regulation in highly qualified athletes*

The stress index SI was studied as an index of the regulatory system's tension because of the dependence of SDNN with increased sympathetic regulation. The

athletes' results were interpreted in accordance with the regulatory system functional state assessment proposed by N.I. Shlyk in 2003 [7-8].

According to the express assessment criterion of the predominance the heart rate regulation type (autonomous or central) based on SI (arbitrary units) VLF (ms2) indicators, athletes were divided into 4 groups:

• Type I with moderate predominance of central regulation more than 100 less than 240

• Type II with a pronounced predominance of central regulation more than 100 less than 240

• Type III with a moderate predominance of autonomous regulation 30-100 more than 240

• Type IV with a pronounced predominance of autonomous regulation (with TP>8000 ms2) less than 30 more than 240 (Table 3)

Table 3. Young athlete's heart rate regulation type predominance (autonomous or central).

Heart rate regulation type			
Type I	**Type II**	**Type III**	**Type IV**
0	15%	80%	5%

All the temporal and spectral indicators of HRV have the greatest variability in an acute exercise test (changes in rest-load dynamics) for the quickest determination of the autonomic regulation type.

Three rhythmograms' analysis shows different recovery degrees of athletes after previous identical training load. It's revealed by HRV analysis data, most athletes have an optimal level of vegetative balance at rest and a correct response to orthostatic impact, which indicates the body functional capability to perform a new volume of training loads.

However, athletes with 3 and 4 types had not fully recovered from the previous training and had a pronounced tension of the central regulatory circuit at rest (type II), also had paradoxical reaction to orthostasis. In 80% of cases, the examined athletes were diagnosed with mobilization of energy and metabolic reserves during physical and psycho-emotional stress.

4. Conclusions

We researched the heart sinus node rhythm by HRV analyses, that varied by the internal and external environmental impacts affected on body regulatory system's homeostasis. That's why the sinus node has binary connections with the body main systems through nerve endings, as well as has a role in the constant release of hormones and metabolites.

Thus, maladaptive states at the level of the regulatory system occur before any metabolic and functional disorders of the organs and systems, also it may become a pre-nosological sign of the disease, in some cases, even ahead of laboratory changes.

The data obtained during the study serve as a model for forming a methodological basis for interpreting the results and characteristics of a young athlete's reaction to training and competitive load.

The method with great reliability helps to determine the compliance of the training process with the functional capabilities of the athlete's body and makes it possible, without special medical education, to identify various heart rhythm disturbances, as well as a state of overtraining. Based on dynamic studies of HRV at rest and orthostasis, it is possible to implement an individual approach to the training process, taking into account the prevailing type of autonomic regulation, which contributes to the real possibility of increasing the level of athlete's functional readiness for training and competitive activities.

Young athletes are more likely than adults to experience atypical reactions to dosed physical activity. It is important to comprehensively determine the results of biomedical research on the practical importance.

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THE SPECIFIC PHYSICAL TRAINING OF YOUNG BOXERS

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Abstract

The study aims to evaluate the performance of direct punches in boxers by measuring the number of repetitions performed over different time intervals using three different types of equipment. In this regard, it is revealed that there are significant differences in the performance of boxers depending on the equipment used. Therefore, it is anticipated that competition gloves will allow for a higher number of repetitions compared to the 2 kg ball and the punching bag gloves. The pilot study was conducted in February 2024 with three boxers aged between 14 and 16 years from the "Iorgu Sports Club" Association in Bucharest. The statistical analysis was performed using the KyPlot program (version 6.0) to evaluate the significance of the results. The results of the study highlight that young boxers demonstrate varying performance based on the equipment used for direct punches, with a decrease in the number of punches when using a 2 kg ball, a significant improvement with bag gloves, and the best results with boxing gloves. This emphasizes the importance of adapting training programs to specific equipment to maximize performance in the boxing ring. In conclusion, the results suggest that young boxers achieve superior performance in direct punch exercises, showing greater efficiency with punching bag gloves compared to the 2 kg ball. There is a significantly increased number of direct punches if using competition gloves, which highlights not only adaptation to the equipment but also improvements in technical skills and physical conditioning. These findings underscore the necessity of specialized training for maximizing performance in the ring.

Key words: *performance, equipment, boxers, direct punches, training session*

1. Introduction

Boxing is a sport that involves both technical skills and exceptional physical skills such as strength, speed, endurance and agility. For young boxers in particular, specific physical training plays a crucial role in developing their performance and preventing injuries. As they progress from beginner to competitive levels, training must be oriented toward the specific demands of the sport, focusing on improving the physical capacities that are fundamental to success in the ring. Studies highlight that biomechanical factors play an important role in learning the hook technique. Thus, educational strategies should be adapted based on these factors to maximize the efficiency of punches (Bingul et al., 2018).

Training planning is essential in boxing, and the training periodization model helps structure physical preparation and maximize athlete performance, inclusively

in contact sports such as boxing (Bompa & Buzzichelli, 2015). Another important aspect is the development of special stability, which enhances the physical performance of boxers and contributes to injury prevention (Bushati, Hysa & Xhaferraj, 2021).

In the context of developing young athletes, specific physical training must be tailored to their physiological characteristics and growth stage. It is essential for training to contribute not only to increasing overall physical capacity but also to developing qualities specific to boxing, such as coordination, balance and quick reaction. Boxing is an extremely demanding sport in terms of energy, involving both the aerobic and anaerobic systems to support prolonged efforts and the intensity of fight rounds. For example, studies show that physiological responses, such as heart rate, oxygen consumption and blood lactate accumulation are essential for monitoring metabolic adaptations to specific boxing training (Ghosh, 2010; Ghosh, Goswami & Ahuja, 1995). Additionally, analyzing the physiological profile of junior and senior boxers underscores the importance of adjusting training to meet the specific requirements of each age category, ensuring optimal performance development (Smith, 2006).

Striking techniques in boxing, along with performance analysis, are essential aspects for improving efficiency in the ring. Training programs centered on boxing significantly contribute to the development of physical fitness and the optimization of technical performance, directly impacting on the efficiency of punches (El-Ashker, 2018). Kinetic and kinematic analyses of maximum effort strikes highlighted the importance of coordination and force control in executing effective punches, especially among amateur boxers (Stanley et al., 2018). Moreover, the development of a specific dynamometer for measuring punch force allowed for an accurate assessment of the force generated by boxers, thus contributing to the adjustment of training programs (Smith et al., 2000).

Training programs for young boxers should include various methods, such as plyometric training and cross-training exercises, meant to improve both athletic performance and kinetic skills, as well as physiological indicators. For example, plyometric resistance training implemented in preparation for the European Championship led to significant improvements in the athletic performance of young boxers from the national team (Gürkan & Aydın, 2024). Furthermore, cross-training exercises have been effective in developing motor skills and essential physiological parameters for boxers (Hussein, 2023). Studies on the impact of boxing on brain health in collegiate amateur boxers reveal the serious adaptations necessary for maintaining long-term health (Wallis, 2021).

Therefore, the specific physical training of young boxers must be well-planned and customized to their individual needs, taking into account their stage of physical development and the specific demands of the competitions in which they participate. Such a holistic approach will contribute to the development of well-rounded athletes capable of performing at the highest level.

2. Material and method

The purpose of the study is to evaluate the performance of direct punches in boxers by measuring the number of repetitions completed over different time intervals, using three different types of equipment. The study aims at determining variations in performance depending on the type of equipment used and identifying significant differences between these conditions.

The hypothesis of the study suggests that there are important differences in the direct punches performed by boxers, entailed by which equipment they use. More specifically, it is anticipated that competition gloves will allow for a higher number of repetitions compared to the 2 kg ball and punching bag gloves due to their technical and ergonomic characteristics.

The fitness tests used in the study consist of executing direct punches in three series of 10 seconds, 20 seconds and 30 seconds using different equipment (Fig. 1): the 2 kg ball (Fig. A), punching bag gloves (Fig. B) and competition gloves (Fig. C).

A. Test 1 B. Test 2 C. Tests 3

Fig. 1. Fitness tests

The applied pilot study was carried out in February 2024 with three boxers of 14 - 16 years old, members of the "Iorgu Sports Club" Association in Bucharest. Statistical analysis was performed using KyPlot software (version 6.0), applying descriptive indicators such as mean, standard deviation (SD), coefficient of variation (CV%), confidence level of the mean (Confidence Level of Mean 0.95) and lower and upper confidence limits of the mean. To test the significance of the differences, the Kruskal-Wallis statistic (Chi-Square, P value) was used. The results were considered significant for $p < 0.05$.

3. Results and discussions

The results obtained from the experiment will be presented in detail, highlighting the mean values, variations and statistical significance of the performances based on the type of equipment used, in order to provide a clear picture of their impact on the physical abilities of young boxers.

Table 1. Results of direct punches with the ball of 2 kg

Statistical indicators	No. of reps in 10 s			No. of reps in 20 s			No. of reps in 30 s		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
mean	13	13	26	23	23.33	46.33	33.33	33.33	66.67
SD	1	1	1.73	1.73	2.08	3.78	2.08	2.08	4.16
CV%	7.69	7.69	6.67	7.53	8.92	8.17	6.24	6.24	6.24
CLM (0.95)	2.48	2.48	4.30	4.30	5.17	9.40	5.17	5.17	10.34
LCLM	10.52	10.52	21.69	18.69	18.16	36.93	28.16	28.16	56.32
UCLM	15.48	15.48	30.30	27.30	28.50	55.74	38.50	38.50	77.01
Chi-Square	24.92**								
P value	0.00161								

Notes: Confidence Level of Mean (0.95), Lower Confidence Limit of Mean, Upper Confidence Limit of Mean; df = 8, Chi-Squart - Kruskal-Wallis Statistics

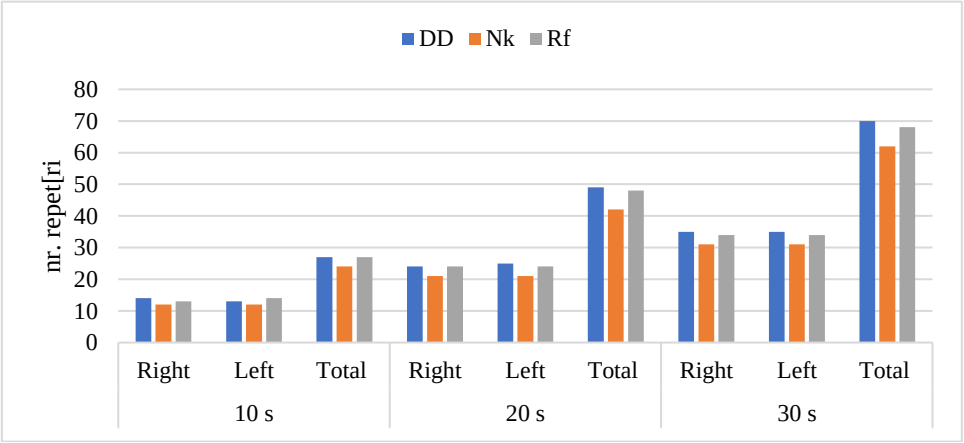

Fig. 1. Dynamics of individual performance in test 1

The individual results presented in Fig. 1 highlight that the athletes (DD, Nk, Rf) achieved varying numbers of punches, both with the right hand (Right) and the left hand (Left). For example, at 10 seconds, the total number of punches varied from 24 to 27. At 20 seconds, the athletes recorded a total of punches ranging from 42 to 49, and at 30 seconds, the total increased to values between 62 and 70.

The descriptive statistical indicators: the mean number of punches for all tests is quite constant, suggesting a similar level of performance among athletes, with a total of 26 punches in 10 seconds, 46.33 in 20 seconds and 66.67 in 30 seconds.

The confidence intervals for the means provide an estimate of the measurement precision, indicating variability in the number of punches but also confidence in the stability of the mean for each type of punch. For example, at 20 seconds, the confidence interval for the mean suggests that the actual number of punches lies between 36.93 and 55.74.

The statistical analysis regarding the Chi-Square test (Chi-Square) revealed a value of 24.92 with a p-value of 0.00161, indicating a very high statistical significance ($p < 0.05$). This shows that there are significant differences between the athletes' performances, depending on the type of punches executed and the execution

time, indicating that training and equipment have a considerable impact on the results.

The results in Table 2 provide a detailed picture of the performances of boxers in direct punch exercises executed with bag gloves, over durations of 10, 20, and 30 seconds. Here is an analysis of the data:

The individual results presented in Fig. 2 for the athletes (DD, Nk, Rf) demonstrated a significantly higher number of punches compared to the previous exercises performed with the 2 kg ball. At 10 seconds, the total number of punches varied from 42 to 53; at 20 seconds, the athletes achieved a total of punches between 81 and 110. At 30 seconds, the total increased to values between 120 and 138.

Table 2. Results of direct punches with bag gloves

Statistical indicators	No. of reps in 10 s			No. of reps in 20 s			No. of reps in 30 s		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
mean	24	24.33	48.33	46	45.67	91.67	64	63.67	127.67
SD	2.64	3.05	5.68	7.81	8.14	15.95	4.58	4.73	9.29
CV%	11.02	12.56	11.76	16.98	17.83	17.39	7.16	7.42	7.27
CLM(0.95)	6.57	7.58	14.12	19.40	20.23	39.62	11.38	11.74	23.08
LCLM	17.43	16.74	34.21	26.59	25.43	52.05	52.61	51.93	104.58
UCLM	30.57	31.92	62.46	65.40	65.89	161.28	75.38	75.41	150.75
Chi-Square	24.54**								
P value	0.00186								

Notes: Confidence Level of Mean (0.95), Lower Confidence Limit of Mean, Upper Confidence Limit of Mean; df = 8, Chi-Square - Kruskal-Wallis Statistics

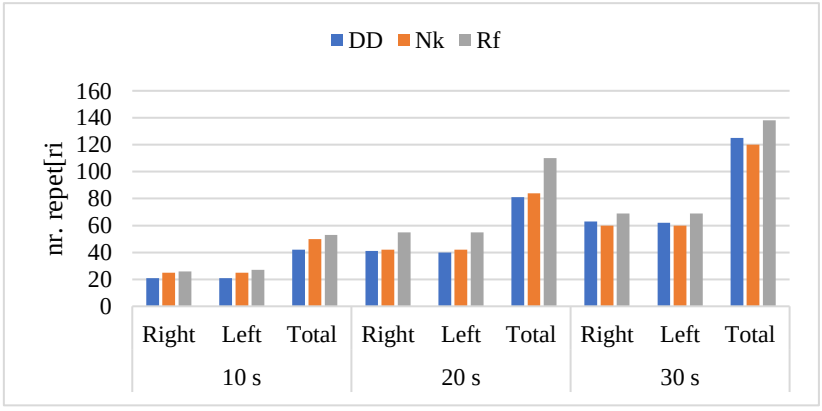

Fig. 2. Dynamics of individual performance in test 2

The results of the descriptive statistical indicators: the mean number of punches shows a clear increase compared to the previous exercises, with an average of 48.33 punches in 10 seconds, 91.67 in 20 seconds and 127.67 in 30 seconds. The confidence intervals for the means provide an estimate of the precision of the results, pointing out that the actual number of punches for the 10-second interval lies between 34.21 and 62.46. This highlights the high variability within the group.

The statistical analysis regarding the Chi-Square test (Chi-Square) resulted in a value of 24.54 with a p-value of 0.00186, indicating a very high statistical significance ($p < 0.05$). This proves that there are significant differences between the performances of the boxers, depending on the type of punches executed and the execution time, highlighting the effectiveness of training with punching bags.

Table 3 presents the results of direct punches executed with competition gloves, over durations of 10, 20 and 30 seconds. Here is a detailed analysis of the data:

The individual results presented in Fig. 3 for the athletes (DD, Nk, Rf) recorded various performances depending on the duration. At 10 seconds, the total number of punches varied from 40 to 52. At 20 seconds, the athletes achieved between 79 and 95 punches. At 30 seconds, the total number of punches ranged from 118 to 150.

Table 3. Results of direct punches with competition gloves

Statistical indicators	No. of reps in 10 s			No. of reps in 20 s			No. of reps in 30 s		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
mean	23.33	23.33	46.67	42.33	42.33	84.67	65.67	65.33	131.00
SD	3.05	3.05	6.11	4.04	4.93	8.96	8.32	8.50	16.82
CV%	13.09	13.09	13.09	9.55	11.65	10.58	12.68	13.02	12.84
CLM(0.95)	7.59	7.59	15.18	10.04	12.25	22.26	20.68	21.13	41.79
LCLM	15.74	15.74	31.49	32.29	30.07	62.40	44.98	44.21	89.21
UCLM	30.92	30.92	61.84	52.37	54.59	106.93	86.35	86.46	172.79
Chi-Square	24.75**								
P value	0.00171								

Notes: Confidence Level of Mean (0.95), Lower Confidence Limit of Mean, Upper Confidence Limit of Mean; df = 8, Chi-Squart - Kruskal-Wallis Statistics

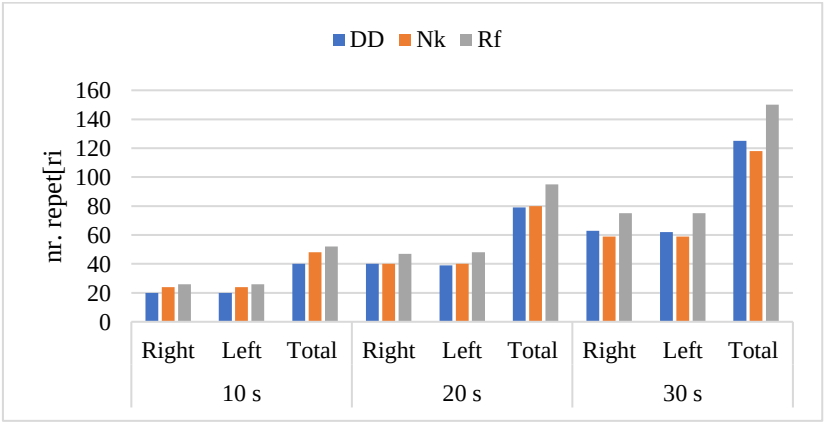

Fig. 3. Dynamics of individual performance in test 3

Analysis of descriptive statistical indicators: the mean number of punches reveals a significant performance, with an average of 46.67 punches at 10 seconds, 84.67 at 20 seconds and 131.00 at 30 seconds. The confidence intervals for the means provide an estimate of the precision of the results. For example, at 10 seconds, the actual

number of punches lies between 31.49 and 61.84, indicating variability in individual performances.

The statistical analysis regarding the Chi-Square test (Chi-Square) resulted in a value of 24.75 with a p-value of 0.00171, indicating a very high statistical significance ($p < 0.05$). This suggests the existence of significant differences between the performances of the boxers, depending on the type of equipment used and the execution time.

The results of the study, reflected in Tables 1, 2, and 3, indicate that young boxers demonstrate varying performance levels based on the equipment used during direct punches. In Table 1, the use of a 2 kg ball led to a lower total number of punches, with an average of 66.67 repetitions in 30 seconds. This demonstrates that the extra weight of the ball may limit the frequency of punches executed, possibly due to increased fatigue or reduced mobility.

In contrast, Table 2 illustrates a significant improvement in performance when boxers used punching bags, achieving an average total of 127.67 punches in the same time interval. This finding is consistent with the study by Chaabène et al. (2015), which highlights the importance of physical qualities and conditioning in boxing performance. The increase in the number of punches can be attributed to the design of the gloves, which allows for better technique application and increased stability during punches, as underlined by Bushati et al. (2021).

The best performance metrics were observed in Table 3, where boxers used competition gloves, reaching an average total of 131 punches. This result supports not only the biomechanical advantages described by Stanley et al. (2018) but also the development of specific skills and adaptations that arise from training with lighter and more aerodynamic equipment. As boxers become more skilled in using the gloves, their technical efficiency improves, leading to an increase in the number of punches.

Overall, the statistical significance of the results (p-values < 0.05 in all comparisons) reinforces the conclusion that equipment plays a crucial role in optimizing performance. The distinct differences in the number of punches based on various conditions emphasize the need for tailored training programs that take into consideration the specific equipment used, as suggested by the specialized literature. This study highlights the importance of incorporating diverse training modalities to enhance the physical and technical skills of young boxers, thus contributing to the improvement of their competitive performance.

4. Conclusions

In conclusion, the data suggest that young boxers exhibit a good level of performance in direct punch exercises, demonstrating greater efficiency when using punching bag gloves compared to a 2 kg ball. Moreover, they achieved a significantly higher number of direct punches with competition gloves, indicating not only a better adaptation to the specific equipment but also improvements in technical skills and

physical conditioning. This highlights the importance of specific training for optimizing performance in the ring.

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BIOMECHANICAL ANALYSIS OF THE BALANCE BEAM ELEMENTS IN YOUNG GYMNASTS

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Abstract

The aim of this study is to biomechanically analyze the acrobatic elements performed on the balance beam by a 10-year-old gymnast, a national vice-champion. Our study identifies the key components of technique, the angular velocity of body segments and the postural control strategies. All these help to demonstrate that a well-developed balancing technique, combined with optimal angular velocity, significantly contributes to improving the performance of young gymnasts. There were used the method of motion postural cues and the Physics ToolKit program for biomechanical video analysis. The biomechanical analysis of the acrobatic elements on balance beam highlights the importance of precise methods for evaluating the range of motion of body segments, thereby contributing to a better understanding of movement dynamics and optimizing gymnastics performance. The results of the analysis show that, during the execution of the Tick-tock and back handspring elements on the balance beam, the angular velocity of the segments, particularly at the back foot and front foot, is essential for ensuring effective rotation and optimal trunk lift, thus improving execution technique. In conclusion, the biomechanical analysis of balance and acrobatic elements on the balance beam is fundamental for enhancing the performance of gymnasts, as the angular velocity and coordination of body segments significantly influence the technical execution. Adapting balance strategies according to the difficulty of the exercises and the height of the beam, along with effective feedback, is very important for developing acrobatic skills in young gymnasts and preventing injuries.

Key words: *biomechanics, acrobatic elements, angular velocity, balancing technique, postural control*

1. Introduction

The biomechanical analysis of balance beam elements in young gymnasts provides valuable insights into the motor mechanisms and balance strategies that contribute to performance in gymnastics. The balance beam is one of the most demanding apparatuses in gymnastics, combining flexibility, strength, coordination and balance control on a narrow surface of only 10 cm. In the case of young gymnasts, where factors such as neuromuscular development and balance are still in progress, understanding how they control their bodies on the beam can help optimize training and prevent injuries (Nyman, 2020; Farana et al., 2023; Small & Neptune, 2024).

Dynamic balance is particularly important in performing acrobatic and artistic

elements on the balance beam, as gymnasts must maintain stability during both slow and explosive movements. Due to the unique challenges it poses, the biomechanical analysis of these movements allows for the identification of the muscular, joint and postural mechanisms involved in maintaining balance and executing complex elements with precision (Manning, 2014; Cabrejas et al., 2023; Leite et al., 2023; Schärer et al., 2023).

Balance on the beam depends on the complex interaction between external and internal forces acting on the gymnasts' bodies. From a biomechanical perspective, stability on the beam is maintained by constantly adjusting the center of mass in relation to the support surface. Specifically, gymnasts must control their center of gravity using lower body stabilization strategies, as well as fine adjustments of the trunk and upper limbs to prevent loss of balance (Prassas, Kwon & Sands, 2006; Bradshaw & Hume, 2012; Hume, Bradshaw & Brueggemann, 2013; Nyman, 2020).

The biomechanical analysis of balance on the beam highlights the influence of the apparatus height on balancing strategies. So, young gymnasts adopt different methods of postural control depending on the movements difficulty, focusing more on visual and kinesthetic feedback as the complexity of the exercise increases (Mitchell, Davis & Lopez, 2002; Kochanowicz et al., 2017; Busquets et al., 2021).

This biomechanical analysis reveals the importance of well-planned physical and technical training for developing dynamic balance and postural control. Specific training on balance beam should include proprioception, strength and coordination exercises to improve the ability of gymnasts to manage external forces and control their center of mass in motion.

2. Material and method

This study aims at analyzing biomechanically the acrobatic elements performed on the balance beam by young gymnasts (10 years old). The study specifically focuses on identifying the key components of the technique, the angular velocity of body segments and the postural control strategies.

The hypothesis of this study is that a detailed analysis of the movements and forces involved in performing acrobatic elements on the balance beam can demonstrate that a well-developed balancing technique, combined with optimal angular velocity of body segments, significantly contributes to the performance improvement of young gymnasts.

The study involved a 10-year-old gymnast, the national runner-up on this apparatus, from the Municipal Sports Club Arad, artistic gymnastics section.

The biomechanical analysis was conducted using the method of motion postural cues (Boloban & Potop, 2014) and the Physics ToolKit software for video biomechanical analysis.

3. Results and Discussions

For the analysis of acrobatic elements on the balance beam, it was necessary to automatically calculate the segmental radius required for the biomechanical study.

The calculation results are presented in Table 1. The biomechanical video analysis was conducted using the Physics ToolKit program, with 30 frames per second. In this regard, each technical element was segmented and analyzed as follows.

Table 1. *Radius of segmental motion in the analysis of acrobatic elements on beam*

Element symbol	Toes (m)		Shoulders (m)	Hand (m)
	L.Front	L.Back		
B_tic	0.662	0.71	0.342	0.736
B_flic	0.601	0.616	0.312	0.634
B_rost	0.64	0.642	0.318	0.699
B_cob	0.512	0.559	0.300	0.535
B_cob-aj	0.603	0.591	0.296	0.522

Notes: Weight – 24.8 kg, Standing reach – 1.65 m, Inertia of rotation IR – 7.94 kg·m^2

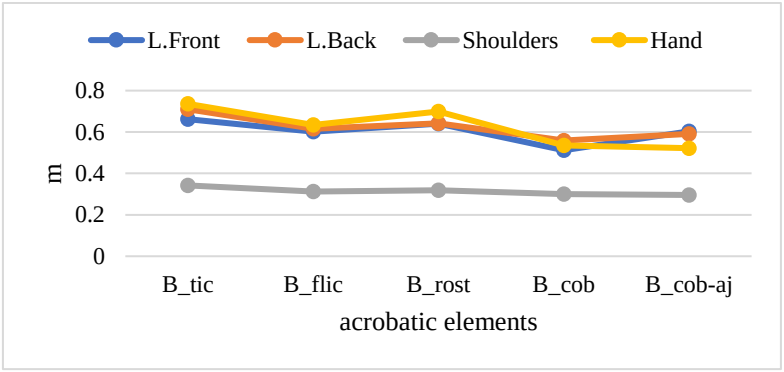


Figure 1. *Radius of segmental motion of acrobatic elements on beam*

The biomechanical analysis of acrobatic elements, such as those on the balance beam, requires precise methods and tools to reduce errors, such as parallax, during video analysis (Stephens et al., 2019), while also incorporating key biomechanical principles for understanding movement patterns and segmental radii (Potop et al., 2014; Potop et al., 2019). The use of advanced techniques and software tools, like those addressed by Robertson et al. (2013) and Stergiou (2020), ensures accurate assessment of dynamic postural control and sports technique development, essential for optimizing performance and preventing injuries.

Given the specific nature of translation movements with rotation around the center of gravity axis (hip) on the beam, Figure 1 presents the movement radius of body segments for the following elements: tick-tock and back handspring on one leg – analyzed separately, backward roll in tuck position with opening in a handstand, dismount from a round-off with back layout salto, with and without assistance, and artistic jumps, considered linear movements. This figure reflects the principles of human biomechanics and motion, as discussed by Azeez et al. (2012) and Herman & Herman (2016), highlighting the importance of understanding these dynamics for effective performance analysis and training optimization.

PP P1 P2 P3 P4 P5 PF

A. Tick-tock

PF P5 P4 P3 P2 P1 PP

B. Flick-flack on one leg

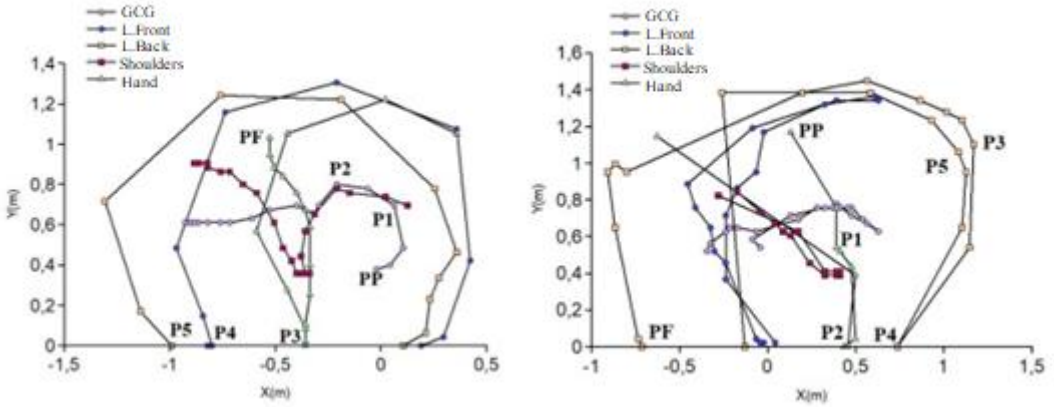
Fig. 2. *Tick-tock connected with one-leg flick-flack on balance beam – presentation of the technique key components*

Phasic structure of the key components:

1. Tick-tock – with 1-sec. marking for each of the following phases (fig. 2 & 3 A):
PP (t -0.00 sec) – launching posture – forward lunge with body alignment;
P1 (t – 0.067 sec) - standing on one leg slightly bent with body alignment in horizontal plane (planche) – Part I;
P2 (t – 0.2 sec) – back leg swing (LBack), front leg push (LFront) and support on arms (B.);
P3 (t- 0.- 0.367 sec) - transition through split (180°) into handstand – moment 1;
P4 (t – 0.5 sec) – support on back leg while front leg is maintained vertically;
P5 (t – 0.6 sec) - transition through split (180°) into handstand – moment 2;
PF (t – 0.767 sec) – transition into concluding posture (PF) on both feet – launching posture for flick.

2. One-leg back flick-flack– on beam (from connection), (fig. 2 & 3 B):
PP (t – 0.033 sec) **–** starting posture, vertical torso, arms up, from PF of tick-tock
P1 (t – 0.1 sec) – position of takeoff from the beam, torso in extension, arms up;
P2 (t – 0.133 sec) – maximum height of the GCG – flight phase;

P3 (t – 0.233 sec) – Support on balance beam in handstand split;
P4 (t – 0.333 sec) – Support on front leg, pushing the arms;
P5 (t – 0.467 sec) – Support on back leg; torso lifting;
PF (t – 0.667 sec) – Concluding posture



B. One-leg flick-flack ⟵ A. Tick-tock ⟶

Fig. 3. *Acrobatic connection tick-tock and one-leg flick-flack*

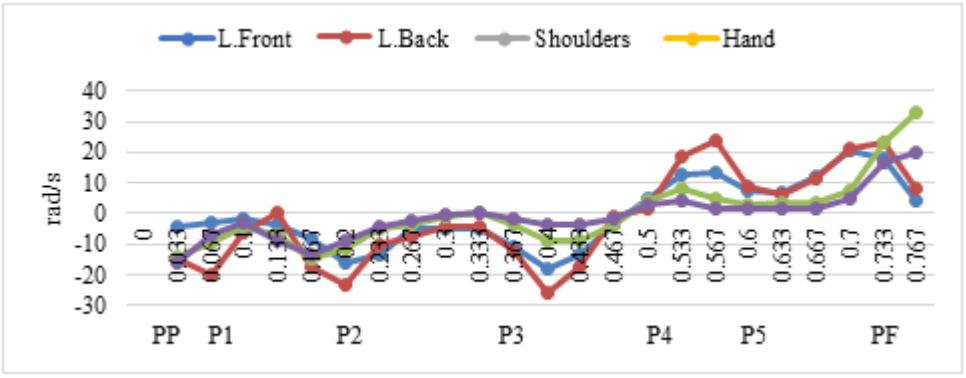


Fig. 4. *Results of angular velocity of segments in tick-tock*

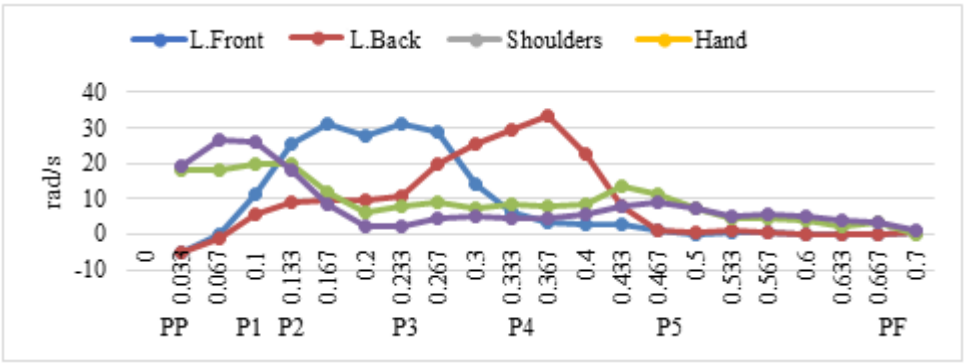


Fig. 1. *Results of segments angular velocity in one-leg flick-flack from connection*

Figures 4 and 5 present the results of the angular velocity of segments (front leg, back leg, shoulders and hands), highlighting the key moments of execution technique in the tick-tock and back handspring (flick-flack) on one leg on the beam. The analysis of the data shows that, during the tick-tock, higher values are observed at the back foot, ensuring the rotation of the body in one-legged support and return to the front foot position. Regarding the back handspring, a greater angular velocity is pointed out at the front foot in the first part of the handspring. This also facilitates the push for the rotation, followed by the back foot, leading to the torso raising into the concluding posture through optimal velocities of all segments.

These findings underscore the critical importance of angular velocity in executing acrobatic elements on the balance beam, as highlighted in various studies, including Potop et al. (2022), who explored the biomechanical characteristics in junior gymnasts aged 9-10 years, and Potop et al. (2013), who focused on gymnasts aged 12-14 years. Additionally, Kołaczkowski & Sayah, (2015) conducted a comparative study that examined kinematic aspects relevant to the back handspring. Other research, such as Potop et al. (2014), provided insights into the key biomechanical characteristics involved in dismounting off the beam. Besides, Potop et al. (2015) dealt with the topic of the implementation of e-learning in specific didactics for women's artistic gymnastics, further contributing to the understanding of training methodologies in this sport.

4. Conclusions

The biomechanical analysis of acrobatic elements and balance on the beam is essential for understanding the motor mechanisms and stabilization strategies of gymnasts, thus contributing to performance optimization and injury prevention.

The angular velocity of body segments plays a crucial role in the execution of acrobatic techniques. The optimal coordination between different body parts is necessary for successfully performing elements such as the tick-tock and back handspring(flick-flack), highlighting the need for specialized training.

Young gymnasts must adapt their balancing strategies according to the difficulty of the exercises and the height of the beam, which underscores the importance of visual and kinesthetic feedback in the learning process and the development of acrobatic skills.

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THE SOMATIC CHARACTERISTICS OF JUNIOR FENCERS

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Abstract

The aim of this study was to evaluate the somatic characteristics of junior female fencers from the national team of Romania in the foil event and to determine the correlations between the relevant somatic parameters such as height, weight, muscle mass and mobility, and the sports performance. In this regard, anthropometric tests and statistical analyses conducted with the KyPlot software were used in order to provide recommendations for optimizing training and physical preparation. The study highlighted that, among junior female fencers, somatic parameters such as an average height of 168.4 cm, a bust circumference of 90.3 cm, an arm span of 167.2 cm and a body weight of 61.04 kg, along with a healthy body mass index (BMI) of 21.5 kg/m² and variable mobility (coefficient of variation of 28.9%), significantly influence sports performance. Also, a relatively homogeneous active muscle mass (coefficient of variation of 10.6%) contributes to the stability and efficiency in specific fencing movements. Junior female fencers demonstrate a balanced somatic profile, characterized by moderate weight, appropriate height, and well-developed active muscle strength, while the low coefficient of variation for most parameters indicates somatic homogeneity and a similar level of preparation. However, the greater variability observed in muscle mass and body mass index suggests different stages of biological development, aspects that align with the specific requirements of fencing, where speed, strength and mobility are essential.

Key words: *female fencers, somatic characteristics, sports performance, muscle mass, training sessions*

1. Introduction

The somatic characteristics of young athletes have a significant impact on their performance in competitive sports, including fencing, being influenced by factors such as height, weight, body proportions and body composition (Carter & Heath, 1990). In fencing, reaction speed and agility are vital, and these ones largely depend on muscle mass and its distribution across body segments (Błach, 2020; Ntai et al., 2017). Studies show that fencers with optimized body composition achieve better performance due to the balance between muscular strength and the necessary mobility (Heymsfield et al., 2007; Heymsfield, 2005). Additionally, lower limbs power and agility are correlated with grip strength in various specific positions in fencing (Sarvaiya & Puntambekar, 2022). Reaction time can have significant variations between novice and experienced fencers (Milic et al., 2020).

Research highlighted that junior fencers exhibit a distinct somatic profile compared to athletes in other combat disciplines, such as judo or Greco-Roman wrestling. Height and weight play a crucial role for those who manage to combine a low center of gravity with increased mobility and advanced technique (McArdle, Katch & Katch, 2015). Furthermore, the techniques used in unrestricted combat sports may differ considerably due to specific biomechanical requirements (Downey,

2015). Loss of muscle and bone mass, a phenomenon studied in extreme contexts such as space flights, can affect athletes' performance in combat sports (Thornton & Bonato, 2017). In addition, the use of suspension training has been investigated as a method to improve physical condition and mobility, providing advantages for fencers and other athletes (Monje Morales, 2018).

Growth and development during adolescence vary considerably among individuals, influencing sports performance. Differences in levels of muscular development and motor coordination can directly affect success in competitions. A study conducted by Jagiello et al. (2021) emphasized that, among junior fencers, body mass index (BMI) and body fat percentage affect both movement speed and endurance in prolonged matches. Williams and Walmsley (2000) also highlighted the importance of muscular coordination and reaction time in differentiating between elite and novice fencers, underscoring the impact of these skills on performance. Moreover, studies by Roi and Bianchedi (2008) demonstrated that a scientific approach to fencing has important implications for injury prevention and performance improvement. Turner et al. (2014) added that the determinants of Olympic performance in fencing, such as strength and physical conditioning, are critical for the success of elite athletes, suggesting specific training strategies.

The somatic characteristics of young fencers have a substantial influence on technical execution, reaction time and stability in specific movements such as attack and retreat, providing biomechanical advantages in competition. Fong (2014) points out that these characteristics are fundamental not only for athletic performance but also for health. Cereda (2024) highlights movement as a central element of physical engagement and understanding in sports, while Pavel (2024) reveals the importance of individual lessons in improving the technical and tactical skills of fencers. These perspectives suggest that somatic analysis is not only beneficial for competition but also for the holistic development of athletes.

To conclude, an interdisciplinary approach that combines the study of somatic characteristics with physical and technical training is highly important for the development of junior fencers. This allows for optimal adaptation of training programs, considering individual somatic particularities (Bompa & Haff, 2019). This interdisciplinary approach, combining biomechanical analysis and specific exercise adaptation, not only maximizes the potential of athletes but also supports their balanced physical development.

2. Material and method

This study intends to evaluate and analyze the somatic characteristics of junior female fencers to determine their impact on performance in fencing competitions. The aim is to identify relevant somatic parameters such as height, weight, muscle mass and mobility, and to assess the correlations between these factors and athletic performance, in order to provide recommendations for optimizing training and physical preparation for young female fencers.

The research was organized within the national junior fencing team of Romania, specifically in the foil section, following a program established and approved by the management of the Romanian Fencing Federation and the Romanian Olympic Committee. It is noteworthy that we personally attended and participated in several activities (training sessions, training camps and competitions) conducted with the foil fencers, receiving support from the technical training team and the Romanian Fencing Federation as well.

The anthropometric testing aimed to evaluate the following indices: height (cm), bust (cm), arm span (cm), mobility (cm), actual weight (kg), optimal weight (kg), BMI (kg/m²), active mass (kg, %). The statistical analysis was performed by means of the KyPlot program, using descriptive indices: mean, SD, Cv%, min, max and CLM(0.95).

3. Results and Discussions

The detailed evaluation of somatic indices in junior female fencers is essential for ensuring balanced development and achieving optimal sports performance. In this regard, the team of athletes underwent regular medical check-ups at the National Institute of Sports Medicine in Bucharest. The data are presented in Table 1.

Table 1. Results of somatic indices in junior female fencers

Parameters	mean	SD	Cv%	min	max	CLM(0.95)
Height (cm)	168.4	6.73	3.99	154.9	181.9	4.28
Bust (cm)	90.3	3.52	3.90	82.8	97.5	2.24
Anv. (cm)	167.2	6.78	4.05	156	181	4.31
MBL (cm)	16.5	4.77	28.9	10	25	3.03
GR.act (kg)	61.04	9.26	15.2	52.9	87	5.88
IMC (kg/m^2)	21.5	2.91	13.5	18.5	28.9	1.85
MA (kg)	51.4	5.44	10.6	46.6	65.8	3.45
D. BIA (cm)	37.4	1.49	3.98	35.5	41.5	0.89
D. BITR (cm)	30.8	1.36	4.41	29.5	34.5	0.82
PTR (cm)	84.4	4.94	5.86	79	99	2.98

Note. Anv – arm span; MBL – mobility; GR act –active weight; MA –active muscle mass; PTR – thoracic perimeter; CLM - Confidence Level of Mean (0.95)

1.Height: the average height value (168.4 cm) indicates that the studied junior fencers have a moderate height, consistent with general standards for girls in this age group, being nearly average compared to other combat sports (Raphael & Davis, 2018). The relatively low coefficient of variation (3.99%) reveals a high homogeneity of this parameter within the group. In the specialized literature, the height of junior fencers is correlated with the advantage of a longer reach in duels, which can provide benefits in both defense and attack.

2.Bust: the average bust circumference value of 90.3 cm shows a physical build suitable for an athlete, with a low coefficient of variation, reflecting a relatively

homogeneous group in this regard. This is an important component in assessing overall body structure. A well-developed bust is crucial for supporting respiratory function and strength, especially in sports that involve rapid trunk movements, such as fencing (Watkins, 2010).

3.Arm span (Anv.): the arm span of 167.2 cm is very close to the height, which corresponds to general observations in combat sports. A moderate coefficient of variation proves that there are some individual differences among athletes, but these are not very pronounced. Arm span is essential in fencing, significantly impacting on the ability to reach the opponent quickly.

4.Mobility (MBL): the high coefficient of variation (28.9%) indicates a very high variability of muscle mass among the fencers, which may suggest different stages of muscle development and physical maturation. This parameter is important for performance in fencing, as muscle mass has a strong influence on maintaining strength and speed of movement. The literature emphasizes the importance of optimal muscle mass for speed and strength sports, such as fencing, especially during rapid exchanges of attack and defense (McArdle, Katch & Katch, 2015).

5.Body weight (GR. act): the body weight value (61.04 kg) is moderate, but the relatively high coefficient of variation (15.2%) highlights considerable variations among participants. This variation may be explained by individual differences in body composition, including the proportion of muscle mass and body fat. According to Jagiello et al. (2021), optimal weight in athletes is directly linked to performance, and a balance between weight and muscle power is essential for the explosive movements characteristic of fencing.

6.Body Mass Index (BMI): the average BMI (21.5 kg/m²) proves a healthy and balanced body composition, aligning with the norms for young athletes. However, the coefficient of variation (13.5%) suggests moderate differences in body composition, which may reflect varying degrees of physical development. An optimal BMI is important for performance, and values within normal limits are essential to prevent joint overload and reduce the risk of injuries (Watkins, 2010).

7.Active muscle mass (MA): the low coefficient of variation (10.6%) reveals relative homogeneity in muscle mass among the athletes.

8.Arm and trunk parameters: D. BIA and D. BITR (biacromial and bitrochanteric dimensions) highlights average dimensions and small variations, being relevant for body balance. *PTR (chest circumference)* reflects adequate chest development, necessary to support endurance and resistance efforts in fencing.

The analysis of somatic characteristics among athletes is essential for understanding performance in fencing, and recent studies suggest that the structure of movements, such as the lunge, varies significantly between elite fencers and beginners (Balkó, Balkó & Süss, 2021). Additionally, the personalities of players can influence strategic approaches in competition, a topic that has been analyzed in detail in the research of Piepiora (2020). Also, the use of bioelectrical impedance analysis to assess athletes' body composition provides valuable insights that can enhance training and recovery programs (Gligoroska, Manchevska & Todorovska,

2017). These perspectives highlight the importance of an interdisciplinary approach in optimizing the performance of athletes.

Body composition also plays a crucial role in injury prevention. Young athletes who maintain a balance between muscle mass and flexibility are less prone to muscular or joint injuries (Watkins, 2010). This analysis of somatic characteristics becomes decisive not only for improving performance but also for ensuring the healthy physical development of young athletes. For instance, Sutton and Stewart (2012) deal with the impact of body composition on health and performance in sports and physical exercise. Also, a study by Martins et al. (2022) highlighted the variations in body composition between injured and uninjured professional football players, revealing the importance of this aspect in managing injury risks. Furthermore, Overmoyer and Reiser (2015) identified relationships between lower limb flexibility, asymmetries and Y balance test results, suggesting that adequate flexibility may contribute to reducing injury risks.

In conclusion, optimized somatic characteristics, combined with refined technique and well-developed physical condition, are fundamental for excelling in junior fencing.

4. Conclusions

Junior fencers exhibit a balanced somatic profile, characterized by moderate weight, tall stature and well-developed active muscle strength. Average values of the coefficient of variation for most parameters indicate a homogeneous group in terms of somatic characteristics, highlighting a similar level of training. However, the greater variability in muscle mass and BMI may reflect different stages of biological development. These somatic parameters align with the specific athletic requirements of fencing, where speed, strength and mobility are essential.

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PHYSICAL TRAINING IN SWORDSMANSHIP, WITH 10–11-YEAR-OLD CHILDREN

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Abstract

This research aims to evaluate the relationship between anthropometric indices and physical performance in young athletes aged 9 to 10 who practice fencing. A group of 12 athletes from the "Stesial" Sports Club Association in Bucharest participated in this research. The study included measuring anthropometric indices such as height, weight, arm span and foot length, as well as assessing physical training through long jump tests and striking exercises. Statistical analysis was conducted using the KyPlot software, applying descriptive indices and the Pearson linear correlation analysis to examine the relationship between the studied variables. The results suggest a variable correlation between anthropometric indices and physical performance, highlighting the need for personalized training programs to optimize the development of young fencers. The analysis of anthropometric indices in 9-10-year-old fencers revealed a consistent average height but a significant variation in weight, proving that weight may influence physical performance. The varied distribution of arm span and foot length emphasizes the impact of these dimensions on the skills required in fencing. The assessment of physical training showed moderate variation in performance in lunges, greater consistency in lunge hits and significant variability in straight hits. All these underscores the necessity of systematic evaluation of physical skills to adapt training to the individual needs of athletes. The Pearson correlation analysis revealed that, although height and weight do not show a significant correlation with physical performance, arm span and foot length negatively influence performance, particularly in Test 3, thus suggesting the need to adapt training to address these varied relationships. The review of the initial hypothesis confirmed that athletes with favorable anthropometric indices did not demonstrate high physical fitness. The correlations observed between weight, arm span and physical performance are weak or negative, indicating that other factors may influence performance.

Key words: *anthropometric indices, physical performance, fencing, correlation, training*

1. Introduction

Physical training in fencing for children aged 9 to 10 represents an important opportunity to develop fundamental motor skills, specific physical conditioning and essential psychological characteristics for this sport. This age group corresponds to the "late childhood" stage, when children undergo accelerated development both physically and mentally. According to Malina (2004), during this stage, the pace of growth and maturation is significant, directly impacting the athletic potential of children. In this context, it is crucial to implement a training program that meets the specific needs of growing children, emphasizing the balance between physical development and the enhancement of motivation and enjoyment in practicing the

sport.

At the age of 9-10 years, children exhibit an increased capacity to develop complex motor skills, including coordination, agility and reaction time, all of which are essential in fencing. According to Malina and his colleagues (2008), during this stage of development, children are capable of refining their movements and mastering advanced sports techniques through activities involving repetition and structured training. Fencing is a sport that requires quick movement, coordination and tactics. Therefore, it is ideal for stimulating these fundamental motor skills.

Physical conditioning should focus on the overall development of muscular endurance, flexibility and aerobic capacity, which play a central role in fencing performance. Research by Lloyd and Oliver (2012) shows that exercises involving multiple muscle groups and specific movements can help build a solid foundation for further strength development. At this age, strength training should be performed using light weights or bodyweight exercises, avoiding overload in order to prevent injuries (Behm et al., 2008). Additionally, studies by Behringer and colleagues (2010) suggest that strength training can be beneficial for growing children and adolescents, contributing to healthy muscle mass development.

In addition to physical development, fencing training should also promote psychological qualities such as discipline, concentration and quick decision-making. In combat sports like fencing, the ability to anticipate the opponent's movements and react quickly is essential. According to Weinberg and Gould (2023), developing these cognitive and psychological skills at a young age contributes to creating better-prepared athletes mentally, capable of handling competition pressure in the long term. Gill, Williams and Reifsteck (2017) emphasize that a training environment that fosters mental development can also support intrinsic motivation and long-term commitment to the sport.

Physical training in fencing for children of 9-10 years old must be adapted to their motor, physical and psychological development needs. Implementing a varied training program that includes coordination exercises, muscular endurance and mental skill development will provide a solid foundation for their future athletic progression. At the same time, it is important that the training sessions are enjoyable and motivating in order to maintain the interest and joy of these children in practicing fencing.

2. Material and method

The purpose of the research is to evaluate the relations between anthropometric indices and physical performance in young athletes aged 9 to 10 who practice fencing.

The research hypothesis is that a significant correlation between anthropometric indices and physical performance of the athletes can be found out. In this regard, it is assumed that athletes with favorable anthropometric indices (such as greater height and arm span) will exhibit superior physical performance in tests such as the long jump and striking exercises compared to those with less favorable indices. It is also

anticipated that the correlation analysis will reveal specific patterns in the relationship between these variables, thereby suggesting directions for optimizing training programs for young fencers.

The study was conducted at the "Stesial" Sports Club Association in Bucharest in March 2024, with a sample of 12 athletes aged 9 to 10 years who have been practicing fencing for approximately 2 or 3 years. Among the athletes, Tufiș Eva stands out, having won 1st place at the Under-9 National Championship, and Dinas Sofia, who placed 3rd at the Under-12 competition in Sofia, Bulgaria.

The sample consists of 10 girls and 2 boys, out of which 10 right-handed athletes and 2 left-handed. The following anthropometric indices were measured during the study: Height (cm), Weight (kg), Arm Span (cm) and Foot Length (cm).

Additionally, to assess physical training, the following tests were administered: Test 1 - Standing long jump (cm); Test 2 - Lunges in 60 seconds (number of repetitions), Lunge hit in 60 seconds (number of repetitions); Test 3 - Straight hit in 60 seconds (number of repetitions).

Statistical analysis was performed using KyPlot software, applying descriptive indices such as mean, standard deviation (SD), coefficient of variation (Cv%), CLM - Confidence Level of Mean (0.95), LCLM - Lower Confidence Limit of Mean, UCLM - Upper Confidence Limit of Mean.

Moreover, a Pearson linear correlation analysis was conducted to evaluate the relationships between the anthropometric indices and the physical performance of the athletes. These statistical indices provided a solid foundation for a detailed analysis of the correlations between the anthropometric characteristics and physical abilities of the participants.

3. Results and Discussions

The results of the research, presented in Tables 1 and 2 and in Figure 1, highlight relevant anthropometric indices, the physical performance of athletes aged 9-10 years and significant correlations between these variables, thus providing a solid foundation for improving training strategies in fencing for young athletes.

Table 1. *Results of anthropometric indices in 9-10-year-old fencers (n=12)*

Indices	mean	±SD	Cv%	CLM(0.95)	LCLM	UCLM
Height (cm)	145.5	9.08	6.24	5.77	139.7	151.3
Weight (kg)	36.9	7.33	19.86	4.66	32.25	41.57
Anv. (cm)	143.7	10.1	7.04	6.42	137.24	150.09
LTP (cm)	21.3	2.33	10.91	1.48	19.85	22.81

Notes: LTP –foot length; Anv. – arms span; CLM - Confidence Level of Mean (0.95), LCLM - Lower Confidence Limit of Mean, UCLM - Upper Confidence Limit of Mean

The analysis of anthropometric indices in 9-10-year-old fencers (n=12) shows an average height of 145.5 cm, with a standard deviation of 9.08 cm, indicating a relatively small variation (Cv% of 6.24) and a confidence interval (CLM) of 139.7

cm - 151.3 cm. The average weight of the athletes is 36.9 kg, with a greater variation (Cv% of 19.86), pointing out significant differences among the athletes, while the confidence interval is 32.25 kg - 41.57 kg. The average arm span is 143.7 cm, with a standard deviation of 10.1 cm and a coefficient of variation of 7.04, revealing a more uniform distribution. In contrast, the average foot length (FL) is 21.3 cm, with a standard deviation of 2.33 cm and a coefficient of variation of 10.91%. This shows a correlation between anthropometric dimensions and the physical abilities necessary in fencing, suggesting possible directions for personalizing the athletes' training.

Table 2. *Results of physical training indices in 9-10-year-old fencers (n=12)*

Indices	mean	±SD	Cv%	CLM(0.95)	LCLM	UCLM
Test 1	35.92	7.27	20.2	4.62	31.29	40.53
Test 2	39.3	6.21	15.79	3.95	35.38	43.28
Test 3	53.00	12.67	23.9	8.05	44.94	61.05

Notes: Test 1 - Lunges in 60 seconds (number of reps); Test 2 - Lunge hit in 60 seconds (number of reps); Test 3 - Straight hit in 60 seconds (number of reps); LCLM - Lower Confidence Limit of Mean, UCLM - Upper Confidence Limit of Mean

The results obtained for the physical training indices in 9-10-year-old fencers, presented in Table 2, show an average of 35.92 repetitions for Lunges in 60 seconds (Test 1), with a standard deviation of 7.27 and a coefficient of variation of 20.2%, highlighting moderate variation in performance. For the Lunge hit in 60 seconds (Test 2), the average is 39.3 repetitions, with a standard deviation of 6.21 and a coefficient of variation of 15.79%, indicating more consistent performance among the athletes. Regarding the Straight hit in 60 seconds (Test 3), the average is 53.00 repetitions, with a standard deviation of 12.67 and a coefficient of variation of 23.9%, suggesting greater variability in the performance of athletes. These data underline the importance of systematic evaluation of physical abilities in order to adapt training according to the individual needs of young fencers.

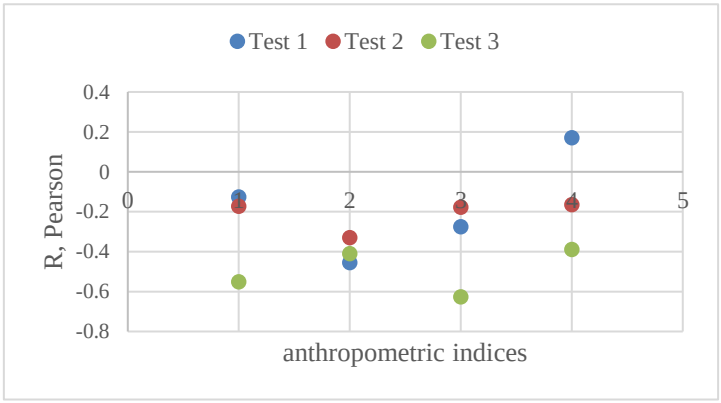

Fig. 1. *Correlation analysis between anthropometric indices and physical training in 9-10-year-old fencers*

The results of the Pearson correlation analysis between anthropometric indices and performance in physical training tests, presented in Table 3, underscore various relationships. Height and weight do not appear to have a significant correlation with

physical performance; the correlation coefficients range from -0.126 to -0.454 for weight in Test 1 and -0.172 for height in Test 2. However, arm span (Anv.) and foot length (FL) show a more pronounced negative correlation in Test 3, with a coefficient of -0.627* for Anv., suggesting that a greater arm span may be associated with poorer physical performance in this specific test. These results demonstrate that anthropometric factors may differentially influence the performance of athletes. Therefore, adaptations in training may be necessary to address these correlations.

The analysis of anthropometric indices, such as height and weight, is essential for evaluating the physical development of young fencers, as highlighted by Pavel et al. (2020), who emphasize the impact of these measurements on the technical-tactical performance of athletes aged 10 to 12 years. Additionally, studies conducted by Kriventsova et al. (2021) and Khokhla & Linetz (2013) reveal that a positive correlation between arm span and performance abilities can provide valuable insights for coaches in adapting training programs.

The correlational analysis between anthropometric indices and the physical performance of young fencers suggests that there is a significant relationship between physical development and technical skills, as shown by Weinberg and Gould (2023), who focus on the impact of psychological capabilities on sports performance. The studies conducted by Lebedev et al. (2017) address the influence of training tasks on psycho-physiological indicators, revealing the importance of adapting these tasks to maximize training efficiency in children.

4. Conclusions

The analysis of anthropometric indices in 9-10-year-old fencers highlights the importance of physical development in young athletes. The constant average height and the significant variation in weight suggest influences on physical performance. Additionally, the varied distribution of arm span and foot length underscores the impact of these dimensions on the skills necessary in fencing. The results emphasize the need for personalized training to optimize the physical and technical preparation of athletes.

The results concerning the physical training of 9-10-year-old fencers show a moderate variation in performance in lunges, greater consistency in the lunge hit, and significant variability in the straight hit, pointing out the necessity for systematic evaluation of physical abilities to adapt training to the individual needs of athletes.

The Pearson correlation analysis reveals that, while height and weight do not show a significant correlation with physical performance, arm span and foot length negatively influence performance, especially in Test 3. This fact reveals the need to adapt training to address these varied relationships.

Analyzing the results, it is found that the hypothesis that athletes with favorable anthropometric indices (such as greater height and arm span) should have superior physical performance is not supported by the data obtained. The correlations between weight, arm span and physical performance are weak or negative, suggesting that other factors may influence the performance of athletes. Therefore, the hypothesis

requires a revision, indicating that the relationship between anthropometric indices and physical performance is likely more complex than initially anticipated, and training programs should be adapted to reflect these varied correlations.

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CALCIUM AS AN INFORMATIVE MARKER FOR ASSESSING THE COMPENSATORY BODY REACTIONS OF ATHLETES IN MIXED MARTIAL ARTS

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Abstract. *The study purpose*. Determination of the peculiarities of changes in the level of calcium in the blood serum of athletes of the striking style of fighting in mixed martial arts in response to the load in different training modes. *Materials and methods.* The research involved 75 sportsmen of a striking style of fighting in mixed martial arts aged 19±0.7 years. Three research groups were formed. Study participants used experimental modes of training loads for 3 months. The biochemical analysis of the blood of sportsmen was carried out at the beginning and the end of the research in a state of rest and after a training load. Nonparametric methods of mathematical statistics were used. *Results*. The research showed that in the third group of sportsmen who used the type C mode of training loads of (R_a=0,74), the concentration of calcium in blood serum in response to a physical stimulus did not change. However, in sportsmen of the first and second groups the studied biochemical index of blood in response to power loads, that are supplied with energy supply due to the anaerobic-glycolytic mechanism of ATP resynthesis, increased on average by 2.3% ($p<0.05$) in comparison with a state of rest. *Conclusions*. Підвищення рівня концентрації кальцію в сироватці крові відбувається у спортсменів тих груп, які використовують в процесі силової підготовки анаеробно-гліколітичний механізм енергозабезпечення м'язової діяльності не залежно від варіації компонентів навантаження. The increase in the level of calcium concentration in the blood serum occurred in athletes of those groups who used an anaerobic-glycolytic mechanism of energy supply of muscle activity in the process of strength training, regardless of the variation of load components.

Key words: *mixed martial arts, load regimen, calcium concentration.*

1. Introduction.

The search for effective methods of assessing the adaptation and compensatory reactions of athletes to a physical stimulus in mixed martial arts is one of the controversial issues discussed by scientists (Antoniettô et al., 2022; Chernozub et al., 2022; Shtefiuk et al., 2024). One of the informative criteria for assessing the body's compensatory reactions during exercise is changes in the level of biochemical marker calcium, which is actively involved in the work of various enzymes and affects the rate of nerve impulse transmission during muscle contraction (Liu et al., 2022; Tota & Wiecha et al., 2022). This blood biochemical indicator is not only the most abundant macronutrient in the human body but also a clear criterion for assessing the development of metabolic acidosis during high-intensity or high-volume physical activity under conditions of the anaerobic-glycolytic mechanism of energy supply of motor activity (Folhes et al., 2023). It is known that in the conditions of metabolic acidosis (accumulation of energy decomposition products

and decreased cellular pH), the calcium concentration in the blood serum increases, which is caused by a decrease in the ability of albumin to bind to calcium (Tota & Wiecha et al., 2022).

Thus, studying the nature of changes in the level of calcium in the blood serum of athletes of the examined groups in the conditions of using the proposed modes of training loads in the process of special strength training will allow us to determine the nature of adaptation and compensatory reactions to a stressful stimulus. The training modes differ significantly from each other in their structure, parameters of components, and especially mechanisms of energy supply.

*The study purpose***.** To define features of changes in calcium level in the blood serum of sportsmen of the striking fighting style in mixed martial arts in response to load in different training modes.

2. Material and method

The research involved 75 sportsmen of a striking fighting style in mixed martial arts (MMA) aged 19±0.7 years. Three research groups were formed. Sportsmen of the 1st group used type A training mode (R_a=0.56). Representatives of the 2nd group 2 followed type B training mode (R_a=0.67). During this research, group 3 participants used type C training mode (R_a=0.74). Biochemical analysis of athletes' blood was carried out at the beginning and the end of the study in a state of rest and after training load. The concentration of calcium in blood was determined by the photometric method on the spectrophotometer StatFax 4700 from reagents Liquick Cor-PHOSPHORUS (Poland). Statistical analysis of the study results was performed using the IBM *SPSS*Statistics 26 software package (StatSoftInc., USA).

3. Results and Discussions

Table 1 presents three experimental modes of training loads developed for the examined sportsmen of the striking fighting style in MMA and used in the process of special strength training during twelve weeks. For the development of these modes, the method of quantitative estimation of a level of physical loading in power sports was used. The most popular power fitness variations of load component combinations and values of their parameters were also used depending on the direction of power training (Chernozub et al., 2018).

The study showed that at the beginning of the research, the basal level of calcium in the blood serum of sportsmen of the third group was 8.5% ($p<0.05$) higher in comparison with the results of the first group athletes. The obtained results of the research at this stage demonstrated that the controlled biochemical index of blood in sportsmen of the first group was 5.1% ($p<0.05$) lower in comparison with the level of calcium concentration in the blood serum of the second group.

Table 1 *Training load modes developed for study participants to use in the process of special power training in MMA*

Training load modes	Features of training load modes
Type A (R_a=0.56)	Low-intensity and high-volume workloads are used. Anaerobic-glycolytic mode of energy supply for muscle activity. Full range of motion with fixation at the peak point during the concentric phase. The duration of repetition is 4 s (the concentric phase of movement is 1 s; the eccentric phase is 2 s; fixation at the peak point is 1 s). 11-13 repetitions are performed in a set. The work duration in a set is 44-52 s. Rest between sets lasts 70-75 s. The projectile working mass is 56-59% of 1RM.
Type B (R_a=0.67)	Loads of average intensity and work volume are used. Anaerobic-glycolytic mode of energy supply for muscle activity. Full range of motion without fixation at the peak point. The duration of repetition is 5-6 s (the concentric phase of the movement is 2 s; the eccentric phase is 3-4 s). 7-9 repetitions should be performed in a set. The duration of work in each set is 42-54 s. Rest between sets lasts 55 s. The projectile working mass is 66-69% of 1RM.
Type C (R_a=0.74)	Loads of high-intensity and small work amounts are used. The anaerobic-alactate mode of energy supply for muscle activity is used. Partial (90%) amplitude of movement without fixation at the peak point. The duration of repetition is 8-9 s (the concentric phase of movement is 8-9 s; the eccentric phase is 5-6 s). 3-4 repetitions are performed in each set. The maximum duration of work in a set is 27-35 s. Rest between sets lasts 40-45 s. The projectile working mass is 73-76% of 1RM.

The analysis of the laboratory research results after training loads at the beginning of the research testify that the level of calcium in the blood serum of the third group sportsmen did not change significantly. However, in sportsmen of the first group who used the mode of training loads of type A (R_a=0.56), the concentration of calcium in blood serum increased in response to a given physical stimulus by 6.3% ($p<0.05$). A similar character of changes of the studied index was found in representatives of the second group where it scaled by 5.2% ($p<0.05$) in response to power loads using the training mode of type B (R_a=0.67).

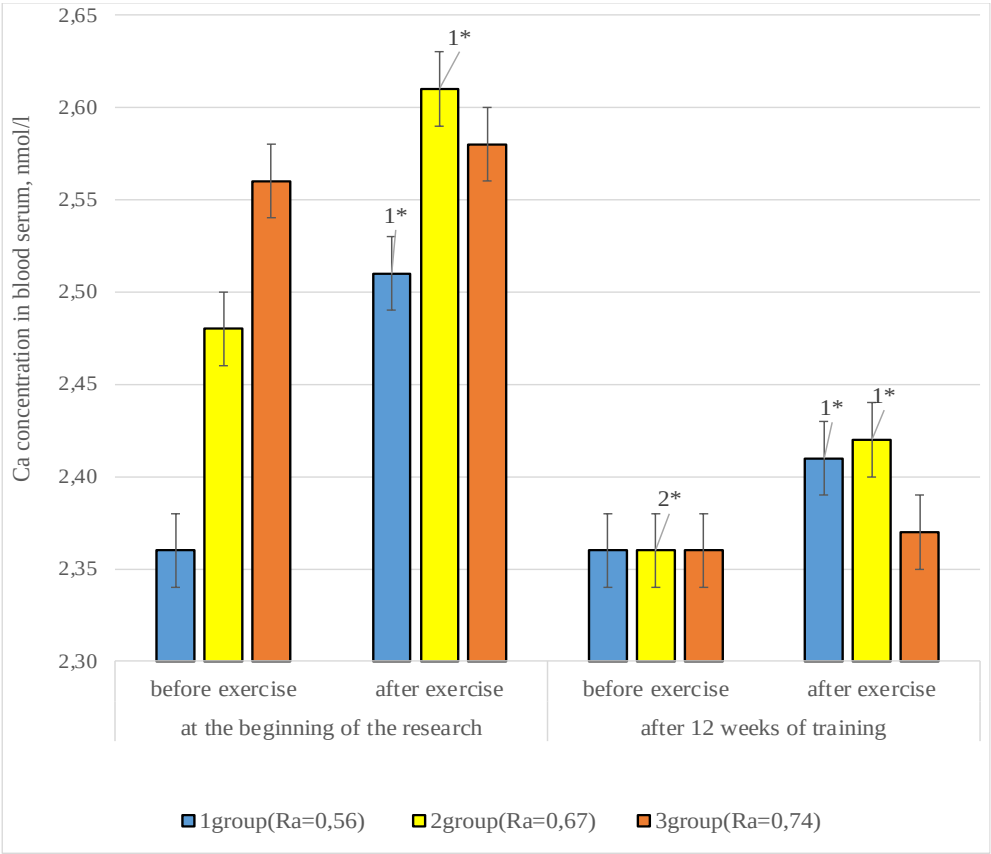

Figure 1. Results of changes in calcium concentration in the blood serum of athletes of the examined groups during 12 weeks of training under conditions of different power load regimes, n=75

*Notes: 1 – p<0.05, compared to the indicators before exercise; 2 – p<0.05, compared to the indicators before the study; * – p<0.05*

In sportsmen of the first and second groups, there was a growth in the parameters of the studied biochemical index of blood on average by 2.3% (p<0.05) in comparison with the state of rest. The observed increase was a response to power loads supplied with energy due to the anaerobic-glycolytic mechanism of ATP resynthesis.

Investigating the peculiarities of dynamics in the basal level of calcium concentration in the blood serum of sportsmen we noted different tendencies in changes of this biochemical indicator. Thus, the first group of sportsmen had no changes in the parameters of the basal level of calcium in the blood. The results of the second group of sportsmen decreased by 4.8% (p<0.05) during the research compared with the basal level of calcium in blood serum. The same dynamics of the researched biochemical index of blood were observed in sportsmen of the third group for a similar period, but it had a more pronounced character – by 7.8% (p<0.05). However, attention should be paid to the fact that representatives of the second and

third groups used completely different training modes which had contrasting structures and indicators of load. Moreover, significantly different energy supply mechanisms were used to ensure intense muscular activity.

4. Conclusions

The increase in the level of calcium concentration in the blood serum occurred in those groups where sportsmen used an anaerobic-glycolytic mechanism of energy supply of muscular activity in the process of strength training, regardless of the variation of load components.

The obtained results indicate a possible increase in adaptive glycogen reserves in working muscles, an increase in the level of body resistance to a similar level of the physical stimulus, or optimization by saving the anaerobic-glycolytic mechanism of energy supply of muscle activity.

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GENDER-SPECIFIC CONSIDERATIONS IN FORMULATING TRAINING AND COMPETITION REGIMENS FOR ELITE FEMALE ATHLETES: INSIGHTS FROM LITERATURE ANALYSIS AND EXPERT OPINION

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Abstract

This study aimed to identify gender-specific considerations crucial for devising training and competition load plans for elite female athletes in sports games. Utilizing bibliometric analysis and expert surveys involving 20 sports scientists and coaches, insights were gathered from leading nations in sports science. Findings highlight the impact of menstrual cycle variations on performance, injury risks, strength training principles, and psychological factors. Integrating these considerations can optimize the performance and well-being of female athletes. Notably, challenges in women's sports, such as outdated training systems and inadequate gender-specific support, were identified across certain countries.

Keywords: *gender-specific; elite female athletes; gender characteristics; special physical preparation.*

1. Introduction

Numerous scientific investigations worldwide are dedicated to women's sports, covering psychological readiness, menstrual cycle correlations, anthropological traits, hormonal influences on performance, and motor skill development (Abe et al., 2003; Borysova et al., 2020; Emmonds et al., 2019; Michelekaki et al., 2023; Shakhlina, 2021). However, the integration of these findings into elite female sports practice appears to be incomplete, as evidenced by a discrepancy between existing literature and expert opinions. A notable gap exists in sports science and medicine research focusing on elite female athletes, posing challenges in developing evidence-informed practices tailored to their needs.

Applying research findings derived from male athletes to female athletes may be inadequate due to distinct biological differences, emphasizing the necessity for gender-specific approaches. Gender-specific psychophysiological disparities, including attention, mobility, and balance function, are evident between elite male and female athletes, highlighting the importance of tailored training methods. Fluctuations in female sex hormones throughout the menstrual cycle can significantly impact various aspects of athletic performance, necessitating personalized training and nutrition strategies. Insufficient research explores the influence of gender-specific psychosocial stressors on the mental health of elite female athletes, indicating a need for further investigation in this area. The extant

literature may not comprehensively address the nuanced challenges encountered by elite female athletes in practice. This underscores the significance of targeted research aimed at incorporating gender-specific factors into the planning of training and competition loads (Nagorna et al., 2023).

The purpose of the study was to delineate gender-specific considerations pertinent to the formulation of training and competition regimens for elite female athletes within contemporary sports, drawing upon extant literature and insights garnered from an expert survey conducted across leading nations in sports science.

2. Material and methods

Bibliometric methodologies were employed to collate seminal publications in sports sciences, leveraging databases including Scopus, the Clarivate Analytics Web of Science Core Collection, Google Scholar, Webometrics, and Perplexity. Expert inquiry and assessment techniques were utilized to ascertain prevailing challenges encountered in women's elite sports. A cohort of 20 experts, comprising sports scientists and national team coaches with demonstrable experience in elite female athlete management, was selected from a pool of 160 respondents. Analysis of experts' narratives provided nuanced insights into the status of women's sports across diverse countries and sporting disciplines, facilitating the identification of overarching issues pertinent to the planning of training and competition regimes for female athletes. Mathematical and statistical analyses were conducted using the computational and graphical capabilities of "Statistica" (Statsoft, version 7.0) and Microsoft Excel 2010 software packages.

3. Results and Discussions

Based on the retrieved search results, several key gender-specific considerations emerge regarding the planning of training and competition loads tailored for elite female athletes in modern sports (Emmonds et al., 2019; Meignié et al., 2021; Michelekaki et al., 2023; Shakhlina, 2021).

Menstrual Cycle Impacts: Research underscores the influence of fluctuations in female sex hormones throughout the menstrual cycle on athletic performance, mood regulation, and sleep patterns in female athletes. Variations in factors such as metabolism and muscle activation across the menstrual cycle necessitate personalized approaches to training and nutrition.

Injury Risk and Prevention: Studies reveal elevated rates of specific injuries, such as ACL tears, among female athletes compared to their male counterparts, attributable to factors such as ligamentous laxity, biomechanical alignment, and hormonal fluctuations. Implementing targeted injury prevention programs addressing these gender-specific risk factors is imperative for safeguarding the well-being of female athletes.

Strength and Conditioning: Strength training protocols designed for female athletes should align with established principles applicable to male athletes, emphasizing exercises that engage multiple muscle groups, joints, and high-intensity

workouts. Considerations regarding the female athlete triad, encompassing energy availability, menstrual function, and bone health, assume significance in crafting effective training regimens.

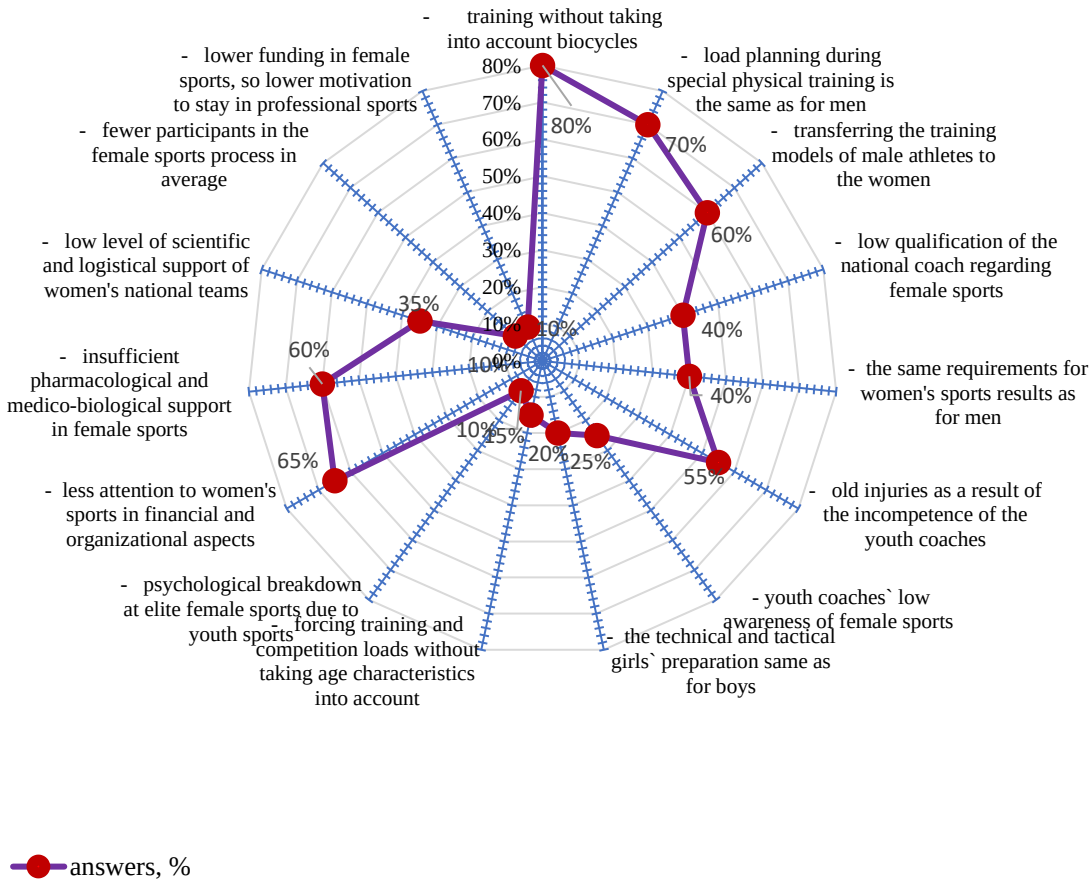

Figure 1. *The analysis of the experts' analytical notes about the problems of modern sports training of elite athletes takes into account the peculiarities of sexual dimorphism (n=20).*

Psychological and Physiological Factors: Gender-specific considerations, including the impact of the menstrual cycle on performance, mood, and sleep patterns, necessitate interventions encompassing education, support, and tailored strategies. Discrepancies in stress hormone responses and other physiological

variables between male and female athletes can inform the optimization of training and competition strategies.

By integrating these gender-specific considerations into the formulation of training and competition regimens, coaches and sports scientists can enhance the performance, health, and overall well-being of elite female athletes in contemporary sports.

A content analysis of literature-derived data facilitated the identification of leading countries in sports science specificate in gender questions, including America, Canada, England, Switzerland, Norway, China, South Africa, Ukraine, and Poland. An expert group comprising 20 officials and national team coaches from these nations identified several primary challenges in female sports, depicted in Figure 1: outdated training systems disregarding biological cycles - 80%, residual injuries or illnesses stemming from inadequate coaching practices - 55%, the inappropriate transference of male-centric training models to female athletes - 60%, insufficient pharmacological and medico-biological support during training, competitions, and recovery - 60%, uniform load planning for special physical training irrespective of gender - 70%, and relatively diminished financial and organizational attention towards women's sports - 65% (Nagorna et al., 2023).

4. Conclusions

The retrieved search results underscore significant gender-specific considerations in formulating training and competition load plans tailored to elite female athletes in modern sports. These considerations encompass the impact of menstrual cycle fluctuations on athletic performance, the heightened risk of specific injuries, the importance of aligning strength training protocols with established principles while addressing the female athlete triad, and the necessity for interventions targeting psychological and physiological factors. Integration of these considerations into coaching and scientific practices holds promise for enhancing the performance, health, and overall well-being of elite female athletes. Furthermore, a content analysis identified leading countries in sports science, with Ukraine emerging as a notable contributor. Challenges identified by experts underscore the need to address outdated training systems, injury prevention, inappropriate transference of male-centric models, inadequate socio-economic support, and insufficient attention to women's sports.

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THE IMPACT OF VARIOUS TRAINING METHODS ON REACTIVE AGILITY IN YOUTH SOCCER PLAYERS: A SYSTEMATIC REVIEW

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Abstract

This systematic review evaluates training interventions aimed at enhancing reactive agility in youth soccer players. A comprehensive search was conducted in the Web of Science database, complemented by a thorough review of relevant literature. The study included experimental research focusing on healthy children aged 6 to 19 years, published in English from 2000 to 2023. After rigorous screening, 8 studies were included in the final analysis. Key findings indicate that specialized interventions, such as isoinertial training, plyometrics, neuromuscular exercises, change of direction (COD) drills, Speedcourt sessions, video-based visual training, and small-sided games (SSG) drills, significantly improve reactive agility compared to regular football training. While the results are promising, limitations such as participant heterogeneity, varying protocols, and measurement tools must be considered. The review suggests that coaches should employ a diversified training approach tailored to individual needs, and sports organizations should integrate these evidence-based protocols to enhance performance. Future research should focus on large-scale, controlled trials with standardized measures to further validate these findings and optimize training strategies for young athletes.

Keywords: *agility, soccer, youth, training*

1. Introduction

Successful performance in team sports, such as soccer, requires change-of-direction ability, but also well-developed perceptual and decision-making skills that are evidenced by superior anticipatory motor performance"(Pojskić et al., 2018). Agility, or reactive agility as mentioned in almost all studies means "a rapid whole-body movement with a change of velocity or direction in response to a stimulus" (Sheppard & Young, 2006).

Undoubtedly, reactive agility holds significant value in soccer. Nevertheless, experts are yet to arrive at a unanimous decision regarding the optimal approaches to ameliorate this proficiency in young athletes. (R. Lloyd & Oliver, 2012; R. S. Lloyd et al., 2013; Paul et al., 2016; Thieschäfer & Büsch, 2022). Although a previous scoping review with aim of mapping of the body of literature about agility in youth, suggests that agility is trainable in youth, albeit with various underlying mechanism (Thieschäfer & Büsch, 2022).

This study aims to discover the interventions with significant improvement for agility in youth soccer players. The objective of this systematic review is to (i) identify, synthesize, and appraise primary research on training methods for

developing reactive agility in youth soccer players, (ii) evaluate the effectiveness of various interventions in enhancing reactive agility, (iii) provide practical recommendations for practitioners and coaches, (iv) identify research gaps to guide future studies.

2. Methods

The review and analysis were driven in accordance with the Guidelines for Performing Systematic Reviews in Sports Science (Rico-González et al., 2022), in conjuction with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyzes) guidelines (Page et al., 2021).

Eligibility criteria

This systematic review will focus on healthy children (female or male) aged 6 to 19 years actively engaged in soccer. It will include experimental studies examining training programs aimed at enhancing reactive agility in youth soccer players. Studies published in English from 2000 to 2023 will be considered.

Exclusion criteria

Ineligible studies for this systematic review include those focusing on populations outside the specified age range of 6 to 19 years, studies involving unhealthy or inactive children, and those lacking outcomes related to reactive agility in youth soccer players. Additionally, studies with interventions other than training methods (e.g., caffeine supplements) or involving participants practicing another sport, as well as studies not employing experimental designs or randomized controlled trials, will be excluded.

Information sources

Access to one database, Web of Science (accessed on 12.21.2023), was used to comprehensively retrieve relevant studies for this systematic review. Additionally, a thorough examination of the review "Development and Trainability of Agility in Youth" by Thieschäfer and Büsch (2022) was conducted to identify potential sources, ensuring comprehensive retrieval of relevant literature.

Search strategy

In the Web of Science database the search query was structured as follows: (soccer OR football) AND (agility OR reactive OR unplanned) AND (youth OR young* OR prepubert* OR pubert* OR adolescent*). The search was restricted to articles from sport science category and documents published in English.

Selection process

All identified studies were imported into Rayyan (a web and mobile app for systematic reviews) for screening. In the initial step, the software automatically removed duplicate records. Subsequently, two independent reviewers (N.I. and I.M) conducted the title and abstract screening. Any discrepancies were resolved through discussion and consensus. The final step involved a meticulous assessment of full-

text articles, with a third reviewer (M.I.) adjudicating any unresolved disagreements to reach a consensus.

Data collection process

In the data collection process, information from each report was meticulously gathered by N.I. and another reviewer. Working independently, they resolved any disagreements through consensus discussions. A structured template was used to systematically capture key information, including author names, publication year, participant characteristics, intervention details, periodization of interventions, specified outcomes, and results. For studies where the effect size was not provided, it was derived using the Hedges' g formula based on pre-post intervention results and sample size.

Study risk of bias assessment

The quality and risk of bias in each study were assessed using the PEDro scale (Physiotherapy Evidence Database), comprises 11 items assessing the methodological quality of randomized controlled trials in physiotherapy, covering aspects such as randomization, blinding, and the completeness of outcome data (Maher et al., 2003).

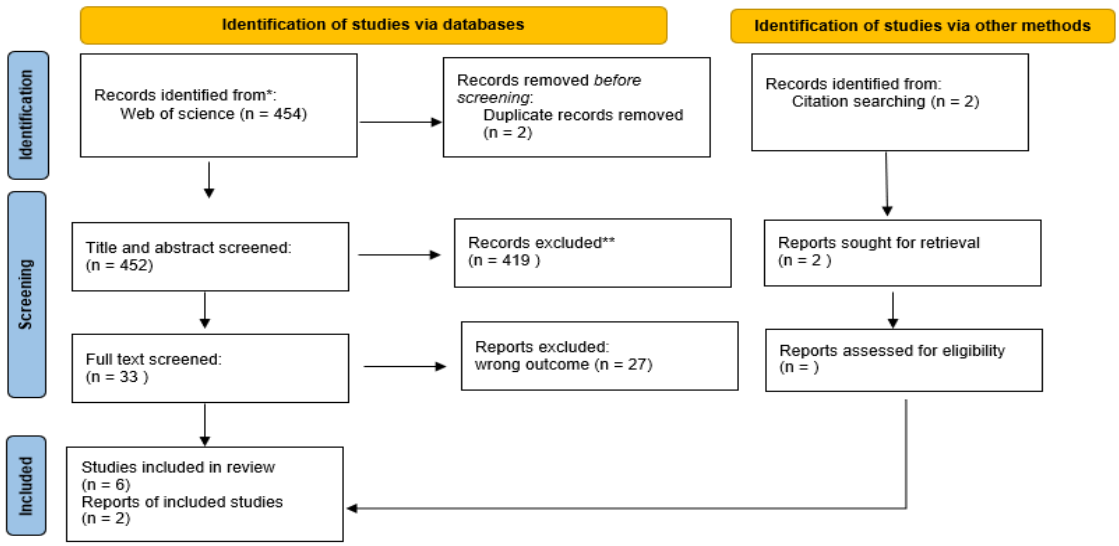

Figure 1. *PRISMA Flow Chart*

3. Results and discussion

The initial search yielded 454 results. After removing 2 duplicates, 452 studies remained. Title and abstract screening excluded 419 studies. Full-text assessment included 33 articles, of which 6 remained. Additionally, 2 studies were identified from references in other systematic reviews and included (see Figure 1).

Table 1 succinctly delineates targeted group details, intervention specifics, and, if available, the periodization of the intervention along with the corresponding effects.

Table 1. *Studies characteristics*

Study	Group/N	Characteristics	Training Intervention	Outcome
(Fiorilli et al., 2020)	FEOG = 18 M	13.21 ± 1.21 yo, 51.25 ± 6.71 kg, 1.65 ± 0.10 m, 3-4 ye, 4 s/w	Isoinertial training (Flywheel), 6 weeks, 2 days/week, 4x7 reps, 120-180s rest	Y-shaped Test, ES = 1.793
	PTG = 16 M	13.36 ± 0.80 yo, 52.10 ± 5.23 kg, 1.68 ± 0.07 m, 3-4 ye, 4 s/w	Plyometric training, 6 weeks, 2 days/week, 3-4x7-10 reps, 72h rest	Y-agility Test, ES = 0.57
(Zouhal et al., 2019)	NTG = 10 M	17.7 ± 0.4 yo, 69.1 ± 7.6 kg, 178.0 ± 8.7 cm, 5-6 s/w	Neuromuscular training, 6 weeks, 2 days/week, 30 min/session	(Zouhal et al., 2018) test, ES = 0.897 (slower), ES = 0.968 (faster)
	CG = 10 M	16.8 ± 0.7 yo, 66.6 ± 9.7 kg, 179.5 ± 7.8 cm, 5-6 s/w	Regular football training	(Zouhal et al., 2018) test, ES = 0.424 (slower), ES = 0.559 (faster)
Trecroci et al. (2016)	EG = 20 NM	10.5 ± 0.30 yo, 37.94 ± 6.00 kg, 1.42 ± 0.05 m, 3.50 ± 0.66 ye	SAQ training, 12 weeks, 2 days/week, 25 min/session	Y-shaped Test, ES = 0.8
	CG = 19 NM	10.7 ± 0.21 yo, 35.24 ± 3.98 kg, 1.42 ± 0.06 m, 3.41 ± 0.55 ye	Soccer-specific drills, 12 weeks, 2 days/week	Y-shaped Test, ES = 0.2
Chaalali et al. (2016)	CODG = 11 M	14.5 ± 0.9 yo, 56.4 ± 7.1 kg, 171.2 ± 5.1 cm, ≥ 4 ye, 5 s/w	COD training, 6 weeks, 2 days/week, 20-25 min/session	RAT test, ES = 1.09
	AG = 11 M	14.5 ± 0.9 yo, 56.4 ± 7.1 kg, 171.2 ± 5.1 cm, ≥ 4 ye, 5 s/w	Agility training, 6 weeks, 2 days/week, 20-25 min/session	RAT test, ES = 2.28
	CG = 10 M	14.5 ± 0.9 yo, 56.4 ± 7.1 kg, 171.2 ± 5.1 cm, ≥ 4 ye, 5 s/w	Regular football training	RAT test, ES = 0.40
Born et al. (2016)	RSmultiG = NM, M	14 ± 0.6 yo, 59 ± 12 kg, 1.74 ± 0.08 m	Speedcourt training, 3 weeks, 2 days/week	Speedcourt test, ES = 1.03
	RSSG = NM, M	14 ± 0.6 yo, 59 ± 12 kg, 1.74 ± 0.08 m	COD training, 3 weeks, 2 days/week	Speedcourt test, ES = 0.28
Nimmerichter et al. (2015)	VISG = 18 M	14.4 ± 0.4 yo, 61.8 ± 8.3 kg, 171.2 ± 7.2 cm, 3–5 ye, 7–10 h/w	Video-based visual training, 6 weeks, 2 days/week	RAT test, ES = 1.15
	CG = 16 M	14.4 ± 0.5 yo, 59.7 ± 8.1 kg, 169.5 ± 7.8 cm, 3–5 ye, 7–10 h/w	Regular football training	RAT test, ES = 0.36

Study	Group/N	Characteristics	Training Intervention	Outcome
Chaouachi et al. (2014)	SSGG = 12 M	14.2 ± 0.9 yo, 54.1 ± 6.3 kg, 167.2 ± 5.7 cm, 3-4 ms	SSG drills, 6 weeks, 3 days/week	RAT test, ES = 0.487
	CODG = 12 M	14.2 ± 0.9 yo, 54.1 ± 6.3 kg, 167.2 ± 5.7 cm, 3-4 ms	COD, 6 weeks, 3 days/week	RAT test, ES = 0.358
	CG = 12 M	14.2 ± 0.9 yo, 54.1 ± 6.3 kg, 167.2 ± 5.7 cm, 3-4 ms	Regular football training	RAT test, ES = 0.223
(Oberacker et al., 2012)	USTG = 9 F	19.0 ± 0.5 yo, 1.69 ± 6.4 m, 67.8 ± 7.7 kg	Unstable surface resistance, 5 weeks, 3 sessions/week	20-m shuttle test, ES = 1.13
	STG = 10 F	19.6 ± 0.5 yo, 1.64 ± 0.32 m, 62.7 ± 6.3 kg	Stable surface resistance, 5 weeks, 3 sessions/week	20-m shuttle test, ES = 1.21

Note: N, number of subjects; RAT, reactive agility test; FEOG, flywheel eccentric overload group; PTG,Plyometric Training group ;M, male; F, female; yo, years old; kg, kilograms; m. meteres; ye, years experience; s/w, session per week; W, week; ES, effect size; s, seconds; NTG, neuromuscular training group; cm, centimeters; EG, experiment group; NM, not mentioned; BMI, body mass index; mo, maturity offset; min, minutes; w:r, work rest ratio; SAQ, speed, agility and quicness; no, numers; CG, control group; COD, change of direction; CODG, change of direction group; wb, with ball; nb, not ball; AG, agility group; RsmultiG, reactive COD group; RSSG, planed COD group; VIS, video-based visual training group; h/w, hours per week; *ES, calculated from authors; SSGG, small sided games group; ms, maturation stage;

Table 2. *PEDro Scale assesment of included studies*

Author/items	1	2	3	4	5	6	7	8	9	10	11	score
Fiorilli et al. (2020)	Y	Y	N	Y	N	N	N	N	Y	Y	Y	5
Zouhal et al. (2019)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Trecroci et al. (2016)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Chaalali et al. (2016)	Y	Y	N	Y	N	N	N	N	Y	Y	Y	5
Born et al. (2016)	Y	N	N	Y	N	N	N	N	Y	Y	Y	3
Nimmerichter et al. (2015)	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5
Chaouachi et al. (2014)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Oberacker et al. (2012)	Y	N	N	Y	N	N	N	N	Y	Y	Y	4

Risk of bias in studies

No articles were excluded based on the obtained scores. Given the nature of football training and sample selection methods, concealment of allocation and blinding of subjects and trainers were deemed impractical, leading to their non-applicability in this study (Bujalance-Moreno et al., 2019) (see Table 2).

Strength-Based Interventions: Isoinertial training demonstrated a high effect size in enhancing reactive agility (Fiorilli et al. 2016). In another study by Oberacker et al. (2012), significant improvements were observed with both unstable (training

on BOSU® Balance Trainer) and stable surfaces, with stable surface training showing a slightly higher effect size.

Plyometric, Agility, and Speed Training: Plyometric training showed a moderate effect size in improving reactive agility (Fiorilli et al. 2016). An intervention program combining agility, stability, and plyometric exercises also showed significant improvements in agility (Zouhal et al., 2019). Additionally SAQ training demonstrated significant improvements in reactive agility (Trecroci et al. 2016). Both the COD and agility groups showed improvements in reactive agility tests, with the agility group demonstrating greater enhancements (Chaalali et al. 2016b). Another program involving multi-COD movements in response to a visual stimulus on the Speedcourt demonstrated superior reactive agility (D. P. Born et al. 2016).

Skill-Based and Cognitive Training: Skill-based interventions such as SSG drills exhibited significant improvements in reactive agility tests (Chaouachi et al. 2014). Video-based visual training also positively influenced agility in adolescent football players (Nimmerichter et al. 2015).

Comparison with Regular Training: Regular football training generally registered lower effect sizes compared to specialized training interventions in improving reactive agility in youth soccer players Zouhal et al., (2019), Trecroci et al. (2016), Chaalali et al. (2016), Nimmerichter et al. (2015), Chaouachi et al. (2014).

The results of this systematic review focused on youth soccer players align with another systematic review focused on youth athletes, supporting the notion that targeted interventions can significantly enhance reactive agility (Thieschäfer & Büsch, 2022).

While the reviewed studies offer valuable insights, certain limitations must be acknowledged. The heterogeneity in participant characteristics (age, sex, skill level) affects generalizability. Variations in intervention duration, intensity, and frequency complicate comparisons, and different tools for measuring reactive agility introduce potential bias. The systematic search strategy may have missed relevant studies due to terminology variations or publication bias, and excluding non-English studies could introduce language bias. Focusing primarily on peer-reviewed articles may neglect insights from gray literature or unpublished studies. Future research should address these limitations with large-scale, well-controlled studies featuring diverse participants and standardized outcome measures.

The practical implications are significant. Coaches should use a diversified training approach, including neuromuscular exercises, plyometrics, COD drills, Speedcourt sessions, video-based visual training, SSG drills, and resistance training on unstable surfaces. Tailoring interventions to individual needs, positions, and skill levels is crucial for optimizing outcomes. Sports organizations should consider

implementing these evidence-based protocols to enhance reactive agility and improve on-field performance, emphasizing agility training for long-term benefits.

4. Conclusions

This systematic review demonstrates that specialized training interventions, such as isoinertial training, plyometrics, neuromuscular exercises, COD drills, Speedcourt sessions, video-based visual training, and SSG drills, significantly enhance reactive agility in youth soccer players.

However, limitations such as participant heterogeneity, varying intervention protocols, and measurement tools must be acknowledged. Future research should involve large-scale, controlled trials with diverse participants and standardized measures to address these issues. Coaches should adopt a diversified approach tailored to individual player needs, and sports organizations should integrate these evidence-based protocols into their training programs to enhance performance and long-term agility development.

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Physical Therapy and Recovery

CONTRIBUTIONS OF MELOTHERAPY AND DEVICES "EMCOPAD DOCTOR TECH" PASSIVE RESONANTS IN THE PREVENTION AND TREATMENT OF OCCUPATIONAL MANAGERIAL STRESS

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Abstract
Occupational stress is defined as a major concern for employees, organizations and society.
The present study demonstrates that occupational risk factors cause a decrease in the mental and physical health of employees; the study was carried out on a number of 40 subjects, to whom the following tests were applied: "Management Indicator of Socio-professional Pressures" (I.M.P); "Occupational stress indicator" (O.S.I) and "Belov characterization test" (T.C.B.). At the same time, an attempt was made to analyse and combat the emotional implications of stress, which lead to the appearance of the "Burnout Syndrome". We considered it necessary to highlight the existence of significant relationships between stressors and effects and we managed to really exemplify individual differences and the effects of occupational stress at the managerial level.
Considering that occupational stress factors negatively or positively influence the mental health, physical health and energy level of the individual at work, we considered it beneficial to reduce/disappear the effects of occupational stress through the original use of "EmcoPad Dr. Tech" pulsed electromagnetic devices and melotherapy. The paper aims to highlight - as a novelty in research - the emotional implications of stress as well as their connection with the concept of burnout. The study demonstrates the direct action between burnout and stress, between burnout and professional exhaustion, between burnout and anxiety/depression, between burnout and fatigue/episode. The pulsed electromagnetic devices "EmcoPad Doctor Tech (www.DoctorTech.ro)"/(Passive resonant devices WIPO-PCT 01 March 2018 WO 2018/037379 A1) and melotherapy, come to the support of these patients by reducing/disappearing stress, by reducing the implications emotional to stress, through energy release and determines a good management of managerial stress in the professional activity of the individual.

Key words: *occupational stress, stress, self-image, personality, behaviour, pulsed resonant electromagnetic devices EMCOPAD Doctor Tech, melotherapy, the concept of burnout*

1. Introduction

Importance of the problem

Cf. Medical Dictionary, Stress (Eng. = constraint, force, request) – Anglo-Saxon term denoting any aggression from the environment or any state of tension created by the environment and against which the body defends itself through adaptive reactions of overloading the hypothalamus axis pituitary-adrenal.

Stress seriously affects the health of individuals due to accumulated fears, conflicts, worries of all kinds that lead to the internal disharmony of the human body.

Thus, a stressful state is created, and involved in its appearance in the set of individual reactions. Capotescu (2006, p. 20) demonstrates that "organizational characteristics (organizational size, hierarchical structure, job descriptions) can lead to stressors. According to the Michigan model, role conflict, role ambiguity and work load occur. Later, these stressors can lead to stress reactions which are nothing but the affective-emotional physiological responses or the behaviours of the individual (example: high blood pressure, low food satisfaction and even absenteeism).

The amount of stress experienced by an employee is directly influenced by the person's perceptions of the demands in the environment and their perceptions of their own abilities to cope with stressors/acceptance or denial (Heil, 1993).

Siegrist together with his team developed in 1996 the model of the imbalance between effort and reward by which "the relationship of balance or imbalance between effort and reward is postulated, generating the appearance of the state of bliss, satisfaction, eustress, or maybe generative states. of discomfort, distress (Zlate, 2007, p. 584).

The model is based on the principle of reciprocity: a high effort in work combined with low rewards leads to a state of emotional distress and physiological activation (activation of the sympathetic nervous system), which will certainly lead to a predisposition to cardiovascular risk.

The effort was divided into two large categories: extrinsic effort (job attributes: a) responsibility, b) time pressure, c) physical demands) and intrinsic effort (over-involvement).

Over-involvement or overload is perceived as a specific personal coping pattern, considering the demands of the job and the evaluation of rewards.

Manifestations of occupational stress are observed through the stressful behaviours of employees, through a decrease to a decrease in work productivity, through difficulties in adapting to the changes that are related to the workplace.

The duality of the manifestations of occupational stress can be found at the level of the stressed person, as well as at the level of the organization where the existence of a stressful climate is perceived.

Our study

Our study primarily aims to highlight occupational stress at the managerial level, by detecting the presence or absence of stress at work, as well as its effects on the human body.

Through this study we sought to demonstrate that occupational risk factors cause a decline in mental and physical health. At the same time, we followed the emotional implications of stress through the occurrence of burnout.

Given that occupational stress factors negatively or positively influence the mental health, physical health and energy level of the individual at work, we considered it beneficial to use Emcopad Dr. Tech (www.DoctorTech.ro) pulsed electromagnetic devices, melotherapy(*or therapy through music*), techniques of self-regulation and mental training, to reduce/disappear the effects of occupational stress.

Thus, using music, we found that it has effects on the patients' psyche regarding the expression of emotions and non-verbal feelings, noting the installation of relaxation as well as the development and improvement of some motor skills.

Hypothesis of our study

Recuperative therapy through the effects of Emcopad Dr. Tech pulsed electromagnetic devices, melotherapy, self-regulation techniques and mental training, contributes to the reduction/disappearance of the effects of occupational stress, to better communication between the therapist and the patient, but also between the employer and employee, and not least to the reduction/disappearance of burnout. The research hypotheses were confirmed by the obtained results. The research hypotheses were confirmed by the obtained results

Purpose of our work

The work aims to follow, as a research novelty, the effects of Emcopad Dr. Tech pulsed electromagnetic devices (QiPolino), melotherapy, self-regulation techniques and mental training in patients with emotional implications of stress, highlighted in the concept of burnout. The study was designed to demonstrate the direct action between burnout and stress, between burnout and burnout, between burnout and anxiety/depression, between burnout and fatigue/exhaustion. Bobathy (2007, p. 236), defines professional stress or occupational stress at the level of international organizations and showed the relationship between work and stress.

Material and method

The research was carried out on a number of 50 subjects (29 women and 21 men), managers who presented occupational stress with an increased level of stress, i.e. difficulties in adapting to the optimal performance of the tasks of the position occupied by decreasing the work efficiency, to whom I applied three tests: 1. Socioprofessional Pressure Management Indicator (IMP) (Appendix 1) The test comprises a questionnaire with biographical data 8 scales and 24 subscales that measure the sources and effects of socioprofessional pressures, coping strategies and individual differences..

The Occupational Stress Indicator (O.S.I.) (Appendix 2) and Belov Characterization Test (Appendix 3) were applied.

On the basis of this professional choice, as subjects, company managers were chosen who were subjected to this experiment. An experiment was carried out based on the application of Emcopad Dr. Tech resonant devices and melotherapy programs.

The use of EmcoPad Doctor Tech (fig. 1) devices determines the harmonization of fields that are in disharmony. We found it necessary to use musical frequencies between 432 Hz and 6,000 Hz. The musical scores were auditioned on headphones. Thus, they should not be developed and applied randomly, but based on judiciously prepared protocols.

Our Passive Electromagnetic Patch for Activating Acupuncture Points – EMCOPAD Doctor Tech is a passive resonance electronic device that ensures interaction with acupuncture points by simply applying it to the points corresponding to the condition being treated.

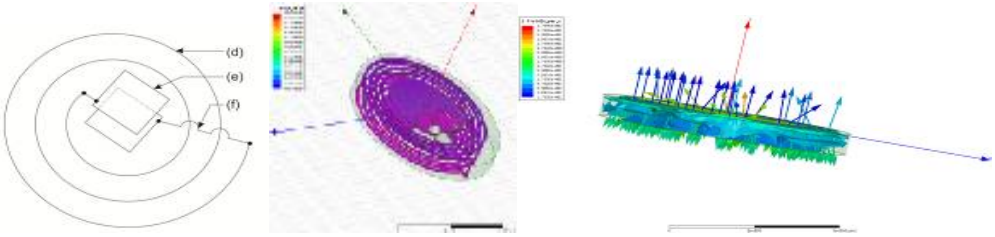

Figure 1. *Presentation of "EmcoPad Doctor Tech" devices*

The action of the QiPolono -EMCOPAD devices can be assimilated to a firm massage as well as a melodious caress, caused by pulsating (with the frequency at which we calibrate them) and harmonic actions, being in a mathematical relationship with musical notes (the harmonic of the LA musical note).

QiPolino-Passive Electromagnetic Patch for Activating Acupuncture Points EMCOPAD acts as a smart acupuncture needle and allows the use of TCM (Traditional Chinese Medicine) concepts.

Organization and conduct of research

The complex experiment using pulsed electromagnetic devices QiPolino EMCOPAD Dr. Tech, melotherapy and self-regulation techniques, was carried out between February 01, 2022 - May 31, 2023, within the Qi Integrative Medicine Center in Bucharest, Romania, at the "Professional Centre Physiotherapy Services" Aberdeen, Scotland - UK, and at the company headquarters in Bucharest - Romania and Aberdeen, Scotland - U.K. and Dorchester-U.K. Through this research I considered it useful to demonstrate how stress at work directly affects the individual's life on three levels: - INDIVIDUAL, - SOCIAL, - RELATIONAL – INTERHUMAN COMMUNICATION. The effects of occupational stress are visible in the physical plane through somatic manifestations, as well as in the mental plane through decreased self-esteem and behavioural reactions.

The action programs were drawn up according to a special protocol, adapted to these subjects. Depending on the age and the degree of stress, after which the obtained results were analysed.

The subjects were investigated by: anamnesis, general clinical examination, joint testing, muscle testing performed in the American 0-5 muscle strength rating system.

The action methodology was carried out by introducing some programs with a duration of 30-50 minutes by the therapist: simple and complex breathing exercises; simple relaxation exercises, melotherapy; the use of pulsed electromagnetic devices EmcoPad Dr. Tech, methods to help the patient to be optimistic, to bear and cope with stress, to gain confidence in himself and the therapist.

In these subjects, we applied melotherapy alongside a conventional treatment – the psycho-pedagogical methods applied in the practice of physical therapy.

Some of the subjects (female) at the beginning of the experiment were refractory to the application of EmcoPad Dr.Tech pulsed electromagnetic devices and melotherapy.

A fact that demonstrated that the protocols were well drawn up, accessible to patients at their homes, contributing to the reduction/disappearance of occupational stress and the improvement of physical and mental condition.

These protocols must be applied as soon as possible, from the date of recognition of the establishment of occupational stress.

These complex programs for the reduction/disappearance of occupational stress must be applied only in specialized institutions by specialists.

The complex mental and physical recovery programs through the reduction/disappearance of stress after being learned and deepened by the patients, will be carried out at home with specialist evaluation at a period of 6 months or as needed!

CONCLUSION

The value of the proposed methods -

"The use of EMCOPAD Dr. Tech pulsed electromagnetic devices and melotherapy", is ensured by the fact that they have all been extensively experienced both in the "Qi Integrative Medicine Center" in Bucharest, Romania, at the "Professional Centre Physiotherapy Services" Aberdeen, Scotland - UK, and at the company headquarters in Bucharest - Romania, Aberdeen, Scotland - U.K. and Dorchester - U.K. by the therapists, obtaining good results, with the success of reducing/disappearing occupational stress and avoiding burnout, with a good socio-professional reintegration of the subjects.

Their synergy leads to the healing and self-healing process.

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INTEGRATION OF FASCIAL MOBILISATION TECHNIQUES IN PHYSIOTHERAPY PRACTICE FOR THE REHABILITATION PEOPLE WITH LOW BACK PAIN

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Abstract

Low back pain has emerged as a progressively serious issue on a global scale, with the duration of incapacity caused by back pain rising by more than 50%. The fascia converts the muscular tissue's contraction. The function of the system is to regulate and control movement by transmitting signals to the skeletal system and coordinating with the nervous and muscular systems. It also regulates the dynamic mechanical forces that impact us as a result of our connection with the environment. The objective of the study was to enhance the rehabilitation process for individuals suffering from low back pain by seamlessly incorporating fascial mobilization techniques into physiotherapy treatment. The investigation was conducted on two groups, each consisting of 12 individuals who were above the age of 30. These individuals showed degenerative changes in the disc-vertebral region, specifically polysegmentation grade II-III according to the Pfirmann scale. Additionally, they had a circular dorsal disc protrusion at the L4-L5 level, with a protrusion size of up to 3 mm. The control group (M) saw positive effects from the physiotherapy program by incorporating fascial mobilizations, as outlined in the suggested model. The second control group (C) followed the physiotherapy program based on the institutional protocol.

Key words: *back pain, rehabilitation, mobilisation, physiotherapy, fascia, techniques.*

1. Introduction

Low back pain is characterized as a sensation of discomfort and pain that occurs below the rib edge and above the lower crease of the buttocks. Unpleasant sensations may or may not accompany it, radiating down the lower leg (Baur et al., 2017, p. 1011). According to low back pain is prevalent in developed countries and impacts around 80% of adults at some point in their lives (Harper, 1019, p. 117). Hence, the cultural norms regarding low back pain must consistently progress. The prevalence of low back pain has been rising on a global scale, resulting in a substantial increase in the number of years people live with disabilities caused by this condition (Vella et al., 2022, p. 3). This increase is particularly prominent in low- and middle-income nations. Prior to explaining fascial mobilization, it is crucial to emphasize the nature of the fascia as a cohesive and communicative network that maintains its distinct physiological structure and functional form. It converts the contraction of muscle tissue into organized motion, conveying this motion to the bones and joints while coordinating with the nerves and muscles. Furthermore, it effectively regulates the dynamic mechanical forces that impact us because of our interactions with the surrounding environment. Proteoglycans, a gel-like substance, infuse stiff fibers that form this fascial network. The network serves as a supportive structure for cells, surrounds organs, and connects the entire system in a functional manner (Hayden et al., 2021, p. 17). Because of its intimate association with each component.

Prior to discussing fascial mobilization, it is crucial to emphasize the nature of the fascia as a cohesive and communicative network that maintains its own physiological and functional structure. It converts the shortening of muscle tissue into organized motion, sending this motion to the bones and joints and coordinating with the nerves and muscles. Additionally, it regulates the dynamic mechanical forces that impact us as a result of our interactions with the environment (Chen,2023, p. 753). Proteoglycans, a gel-like substance, pack the inflexible fibers that make up the fascial network. A watery medium trap this gel. The network creates the ideal environment for each cell, surrounds every organ, and connects the entire system in a functional way. Fascia, due to its strong association with all tissue structures, plays a crucial function in preserving homeostasis and immunity (Matheve, 2023, p. 9).

Gravity, likely the most influential factor in its formation, affects the fascia after childbirth. This force interacts with genetic predispositions and the opportunities (or lack thereof) offered by the environment (Chen, 2024, p. 2). The organism possesses the capacity for self-regeneration, which includes the ability to recover from injury or breakage and adjusts to our unique patterns of movement during activities like respiration and ambulation. Connective tissue cells use proteins that come from food in the bloodstream to keep the body's cells sticking together (Ma et al., 2022, p. 4). Collagen fiber serves as the primary constituent of the structure, complemented by additional fibers such as elastin and reticulin. The same cells also produce a combination of sticky mucopolysaccharides that hold these fibers together. These extensive sugar and protein polymers engage with different amounts of water to form diverse structures with a broad spectrum of characteristics, customized to meet our diverse requirements for stability and mobility (Koppenaal, 2023, p. 5).

2. Material and method

The aim of the research is to improve the rehabilitation process of people with low back pain by effectively integrating fascial mobilization techniques into physiotherapy practice.

Research hypothesis: The incorporation of fascial mobilization techniques into the physiotherapy program is expected to enhance the functional recovery of individuals with low back pain syndrome, hence facilitating an improved recovery process.

Objectives:

- to analyze the theoretical and methodological principles of combining physiotherapy techniques with fascial treatment;
- to improve the functional recovery of individuals suffering from low back pain.to create a systematic framework for designing physiotherapy programs that incorporate fascial therapy for individuals suffering from low back pain;
- to assess the efficacy of the combined approach of physiotherapy and fascial therapy in enhancing functional status and alleviating low back pain.

The research was carried out on two cohorts consisting of 12 individuals each, all of whom were over the age of 30. These individuals had been diagnosed by a medical professional with degenerative disc-vertebral polysegmental changes gr. II–III (Pfirmann), as well as circular dorsal disc protrusion L4–L5 with a prolapse of up to 3 mm. The first control group (M) received the physiotherapy program using a model that combined physiotherapy methods with fascial mobilizations, whereas the second control group (C) followed the physiotherapy program based on the institutional protocol. The study was carried out for a duration of 10 days at the KineticA medical rehabilitation center. The exams were created in two distinct phases, namely the first stage and the final stage. The physiotherapy program was implemented through the process of selecting, designing, and refining the suggested model. This model aimed to assist individuals in achieving as close to a normal existence as possible, both in their professional and social spheres.

3. Results and Discussions.

Following the analysis of the theoretical-methodical theses, we have been able to elaborate on the conceptual framework of the model of association of physiotherapeutic means with fascial therapy (Fig. 1), which implies:

- The basic objectives of the model of association of physiotherapeutic means with fascial mobilizations must aim at reducing the degree of pain and stiffness, which will ensure an increase in the range of action and applicability of therapeutic exercises. Avoid techniques that exacerbate pain or cause discomfort.
- Interventions should be started as early as possible, as this directly influences the effectiveness of the functional recovery process.
- It is important to distinguish a specific gradation of complexity and intensity of action within the intervention process; therefore, we will not start treatment with harsh techniques even if the pain is lower than 3 after VAS.
- The patient must be aware of the sensations he will feel during fascial mobilizations.
- Specific fascial chains will be manipulated in a targeted and personalized manner for each patient.

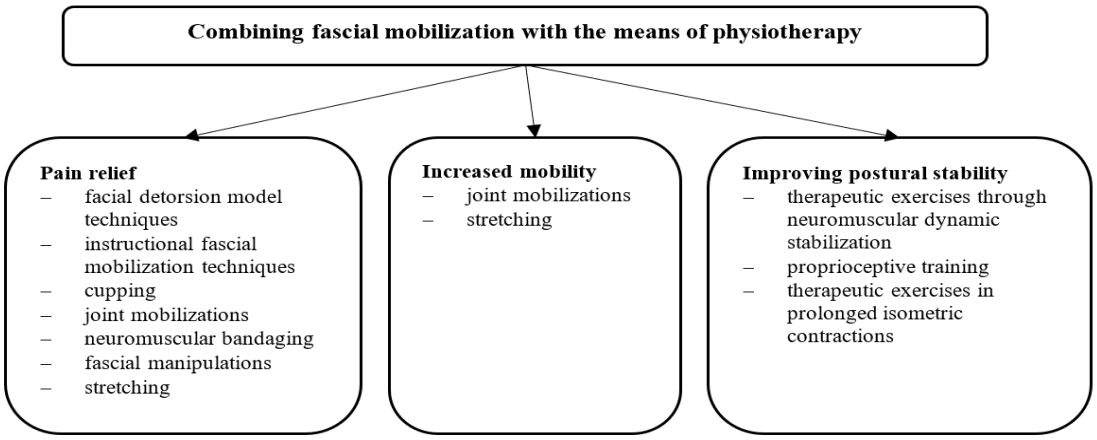

Figure 1. *The model of association of fascial mobilization techniques in the physiotherapy program*

To assess the efficacy of the model we constructed, we examined various characteristics. To measure the intensity of pain, we employed the visual analog scale (VAS), which ranges from 1 to 10 (Tab. 1). The highest score on this scale represents the most intense pain ever experienced. The Shober test was used to quantify flexion mobility in cm. In addition to these functional tests, we also utilized the standardized LBP Waddell and Main questionnaire, as well as the Roland and Morris questionnaire, to assess the progression of disability in the individuals included in the study. The data analysis revealed a favorable progression with statistically significant disparities in both groups.

Table 1. *Test results –initial test values vs. final test values*

No.	Variable	Group	Assessment stages							
			Initial assessments			Final evaluations			t_{if}	P_{if}
			$\overline{X}$ ±m	t	P	$\overline{X}$ ±m	t	P		
1.	VAS	M	9,6±0,4	0,26	> 0,05	3,2±0,36	2,26	< 0,05	5,24	< 0,001
		C	9,4±0,6			5,6±0,58			3,64	< 0,01
2.	SHOBER TEST	M	1,8±0,23	0,24	> 0,05	4,6±0,37	0,28	> 0,05	2,34	< 0,05
		C	1,6±0,26			4,2±0,24			2,26	< 0,05
3.	LBP Waddell and Main	M	8,2±0,84	0,28	> 0,05	4,3±0,34	2,32	< 0,05	3,16	< 0,01
		C	8,4±0,78			6,2±0,42			2,27	< 0,05
4.	Questionnaire of Roland and Morris	M	15,25±1,26	1,36	> 0,05	6,5±1,32	3,24	< 0,01	6,23	< 0,001
		C	14,89±1,28			9,3±1,46			4,78	< 0,001

Nevertheless, the statistical data indicates a much greater improvement in the control group that received fascial mobilization techniques in addition to following the institutional recovery program compared to the control group that only followed the procedure. The sole metric that showed positive changes but lacked statistically significant differences between the tested groups was the Shober test, with a t-student value of 0.28 and a P-value greater than 0.05. The most significant statistical disparities were seen on the VAS scale, with a t-student value of 2.26 and a significance level (P) of less than 0.05. Similarly, in the Roland and Morris Questionnaire, the t-student value was 3.24, with a significance level (P) of less than 0.01. The analysis of the recorded data demonstrates the beneficial impact of fascial mobilization techniques on the recovery of individuals suffering from low back pain. This is evidenced by a reduction in pain intensity as measured by the Visual Analog Scale (VAS), an improvement in lumbar spine mobility, and an increase in motor functionality for daily activities among the participants in the study.

4. Conclusions

- to achieve the desired outcomes, we should recommend, personalize, and tailor physiotherapy programs to the clinical presentation and developmental stage of everyone involved.
- the study's comparison of connections between functional and motor parameters clearly demonstrates the significant impact of fascial procedures on the rehabilitation process of individuals with low back pain.
- the physiotherapeutic program, which incorporates fascial techniques, improves the spine's functional condition. This program improves the mobility of the lumbar spine, reduces the severity of low back pain, and significantly enhances motor functionality in daily activities.

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ENDOSCOPIC VERSUS MINI OPEN CARPAL TUNNEL RELEASE

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ABSTRACT

Carpal tunnel syndrome is the most common peripheral nerve entrapment syndrome worldwide. This condition involves a form of neuropathy caused by compression of the median nerve as it passes through the wrist's carpal tunnel. Diagnosis is made clinically after the patient reports pain at the level of the hand, especially at night, hand muscles weakness and numbness along the distribution path of median nerve in association with positive provocative tests (Durkans's test, Tinnel's test, Phalen test). Treatment is usually non-surgical and involve symptomatic therapy and wrist brace. For refractory cases or those that do not respond to conservative methods, the treatment is surgical. These involves two types of approaches: mini open vs endoscopic carpal tunnel release. With an incidence of 10% of the general population, carpal tunnel syndrome affects the quality of life and is a cost-problem that the public health system faces. The aim of this study is to track the time of returning to work (or daily activities) in relation to the surgical method of treatment chosen.

Key words: carpal tunnel syndrome, endoscopic carpal tunnel release, mini open carpal tunnel release.

1. Introduction

Carpal tunnel syndrome represents the compression and injury of the median nerve when it passes through the osteofibrous canal at the level of the wrist, being the most common peripheral nerve pathology encountered in hand surgery. The reduction of space at this level, associated with edema, inflammation of the tendon, hormonal changes and excessive manual work lead progressively and irreversibly to the appearance of paresthesias and pain, and in severe cases can lead to marked muscle weakness in the thenar area. We will present two surgical methods of treatment and analyze the evolution of the patients in each case [1].

Tissue recovery processes following a smaller incision leads to a shorter recovery time and increased patient satisfaction related to time spenting in the operating room and postoperative scar. At the same time, due to short intraoperative time and period of hospitalization, the costs associated with the intervention will decrease.

This study aims at evaluating the comparative results of endoscopic and minimally invasive surgical treatment in carpal tunnel syndrome. Will be followed: post-operative evolution of the patients, recovery period, the time spent until returning to work, complications rate and symptoms improvement.

2. Materials and methods

The patients present an insidious onset, the symptoms being felt on the level of the first 3 fingers and on the radial half of the 4th finger, predominantly at night. The clinical examination highlights the specific symptomatology by performing the wrist flexion (Phalen test), the Tinnel sign or the compression test at the carpal level. Loss of sensation and muscle atrophy may also be seen. [2] In general, the diagnosis is established clinically, confirmed by imaging methods and electromyography in the case of patients who are to undergo surgery. [3] Surgical treatment is considered when conservative treatment fails. It consists in freeing the median nerve by sectioning the transverse carpal ligament performed through the mini-open approach (MOCTR) or through the endoscopic procedure (ECTR).

This study included 20 patients, diagnosed and treated between 2017-2024, of which 14 patients were treated by the endoscopic method and 6 patients were treated by the minimally invasive method. All patients presented with characteristic clinical signs and symptoms, and the pathology was confirmed by paraclinical methods (EMG). In this study, the following were analyzed: the post-operative evolution of the patients, the recovery period, the time required to return to work, the degree of improvement of symptoms and the existence of complications. To evaluate the functional capacity, the Boston Score was used, which monitors the difficulty of the patients to perform routine activities (Table 1, Table 2).

The patients included in our study ranged in age from 22 to 81 years, the majority being female. They are hospitalized on the day of surgery and the method of anesthesia is established together with the anesthetist: intravenous general anesthesia with additional local anesthesia, axillary block anesthesia or general anesthesia through orotracheal intubation.

Figure. 1.

Figure 2.

The endoscopic intervention involves making a transversal incision of approximately 1.5 cm, under local anesthesia (Figure 1) and hemostatic tourniquet, at the level of the radial border of the palmaris longus muscle. Afterwards, in the distal to proximal direction, complete release of the transverse ligament is performed

(Figure 2). Through this procedure, post-operative symptoms and scarring are reduced, recovery is easier, but iatrogenic damage to the median nerve and other nerve branches is still a danger. [4]

In contrast to the endoscopy, the mini-open procedure needed only basic surgical instruments and the incision was made at the level of Kalpan line. The dissection was performed up to the level to the transverse ligament and additionally the neurolysis of the median nerve was done. If there are no complications, patients leave the health facility the day after the surgery.

The post-operative recommendations included the general methods of care of the surgical wound and the ablation of the suture threads, the medical recovery of the affected limb, anti-inflammatory and neurotrophic treatment, performing an EMG 6 months post-operatively and regular control to monitor the evolution.

3. Results

Most patients reported severe functional impotence pre-operatively due to severe symptoms (pain, loss of sensation, paresthesias), which interfered with the performance of routine activities.

It is noted that the return to work associated with an effective recovery is directly proportional to the age of the patients. Recovery is accelerated the more compliant patients are and the more recovery exercises are performed according to protocols. The Boston Score variation is influenced by the fact that most elderly people avoid using the operated hand, their activity level being generally low. In the case of endoscopic surgery, a reduced intensity of pain can be observed from the second postoperative day, the patients requiring less sedatives and immobilization in a plaster cast not being necessary. No general complications of the wounds were highlighted, in both treatment methods they were healed without the appearance of infections or dehiscences.

The results of the surgical interventions were presented in the following tables, both for the endoscopic treatment (Table 1) and for the mini open treatment (Table 2). The patients were evaluated at 3 months, at 6 months with the electromyography result and at 1 year, but not all operated patients returned to control.

Table 1 *Endoscopically treated patients (b= bilateral intervention; SB= Boston functional assesment score: min. 8 - performs his activity without difficulty max. 40 - cannot perform his activity).*

Patients	Symptoms	Associated Conditions	Postoperative recovery	Complications and their possible etiologies	Return to work	Level of satisfactio n	SB
CI f (b), 34y, 12.2021	Severe	Patient with multiple comorbidities	Specialized center	Loss of sensation IV-V right fingers (extended time of hemostasis), Muscle weakness (ineffective recovery)	-	Satisfied	16
CV f, (b), 59y, 03.2021	Severe	-	Home	Loss of sensation in the left finger III	3w	Very pleased	13
MC b, (b), 58y, 01.2021	Severe	-	-	Slight numbness	7-8w	Very pleased	12
VE f, 69y, 02.2021	Moderately severe, intermittent, preominantly at night	-	Home	Numbness in fingers II and III	3-4w	Very pleased	16
TC f, 69y, 02.2021	Severe	-	-	-	7-8w	Very pleased	10
BI b, (b), 22y, 12.2021	Moderately severe	-	Home	-	1-2w	Very pleased, espacially with the reduced incision	8

Table 2 *Mini-open treated patients (b= bilateral intervention; SB= Boston functional assesment score: min. 8 - performs his activity without difficulty max. 40 - cannot perform his activity).*

Patients	Symptoms	Associated Conditions	Postoperative recovery	Complications and their possible etiologies	Return to work	Level of satisfaction	SB
CA, b, 61y, 12.2018	Moderately Severe	Atrophied thenar and hypothenar muscle area	-	Numbness at the thumb	7-8w	Satisfied	12
PA, f, 49y, 05.2017	Moderately Severe	-	Specialized center (laser therapy) + Home	Mild tingling	10-12w	Satisfied	10
VM f, (b), 73y, 12.2019	Severe	-	Specialized center	Mild numbness in the left hand	3-4w	Very pleased	12
OV f, 56y, 03.2020	Severe	Atrophied thenar muscle area	Home	-	3-4w	Very pleased	10
CM, f, 56y, 03.2020	Severe	-	Specialized center	-	2-4w	Very pleased	11

During the first three months after surgery, the patients treated with the endoscopic method were better symptomatically and functionally. Local wound problems in terms of scarring or scar tenderness were significantly more pronounced in patients undergoing open carpal tunnel release compared to patients undergoing endoscopic carpal tunnel release. Average delay to return to normal activity was appreciably less in group undergoing endoscopic surgery, objectified by electromyographic testing at the end of six months. [1,6]

A group of patients provided us the Electromiography results pre-operatively and 6 months post-operatively, they are divided below (Table 3, Table 4) according to the chosen surgical method.

Table 3 *Pre-and post-operative sensory nerve conduction. (P- Patients, I- Intervention, E- Endoscopic, MO- Mini-Open, CTS - Canal Tunnel Syndrome.*

P	I	Location	Latency (ms)		Maximum amplitude (μV)		Distance (cm)		Velocity (m/s)		Conclusions	
			pre	post	pre	post	pre	post	pre	post	pre	post
C.I. f, (b), 34a, 12.2021	E	MEDIAN R II	3,40	2,60	20,1	37,2	14,5	14,5	42,6	55,8	CTS bilat.	CTS completely remitted bilaterally
		MEDIAN L II	3,25	2,75	31,8	35,1	15	15	46,2	54,5		
		MEDIAN R III	3,85	2,65	13,9	17,3	8	8,5	29,6	56,7		
		L MEDIAN III	3,40	2,65	26,5	33,7	8	8	38,1	55,2		
		R ULNAR V	2,20	1,90	36,5	38,7	12	11	54,5	57,9		
		L ULNAR V	2,30	2,00	41,3	43,9	13	12	56,5	60		
C.M., f, 53a, 01.2020	MO	L MEDIAN	3,7	3,6	27,3	25,8	13,5	14,5	36,9	40,1	CTS R>L	CTS improved
		R MEDIAN	4,1	3,1	4,6	9,7	14,5	15,5	35,5	49,4		
		L ULNAR	2,2	2,3	33,8	21,6	11	12	49,1	51,7		
		R ULNAR	2,3	2,5	28,8	32,8	11,5	14	49,6	55,6		
T.C. f, 69a, 02.2021	E	MEDIAN L II	3,95	3,80	6,3	8,6	13	13	32,9	34,2	CTS bilat. R>L	CTS completely remitted at right hand and stationary at left hand
		MEDIAN R II	NR	3,80	NR	10,7	-	13	-	34,2		
		MEDIAN L III	4,35	4,30	3,2	12,2	14	13,5	28,9	31,4		
		ULNAR L V	NR	NR	NR	NR	-	-	-	-		
		ULNAR R V	2,00	2,15	27,2	29,3	11	12	55,0	55,8		

It has been demonstrated that early return to work is the result of an effective recovery which is directly linked to the age of the patients. Recovery was faster when the patients were more compliant and recovery exercises were performed according to the protocols.

Table 4 *Pre- and post-operative sensory nerve conduction. (P- Patients, I- Intervention, E- Endoscopic, MO- Mini-Open, CTS - Canal Tunnel Syndrome.*

P	I	Location	Latency (ms)		Maximum amplitude (μV)		Distance (cm)		Velocity (m/s)		Conclusions	
			pre	post	pre	post	pre	post	pre	post	pre	post
C.I. f, (b), 34a, 12.2021	E	R ULNAR	3,05	-	14,3	-	-	-	-	-	CTS bilat.	CTS completely remitted bilaterally
		L ULNAR	2,80	-	13,8	-	-	-	-	-		
		R MEDIAN	4,55	-	7,8	-	6	-	31,8	-		
		L MEDIAN	4,35	-	8,7	-	7	-	29,3	-		
C.M., f, 53a, 01.2020	MO	L MEDIAN	5,2	2,0	1,0	7,2	-	-	-	-	CTS R>L	CTS improved
		R MEDIAN	-	5,0	-	7,4	-	-	-	-		
		L ULNAR	2,8	2,7	10,5	11,8	-	-	-	-		
		R ULNAR	2,6	3,3	14,0	13,5	-	-	-	-		
T.C. f, 69a, 02.2021	E	L ULNAR	2,45	-	2,7	-	-	-	-	-	CTS bilat. R>L	CTS improved at right hand and stationary at left hand
		R ULNAR	2,45	-	4,1	-	-	-	-	-		
		L MEDIAN	5,90	-	4,9	-	-	-	-	-		
		R MEDIAN	9,30	-	2,1	-	-	-	-	-		

The average time spent until returning to work was 3.5 weeks in the case of patients treated endoscopically and 5.5 weeks in the case of patients treated mini open, with the mention that some patients voluntarily delayed their retorn. The average Boston Score was 12.5 in the case of endoscopic treatment and 11 in the case of mini open treatment. Variation is influenced by the fact that especially elderly people avoided using the operated hand, their activity level being generally low.

However, the patients were very satisfied with the results in the case of endoscopic treatment, especially due to the small size of the wound, the fact that they were able

to carry out their daily activities immediately postoperatively, but also the very good long-term functional result. Among the late complications listed by the patients in both treatment methods, the decrease in sensitivity of the II and III fingers of the operated hand is highlighted, without disrupting the activity, but also slight paresthesia of the hand, in the case of 3 patients treated by the mini open procedure.

Usually the endoscopic surgery and the open surgery have similar results. The endoscopic method allows a faster recovery time and has no scar tenderness. The open surgery has fewer recurrences and a lower cost. It is necessary to take into consideration the experience of the surgeon, many surgeons do not use the endoscopic method because they don't have enough experience, or they don't have the necessary equipment.[5,6,7].

4. Conclusion

The comparative analysis in relation with our clinical experience presented in the study concluded that the mini-open and endoscopic methods provided functionally similar results, in the long term, but with multiple advantages related to the recovery period, the postoperative comfort and the degree of satisfaction of the patients. . The main complications were represented by muscle weakness and loss of sensivity. To perform endoscopic method it is necessary to consider the skills and experience of the surgeon, as well as the costs and equipment needed. The endoscopic method involved a series of advantages such as: short duration of the surgical intervention, reduced degree of post-operative pain and a faster recovery period, with subsequent benefits on the return to work. Despite the fact that the mini-open method represents a procedure that consumes less financial resources and has a reduced risk of recurrence, the small scar present on the flexor fold resulting from the endoscopic intervention may influence the decision of patients.

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PHYSIOTHERAPY OF THE KNEE WITH ENDOPROSTHESIS: CHALLENGES AND SOLUTIONS

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Abstract

Postoperative progressive functional recovery of a prosthetic knee is an essential process for patients who have undergone post-traumatic or knee arthroplasty. This recovery process aims to restore mobility, muscle strength, function and stability of the knee so that the patient can return to active life and usual daily activities without difficulty. Thus, in the proposed work we want to analyze a patient with knee endoprosthesis, given that, often, the interpretation of this concept has different meanings and connotations. Physiotherapy is indispensable in a hospital, rehabilitation center, public or private medical unit, a fact that is due to the effects and results obtained through its application. That's why we chose to apply 5 physiotherapy sessions and present a positive result in one of the many patients.

Key words: *Recovery, knee, endoprosthesis, physical therapy.*

1. Introduction

Postoperative recovery is of utmost importance after total joint replacement in order to ensure pain-free joint functionality and improve the patient's quality of life. Knee arthroplasty is commonly performed on patients with end-stage osteoarthritis or rheumatoid arthritis of the knee to relieve joint pain, increase mobility, and improve quality of life. The symptoms of arthrosis appear slowly and worsen over time. The pain occurs most often when we stand up, when we start walking, or when we go up or down stairs. Joint stiffness is often common upon waking or after a period of rest in which we do not exercise. We can feel the joint having the sensation that it "snaps" and "cracks" during the movement, and in the last phase we observe an inflammation of the joint (Vizdoagă, A., 2021, p.36.)

Reduced knee flexion is also a feature of gait in people with knee osteoarthritis, influencing the patient's self-perception of the joint. This correlates significantly with pain during walking, muscle strength and knee flexion excursion. Knee kinematics play an important role in the development and degradation of articular cartilage. Healthy cartilage responds to overload by adapting its morphology and mechanical characteristics in areas of greatest stress. In the case of the development of knee osteoarthritis, that load becomes a factor in the progression of cartilage degradation (Tada, M. 2021, p.2). The results of complex sessions and forms of physical therapy used in the recovery of the prosthetic knee helped us to observe visible results and that they have a role in the treatment, prognosis and assessment of joint rehabilitation.

The purpose of the research: Restoring and regaining joint mobility of the knee up to functional limits in a short time following the application of physical therapy.

2. Material and method

In the life of each of us, the mobility and proper functioning of the knee plays a crucial role. When a person is faced with the need for a knee replacement, whether due to an injury, chronic wear and tear of the joint, or other reasons, the rehabilitation process becomes essential to regain quality of life and independence. Rehabilitation of the prosthetic knee is a road that requires patience, determination and proper guidance. In this study, we will explore essential aspects of knee replacement rehabilitation, from the first post-operative days to achieving recovery goals and beyond. We will discuss exercise, physical therapy, pain management techniques, and resources that have helped us along this journey. Regardless of age or activity level, this rehabilitation process can be customized to fit individual needs. It is important to understand that each patient has their own experience and will progress at their own pace. With adequate support and personal effort, it is possible to regain mobility and enjoy the active life the patient deserves again. In what follows, we'll explore the critical first stages of knee replacement rehabilitation, laying the foundation for a successful recovery. At the consultation, patient, aged 57, was given and analyzed a special assessment consisting of:

- pain scale
- Somatoscopic method
- Goniometry
- Joint X-ray

Emphasis was placed on flexion and extension testing of the prosthetic knee in the first physical therapy session (Figure 1a and Figure 1b). The patient's pain worsened after the consultation on the way home and persisted throughout the day. And in the morning he woke up in a good mood performing some routine activities with ease.

a)

b)

Figure 1

a) beginning of the physical therapy session; b) the end of the first session with the application of kinesiotape;

The monitoring of the effectiveness of the proposed recovery program in only 5 physical therapy sessions is presented in (table 1) which generates the dosed time, the number of repetitions of the physical exercises and the techniques used as well as the results obtained after each session. Physiotherapy sessions regularly included assessment of flexion and extension after each session to track the patient's progress and evolution. Average recovery time, degree of improvement in knee flexion and

extension, pain reduction, adaptability with an individualized approach to the patient's personal needs were taken into account.

Table 1 *The effectiveness of the recovery program of the prosthetic knee for the investigated patient.*

No. physical therapy sessions	Recovery program	Time reps/minutes	results
26.02.24	Initial position Supine with support under the knees 1. Lymphatic drainage 2. Passive mobilizations- Flexion and Extension 3. Mobilizations of the patella transversely and longitudinally 4. Passive-active mobilizations 5. Exercises: - Dorsiflexion + Plantarflexion (for tibialis anterior + indirect action on the quadriceps) - Inversion and Eversion (fibular bones - for stabilization) - Heel press down (isometric hamstring contraction) - Internal and external rotation in the hip joint 6. Kinesiotapes for lymphatic drainage	15 minutes. 20 reps. 20 reps. 10-15 reps	After the first session, the patient felt relief, with a decrease in edema and pain, began to drive short distances;
29.02.2024	1. Lymphatic drainage 2. Longitudinal and transverse patellar mobilizations 3. Passive mobilizations (Flexion, Extension) 4. FNP- rhythmic initiation 5. Isotonic concentric flexion 6. Exercises 7. ➔ Plantar flexion + knee down press 8. ➔ Inversion with emphasis on eversion 9. ➔ internal and external hip rotation 10. Lymphatic drainage	15 minutes. 20 minutes. 5 minutes. 10 minutes. 20 reps. 20 reps. 20 reps. 5 minutes.	The lower limb swelled a little and there was a pain that lasted until the evening, including during the night, in the morning the pain disappeared;
4.03.2024	1. 1. Lymphatic drainage 2. 2. Passive mobilizations (Flexion and Extension)	15 minutes. 25 minutes. 5 minutes.	The movement is done with

	3. 3. Postures 4. 4. Exercises 5. - Dorsal flexion + Plantar flexion 6. -Inversion and Eversion 7. 5. Kinesio tapes for lymphatic drainage	 20 reps. 20 reps.	more agility, without pain;
6.03.2024	1. Lymphatic drainage 2. Passive mobilizations - Extension 3. Passive mobilizations - Flexion 4. we work the quadriceps muscle spasms 5. Flexion mobilizations 6. Exercises ● Plantar flexion, dorsi ● Inversion eversion ● Internal, external hip rotation	15 minutes. 5 minutes. 10 minutes. 5 minutes. 5 minutes. 12 repetitions of the exercise. 10 repetitions of the exercise. 1 min.	At night he woke up only 3 times, the night pains decreased;
11.03.2024	1. Lymphatic drainage 2. Patellar mobilizations (from extension) longitudinally, transversely, diagonally 3. Passive mobilizations for Extension 4. Passive flexion mobilizations 5. Passive-active hip flexion and extension mobilizations 6. Exercises 7. ● From supine position - Plantar, dorsal flexion 8. ● From the sitting position we perform the Knee Extension - 10 repetitions 3 sets with a minute break in between 9. Kinesiotapes for lymphatic drainage	15 minutes. 5 minutes. 10 minutes. 10 minutes. 2 minutes. 15 repetitions of the exercise. 10 repetitions of the exercise.	The degree of joint mobility in flexion was 72º. The patient feels well and has no pain.

3. Results and Discussions

Evaluating the effectiveness of a rehabilitation program for a postoperative knee with a prosthesis is a complex process that requires positive feedback after each session. To measure the flexion and extension of the knee with the prosthesis, I used, before and after the session, the goniometer (Gornea, F. 2010, p.37). The data regarding the evolution of knee flexion was shown in (figure 1). The main objective of this rehabilitative program was to improve flexion movement and reduce extension, restore joint mobility, muscle strength, function and stability of the knee

so that the patient can return to active life and usual daily activities without difficulties. The results of the final testing shown in (figure 1) show us a considerable increase in the functional indices tested, which proves the efficiency of the kinetic program followed. Thus, a visible progress can be seen in gaining joint mobility and muscle strength (Tripac, C., Zavalişca A., 2019)

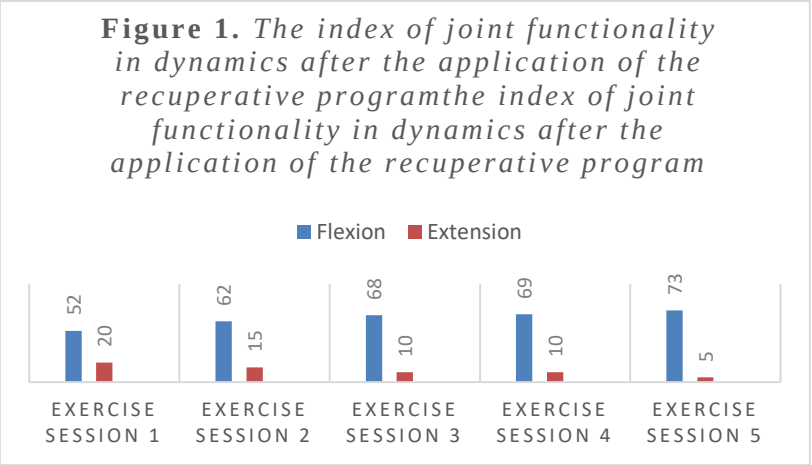

Figure 1. *The index of joint functionality in dynamics after the application of the recuperative programthe index of joint functionality in dynamics after the application of the recuperative program*

The observed improvements and the comparative analysis between the first session and the fifth session are visible, indicating, following the measurements with the goniometer, that the flexion with an angle of 52º can reach, only after 5 intensive and individualized sessions, a flexion with an angle of 73º of joint mobility. After 3 weeks postoperatively, together with the patient, we tried to achieve the highest degree of flexion and extension possible. The kinetic program for a postoperative knee must be customized according to the patient's condition taking into account in the program:

1. Reducing inflammation: In the first sessions, the focus should be on reducing inflammation;

2. Mobility recovery: To prevent joint stiffness, passive or assisted knee mobilization exercises should be introduced gradually. This will help maintain or restore full ranges of motion.

3. Strength exercises: Once the inflammation has subsided, we integrate exercises to strengthen the muscles around the knee.

4. Work on stability: It is important to work on stabilizing the knee post-op to prevent future injuries. Exercises that target balance and stability can be beneficial.

5. Pain Management: Pain management is crucial during the kinetic program. Making sure the patient can do the exercises comfortably and without excessive discomfort.

6. Gradual Progress: The program should be progressive. From lighter exercises in the first weeks after surgery, we move to more intense exercises as the patient recovers.

7. Medical monitoring: The patient should be monitored and evaluated by a

physical therapist or orthopedic doctor during the program. He can make adjustments based on the patient's progress and condition (Figure 2).

Figure 2. *Degrees of mobility in Flexion and extension of the patient.*

8. Education and self-care: We make sure the patient is well-educated about the exercises to perform at home and understands the importance of sticking to the recovery schedule.

9. Return to activities: The program should aim to reintegrate the patient into daily activities, after it is certain that the knee is sufficiently recovered to do so.


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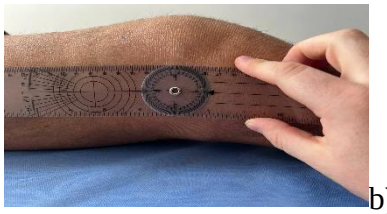
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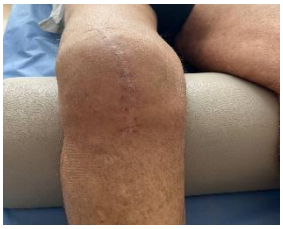
d)

Figure 3. *Measuring degrees of mobility by kinetic program:*

a) Drenaj limfatic

b) Knee extension

c) Knee flexion

d) Postoperative appearance of the prosthetic knee

4. Conclusions

Rehabilitation of the prosthetic knee is a complex and important area of medical rehabilitation. Rehabilitation of the prosthetic knee is an individualized approach. The study showed that personalized treatment, tailored to the specific needs and conditions of patient, can lead to better outcomes. Starting mobilization early and passive exercise immediately after surgery can help prevent joint stiffness and speed recovery. Research has shown that patient education is an essential aspect

of rehabilitation. Patients need to understand techniques, expectations and their role in the recovery process. Constantly evaluating the patient's progress through objective measurements such as knee flexion and extension can guide adjustments to the rehabilitation program. Returning to previous activities was the main goal of the rehabilitation to allow the patient to return to the daily activities he was doing before surgery. This recovery was gradual and well coordinated, so we got a good result, as demonstrated in this study. We continue the physiotherapy sessions and we want to reach a much higher degree of flexion of the prosthetic knee.

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EFFECTIVE STRATEGIES FOR PLANNING PHYSICAL EDUCATION ACTIVITIES THROUGH PHYSIOTHERAPY MEANS FOR PRESCHOOLERS WITH INFANTILE CEREBRAL PALSY

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Abstract: The text elaborates on Infantile Cerebral Palsy (CP), a neurological disorder affecting movement and posture in children, stemming from brain developmental disruptions.

Physical education exercises play a crucial role, enhancing health and functionality by adapting to children's needs. The study aims to improve physical education and rehabilitation for preschoolers with CP. It hypothesizes that integrating kinesiological therapy into physical education can enhance motor skills and school integration. The objectives include evaluating integrated strategies' impact and developing a strategic model.

Results highlight the importance of foundational theoretical models and practical feedback in planning rehabilitation. The strategic model involves psychophysical assessment, planning, reassessment, and correction. Educators and physiotherapists affirm the significance of these processes. Furthermore, the text discusses various intervention methods, including exercises for fine motor skills, perception, and proprioception, crucial for motor coordination. Adapting physical education activities based on these data can enhance motor function effectively.

The conclusion emphasizes a strategic framework for organizing physical education activities, focusing on assessment, planning, implementation, and monitoring. Therapeutic exercises should align with developmental goals and individual needs, emphasizing consistency and variation for optimal outcomes. In essence, the text underscores the importance of a comprehensive approach to rehabilitation for children with CP, integrating theoretical frameworks with practical strategies to enhance motor function and quality of life.

Key-words: cerebral palsy, pediatric, rehabilitation, physical therapy, child, movement, physical activities, exercise program.

1. Introduction

Infantile Cerebral Palsy (CP) is a prevalent kind of neurological disorder. It is a broad word used to describe several neurological illnesses defined by difficulties with movement and posture, resulting in limitations in activities. These disorders are caused by a disruption in the growing brain (Santos, 2022, p. 156). These medical conditions frequently come with related disabilities and additional health issues (Paramonova, 2012, p. 38). Infantile cerebral palsy is a term used to describe a variety of motor function abnormalities that affect many aspects of movement, muscle control, coordination, muscle tone, reflexes, motor skills, oral motor function, posture, and balance (Frank, 1938, p. 45).

Infantile cerebral palsy is a disorder that is not progressive, meaning it does not worsen with time. However, it is still affected by the ongoing changes and progress of growth and development (CDC, 2024). Therefore, the clinical symptoms that are linked to this condition may vary as time progresses (Abbasi, 2021, p. 81). Motor impairment is a characteristic feature that typically occurs alongside other

secondary central nervous system illnesses, including mental retardation, epilepsy, sensory abnormalities (such as hearing and vision), cognitive impairments, and behavioral disorders (Fragala-Pinkham, 2012, p. 1).

Infantile cerebral palsy can be classified into three primary categories: spastic, dyskinetic, and ataxic. Spastic and dyskinetic disorders can also be linked, although less commonly, with ataxia (in mixed forms) (Dorgan, 2016, p. 409).

Günel states that pediatric rehabilitation necessitates a comprehensive strategy to enhance the self-sufficiency of children with disabilities, both in terms of functionality and psychology, and to enhance the overall quality of life for both the child and their family (Günel, 2009, p. 174). Physiotherapists, who are regarded as specialists in mobility, have a vital role in this interdisciplinary approach. The main objective of physiotherapy, as mentioned by Günel, is to assist children with cerebral palsy in reaching their highest level of physical independence within their community (Günel, 2009, p. 176). This involves reducing the impact of physical disabilities while improving the quality of life for both the child and their family, who play a crucial role in this endeavor (Dorgan, 2016, p. 410).

Physical education exercises have a substantial impact on enhancing the health and functionality of children diagnosed with infantile cerebral palsy (Allambergenova, 2020, p. 1). Engaging in these activities can facilitate adaptation in both the central nervous system and muscles, resulting in enhancements in strength, flexibility, and aerobic capacity (Alberto et al., 2012, p. 22). Research has demonstrated that the utilization of neuro-motor rehabilitation exercises and active physical exercise enhances functional independence in children with infantile cerebral palsy (Coates, 2010, p. 1518). Furthermore, research has demonstrated that adapted physical education, which customizes physical activities to suit the specific requirements of children with infantile cerebral palsy, is an efficacious method for enhancing their overall health and functionality (Allambergenova, 2022, p. 2).

2. Material and method

The aim of the study is to improve the physical education and rehabilitation process for preschoolers with infantile cerebral palsy by evaluating and developing strategies for planning physical education and physiotherapy activities.

The study's hypothesis is that planning physical education activities with kinesiological therapy in mind can help preschoolers with infantile cerebral palsy improve their motor skills and fit in better at school. Thus, these strategies could contribute to optimizing the physical education and rehabilitation process for this category of children.

Objectives:

- to evaluate the impact of integrated strategies for planning physical education and physiotherapy activities on the motor functionality of preschool children with infantile cerebral palsy by critically reviewing the literature.
- praxiological investigation of the planning of physical education and physiotherapy activities for preschoolers with infantile cerebral palsy by questioning and analyzing the practice of specialists.

- the development of a strategic model is underway to plan the structure and content of the physical activity and rehabilitation process for preschoolers with infantile cerebral palsy.

To develop and validate a strategic model for planning the structure and content of a program that integrates physical education and physiotherapy for motor recovery in preschool children with infantile cerebral palsy, we conducted an empirical study using questionnaires and interviews with educators and physiotherapists who specialize in children's recovery and have significant expertise in this area.

Thus, 21 educators who interacted with these children and 32 physiotherapists, both from the Republic of Moldova and from other countries, participated in the survey. We based the basic elements of the motor recovery process's structure and content on data from literature and clinical practice and developed the intervention guidelines and strategies by analyzing the opinions of specialists directly working with these children and correlating all this information with existing modern theories and methods in the field.

3. Results and Discussions

The primary focus in developing a rehabilitation system for pre-school children with cerebral palsy is to create a foundational theoretical model. This model will serve as the basis for the strategy and guide the progress of the work. Through a comprehensive analysis of the research literature, we were able to discover a collection of theoretical-methodological principles that served as the foundation for the creation of successful motor rehabilitation programs for toddlers diagnosed with cerebral palsy. This theoretical model can be structured as a primary logical and structural framework, with the purpose of determining the direction and goals of the motor rehabilitation system specifically designed for children diagnosed with cerebral palsy.

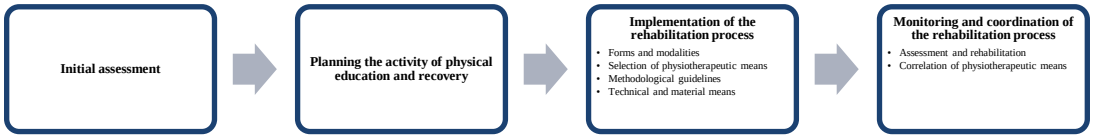

Figure 1. *Strategic model for planning the rehabilitation process through physiotherapy means in physical education activities for preschool children with infantile cerebral palsy.*

After developing the fundamental procedures and sub-procedures (Fig. 1) to assist children with infantile cerebral palsy in regaining their motor abilities, we sought feedback from individuals regarding the significance and indispensability of these suggested procedures (Fig. 2). Both educators and physiotherapists acknowledged the significance of these processes, although some had limited familiarity with them. The key parts that were identified as crucial are the psychophysical and somatofunctional assessment, the planning of the motor

recovery process, the reassessment, and the correction within the intervention program. These features have negligible variances in terms of their significance.

The study proposes a strategic approach to organizing the rehabilitation process for preschool children with infantile cerebral palsy using physiotherapy in physical education activities (Fig. 1).

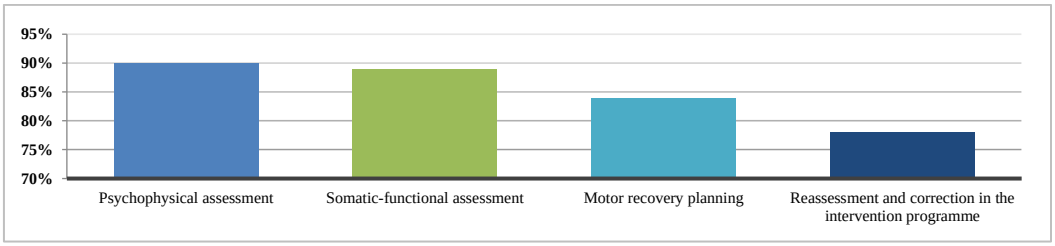

Figure 2. *Graphical presentation of the basic processes for implementing the motor recovery program in preschool children with infantile cerebral palsy*

It is crucial to assess the performance of preschoolers with infantile cerebral palsy in various intervention methods to develop effective programs for physical therapy and physical education activities for these children. Understanding these data and adapting them into a framework appropriate for motor recovery can improve therapeutic and functional outcomes for children with special needs. In the most relevant categories of educational units, the respondents marked exercises as occupational therapy, with 85% of these data suggesting that the majority opt for exercises—applied utilities. These results could be integrated into physical education activities to support the development of self-care and object-handling skills. Psychomotor training exercises (71%) indicate the development of skills under changing motor tasks and environmental conditions. The integration of these activities into physical education activities could enhance children's motor coordination and control. Prehension exercises: 85% reflect a high need for the development of fine skills. In physical education and rehabilitation activities, it is recommended that the emphasis be placed on the development of fine manipulation skills and hand coordination. Exercises for the training of perception and motor skills—70%, according to the respondents' opinions—are no less important than the other educational units and should be oriented toward the development of sensory skills and motor coordination. Their integration into physical education activities would increase awareness and control of movements. Neuroproprioceptive facilitation techniques with a moderate score of 69% suggest the applicability of using these techniques to stimulate the body's proprioceptive systems. Integrating these educational units into physical education activities could enhance awareness and control of movements. Balance and coordination exercises scored 61%, suggesting their important role in developing orientation and stability of movements when performing motor tasks. General physical training exercises (50%) highlight the need to develop cardiorespiratory capacities, muscle strength, and flexibility,

which should be integrated into physical education and rehabilitation activities to improve children's overall functional status.

Adapting these data in the planning of physical education activities for pre-school children with infantile cerebral palsy can contribute to the development of effective programs aimed at improving motor function, coordination, and physical abilities in a child-friendly way (Fig. 3).

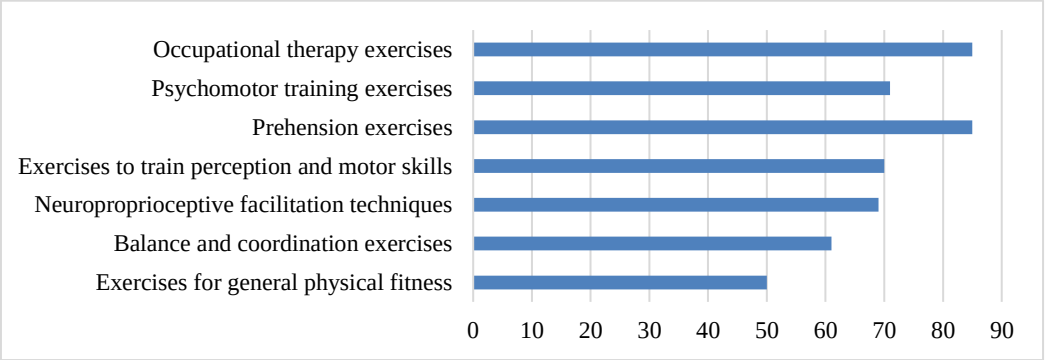

Figure 3. *Graphical interpretation of the categories of educational units*

Most respondents have suggested incorporating physiotherapy into the rehabilitation regimen for preschoolers with infantile cerebral palsy. The design of these exercises aligns with the physiological effects and objectives of the intervention, specifically tailored to meet the daily lives and academic demands of these children. We must categorize physical exercises according to the following characteristics:

the objectives of the study are to address the developmental, cognitive, corrective, and formative elements of children with infantile cerebral palsy. 87% of the respondents identified these objectives.

the physiological impact of action involves training, stimulating, and inhibiting to achieve unique benefits tailored to the individual needs of children, as reported by 89% of respondents. We propose several criteria for selecting and modifying physical workouts to optimize their corrective impact, including:

• engagement of major muscle groups for overall motor function (as reported by 92% of participants).

• 84% of responders reported overcoming a significant level of endurance to engage in sufficient physical exertion for development.

• sustaining a consistent rate of motion (78% of participants).

• 76% of respondents indicated a preference for selecting the frequency of repeat within a certain time range.

It is crucial to emphasize the significance of adjusting the technical method of implementation and the level of effort based on the specific requirements of preschoolers with infantile cerebral palsy. Furthermore, as per the specialists, it is recommended to vary physical activities, distribute them equally throughout the day,

and incorporate them into the daily schedule, even when children are at home with their parents, to guarantee efficient and uninterrupted healing. A well-structured and tailored physical exercise program is crucial for rehabilitating preschool children with infantile cerebral palsy. This program should have numerous objectives and be customized to meet the specific needs of each kid.

4. Conclusion

An examination of the literature and practical experience has resulted in the creation of a strategic framework for organizing physical education activities for preschoolers with infantile cerebral palsy. This framework is based on four fundamental processes: initial assessment, planning of physical education and rehabilitation activities, implementation of the rehabilitation process, and monitoring and coordination of the rehabilitation process.

The fundamental systematic principles for incorporating physiotherapeutic methods into physical education activities for preschoolers with infantile cerebral palsy should focus on psychomotor and somato-functional preparation. Therapeutic exercises should have a practical and functional motor structure, with goals aimed at development, correction, and training.

We must adjust the entire process to the technical modalities for performing therapeutic exercises, carrying them out consistently with continuous variation to accommodate the specific characteristics and individual needs of the group of children. This process should serve as the organizational foundation for specialists conducting physical education and rehabilitation activities for children with cerebral palsy.

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Varia

PECULIARITIES OF CHANGES IN BODY COMPOSITION INDICATORS IN STUDENTS WITH HYPOKINESIA IN CONDITIONS OF POWER FITNESS TRAINING

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Abstract. *The study purpose*. Determination of the influence of power fitness training developed for students with hypokinesia and generally accepted physical education health programs on body composition indicators. *Materials and methods.* The study involved 90 female students aged 19±0.3 years. 60 students with hypokinesia (groups B and C), and 30 physically healthy students (group A). Representatives of group A used physical education wellness programs. Participants of group B followed health-improving physical education programs. Group C students took up models of power fitness training. Indicators of body composition were determined using the method of bioimpedancemetry. *Results*. The level of body fat mass of students with hypokinesia observed at the beginning of the study was 3.4% ($p<0.05$) higher compared to the group of healthy participants. At the same time, the fat-free mass indicator in representatives of groups with hypokinesia was 7.6% ($p<0.05$) lower compared to the results in the group of healthy students. Using models of power fitness training for 8 weeks, students with hypokinesia decreased their body fat mass by 3.2% ($p<0.05$). However, the level of fat mass in students with hypokinesia who used physical education wellness programs did not change significantly. *Conclusions*. Using models of power fitness training by students with hypokinesia in the process of motor activity contributes to the most pronounced positive changes in bioimpedancemetry indicators. These changes indicate the processes of long-term adaptation.

Key words: *hypokinesia, power fitness, body composition, bioimpedancemetry, female students.*

1. Introduction. The decrease in motor activity and, as a result, the manifestation of a non-aggressive tendency to change the level of resistance of students' body systems to external stressful stimuli leads to the development of hypokinesia (Yamasaki, 2023; Latino & Tafuri, 2024). It is known that in a state of hypokinesia, students' functional capabilities decrease, and the activity of neurohumoral mechanisms is disrupted, which negatively affects not only their physical development but also their mental activity, especially the effectiveness of information perception and its detailed analysis with further use in practical activities (Dieckelmann et al., 202).

One of the key factors in solving this problem is an innovative integral approach to optimizing the physical education system (Chernozub et al., 2018; Bauer et al., 2023). The development of effective models of training aimed at increasing the functional capabilities of students with hypokinesia, using the basic principles, methods, and means of fitness, is one of the priority tasks of scientists (Chen & Nakagawa, 2023; Chernozub et al., 2023). The practical implementation of this issue

will help to increase student's ability to counteract external stressful stimuli in the shortest possible time. This is especially true for physical, social, psychological, mental, and other types of stress that affect the level of hypokinesia. A detailed study of the main patterns of modeling the process of physical activity correction will allow students to determine the optimal range of methodological aspects. Using power fitness means to solve the issue of optimization of the physical education process will help to increase the adaptive body reserves.

*The study purpose***.** Determination of the influence of power fitness training developed for students with hypokinesia and generally accepted physical education health programs on body composition indicators.

2. Material and method

The study involved 90 students aged 19±0.3 years. The average height of study participants was 165±0.3 cm, and their body weight was 66±1.6 kg. Three experimental groups of 20 people were formed. Group A included physically healthy female students. Groups B and C consisted of female students with hypokinesia.

Representatives of Group A used generally accepted physical education programs for university students during their classes. Group B participants followed health-improving physical education programs for special medical groups in the process of rehabilitation. Students of group C took up models of power fitness training in the process of motor activity. The models were based on isolation exercises aimed at involving specific muscle groups. The principle of premature fatigue of the main muscle group was used due to its preliminary exhaustion in the conditions of isolation exercise. These changes in the training regimen contributed to the economical expenditure of the body's energy reserves (creatine phosphate and muscle glycogen) during muscle activity. The duration of the study was 8 weeks. Using the non-invasive method of bioimpedancemetry, the following body composition parameters were determined: body fat (BF, %), fat-free mass (FFM, kg), and active body cell mass (BCM %). Statistical analysis of the study results was performed using the IBM *SPSS*Statistics 26 software package (StatSoftInc., USA).

3. Results and Discussions

Fig. 1 graphically presents the results of changes in body fat mass (BF, %) in study participants during 8 weeks of training.

The analysis of the results observed at the beginning of the study shows that the level of body fat mass in the representatives of groups B and C was 3.4% ($p<0.05$) higher than in the group of healthy students. This fact indicates an excess of fat mass in students of both groups with hypokinesia, which is one of the manifestations of physical inactivity.

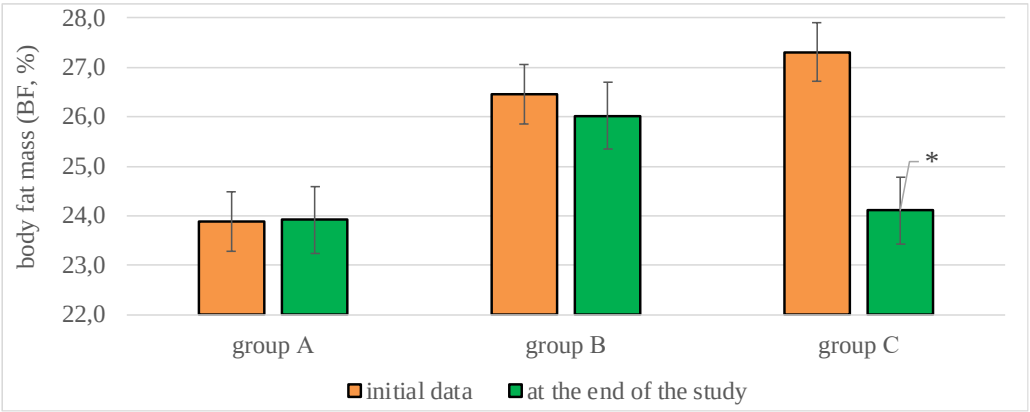


Figure 1. Results of changes in the level of body fat mass (BF, %) in female students of the studied groups during 8 weeks of using different models of muscle activity, n=90

*Note: * is p<0.05, compared to the indicators before the study*

The results noted at the end of the study indicated different changes in the level of fat mass in the representatives of the studied groups. The obtained results showed that the level of body fat mass decreased by 3.2% ($p<0.05$) only in a group of students with hypokinesia who used a model of power fitness training during classes. This fact indicates the possibility of involving a large number of motor muscle units during exercise, which contributed to significant energy expenditure.

The results presented in Fig. 2 demonstrate the peculiarities of changes in the indicator of fat-free mass in students of all three groups during the study.

At the beginning of the research, the fat-free mass index in the group of physically healthy students was 7.6% higher than the parameters observed in the representatives of the other two groups. This fact indicates that students with hypokinesia had problems with the level of muscle mass development. Under conditions of hypodynamia, muscle fibers atrophy, and there occurs a decrease in the number of active motor units of those groups that are minimally used in conditions of motor activity.

The analysis of the final results shows that only representatives of groups B and C had positive changes in the fat-free mass indicator. Students with hypokinesia who used the model of power fitness training significantly increased the fat-free mass indicator by 3.4% ($p<0.05$). This fact testifies to the expressed hypertrophy of the involved muscle groups, due to the use of moderate-intensity loads in power fitness classes.

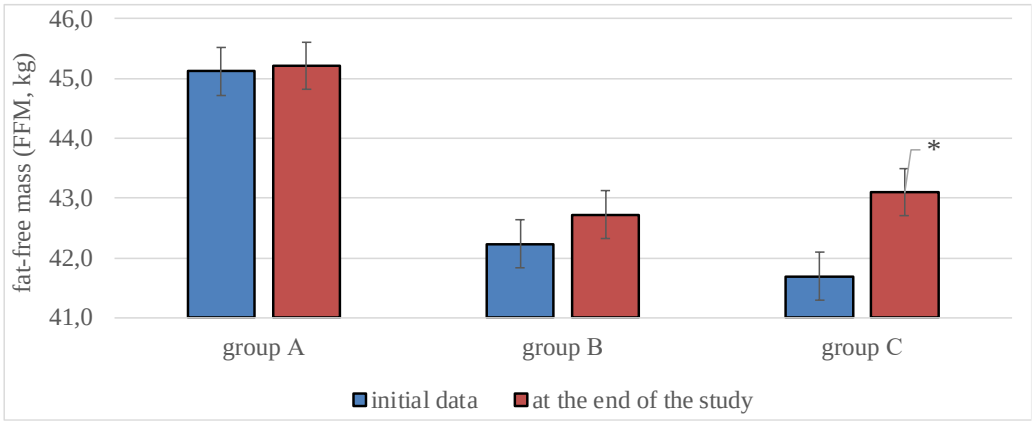
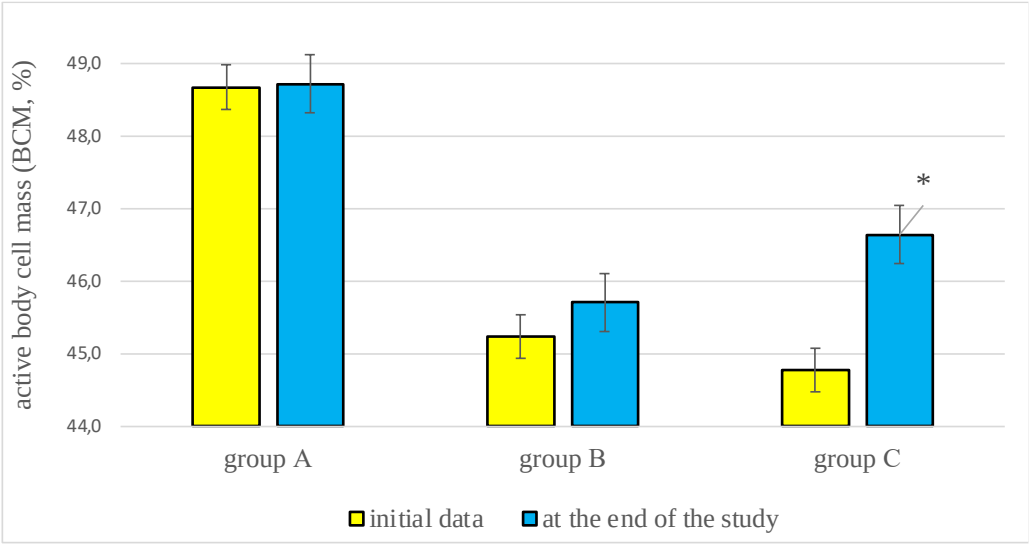


Figure 2. Results of changes in fat-free mass (FFM, kg) in female students of the studied groups during 8 weeks of using different models of muscle activity, n=90

*Note: * is p<0.05, compared to the indicators before the study*

The results of changes in the parameters of active body cell mass in study participants during 8 weeks of the research are shown in Fig. 3.



2. **Figure 3.** Results of changes in active body cell mass (BCM, %) in female students of the examined groups during 8 weeks of using different models of muscle activity, n=90

*3. Note: * is p<0.05, compared to the indicators before the study*

4.

The initial results indicate that the level of BCM was 3.8% (p<0.05) lower in the representatives of groups B and C compared to the data revealed in the group of healthy students. This fact reflects the processes of maladaptation that occur in the body during hypokinesia, caused by a decrease in motor activity and a decrease in adaptive reserves.

During the research, it was proved that the use of power fitness training models positively affected the dynamics of the BCM indicator in students with hypokinesia in the process of physical education. Parameters of this indicator of body composition increased by 1.8% ($p<0.05$). The index of active body cell mass did not change significantly in representatives of the other two groups during the study.

5.

6. 4. Conclusions.

7.

8. The use of models of power fitness training by students with hypokinesia in the process of motor activity promotes the most pronounced positive changes in the studied indicators of bioimpedancemetry. Thus, the use of power loads of isolated character, and the principle of premature fatigue of the main groups of muscles are key components of models of power fitness training for students with hypokinesia. Practical realization of these factors will positively influence not only the morphometric parameters of their organism but also the level of adaptation reserves.

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CONTINUOUS EDUCATION OF SPECIALISTS IN THE FRAMEWORK OF HYBRID EDUCATION - INVESTIGATIVE APPROACH

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Abstract
Because contemporary society is constantly changing and so is the education system, the individual and professional development of specialists is a necessary condition in order to remove all the obstacles that intervene in the access and participation of students in the instructional-educational process. The purpose of the research is to argue the need for continuous training of specialists in the field of physical culture and sports in relation to the modernization of education systems and the change of organizational forms. By means of an analytical approach, the paper aims to highlight the importance of the continuous training of specialists in a hybrid educational context as well as its benefits in the field of physical culture and sport. The objectives of the research consist in identifying and achieving an objective and relevant feedback regarding the needs of specialists in the context of changes and modernization of the education system. Organization and conduct of the experiment: I developed a multiple-choice questionnaire, in which 121 respondents from the field of school education participated. The research methods were: the analysis of specialized literature, the application of a questionnaire regarding the identification of the continuous training needs of teaching staff and sports coaches; the mathematical-statistical method of data processing. Findings and results. The analysis of the results of the questionnaire will provide a detailed understanding of respondents' perceptions, knowledge and needs regarding continuing education in the context of hybrid education. Conclusions and recommendations. Continuing professional training study programs ensure the development of the professional skills of specialists in the field.

Keywords: approach, continuous training, specialists, hybrid education, students

1.Introduction

Because contemporary society is continuing to change and so is the education system, the individual and professional development of specialists is a necessary condition in order to remove all the obstacles that intervene in the access and participation of students in the instructional-educational process. These changes have had a significant impact on education systems, with young people and adults benefiting from new conditions in terms of their development. The life experiences of contemporary children differ considerably in many aspects from those of children in the eighties or nineties [3]. The Romanian school physical education, currently in full process of conceptual reform, requires, among other things, the reconsideration of the methods and means used in order to make the instructional-educational process more efficient aimed at improving the level of expression of the individual's ability to move, the acquisition, training and development of skills and the attitudes necessary for the complex affirmation of the students' personality, in our case preadolescents [2]. In hybrid education for the development of skills and abilities, the teacher uses technology in a complementary way that, together with digital

educational resources, supports the learning process, offering the possibility to carry out didactic activities offline and online, synchronously and asynchronously. From the teacher's perspective, such a learning device requires multiple skills and availability, the time and effort used being significantly more pronounced [1]. Physical education also argues the need for continuous training of specialists in the field of physical culture and sports in relation to the modernization of education systems and the change of organizational forms. By means of an analytical approach, the paper aims to highlight the importance of the continuous training of specialists in a hybrid educational context as well as its benefits in the field of physical culture and sports.

2. Material and method

The research methods conducted were: the analysis of specialized literature, the application of a questionnaire regarding the identification of the continuous training needs of teaching staff and sports coaches, as well as the mathematical-statistical method of data processing. The objectives of this research consist in identifying and achieving an objective and relevant feedback regarding the needs of specialists in the context of changes and modernization of the education system. In order to achieve the objectives, we developed a multiple-choice questionnaire, in which 121 respondents from the field of school education participated.

3.Results and Discussions

The analysis of the results of the questionnaire will provide a detailed understanding of the respondents' perceptions, knowledge and needs regarding the impact of continuing education on the way of organizing physical education lessons in hybrid primary education. Below we will reflect the most relevant data obtained following the application of the questionnaire. Answering the question addressed to school teachers *Which of the following forms of education do you think would be the most effective in the primary cycle?*, 7.4% of the respondents claimed that hybrid education would be a form of organization in a special context in which the physical version preferred by 91.7% cannot be implemented, 0.9% prefer the online version (Figure.1)

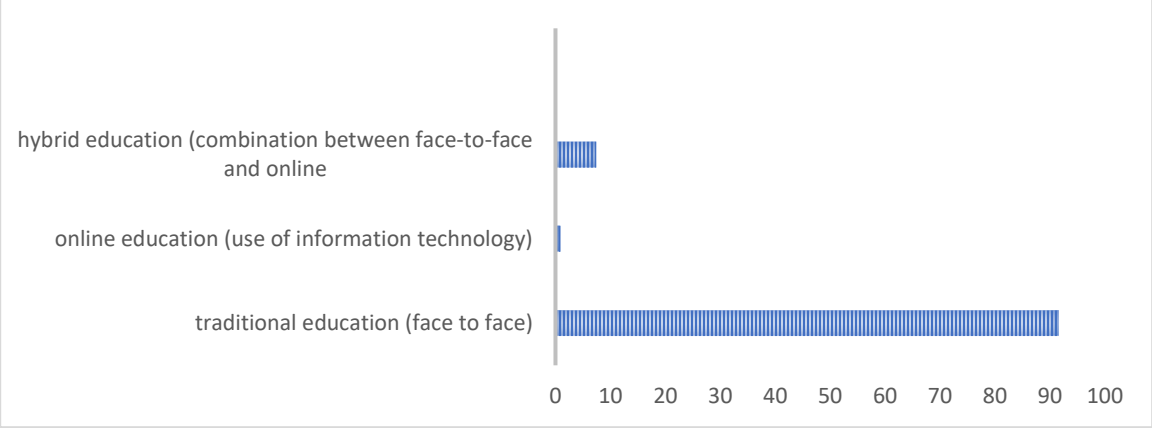

Figure 1. Which of the following forms of education do you think would be the most effective in the primary cycle?

The results indicate that 60.8% of the respondents have used the variant of hybrid education and are familiar with this variant, while 39.2% have never used this variant (Figure.2).

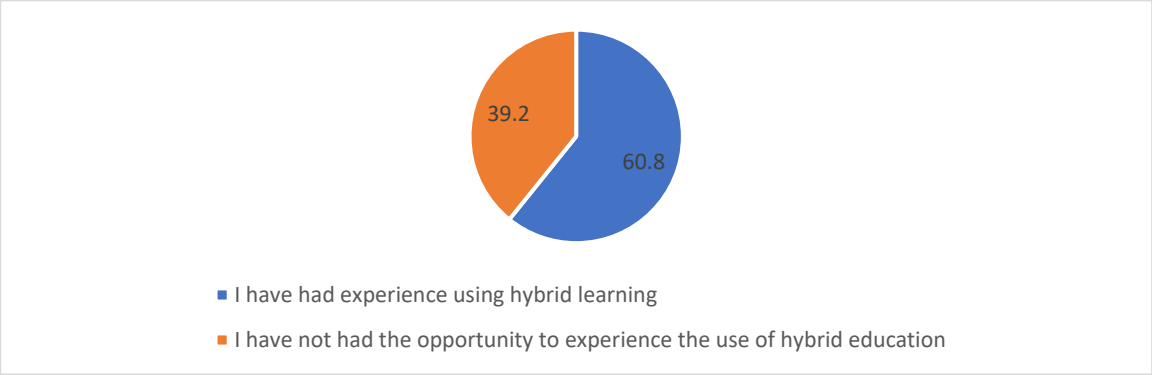

Figure 2. In primary education, have you experienced the use of hybrid education?

The analysis of the results reveals that 17.8% of respondents provide online materials and resources for home activities, 31.4% plan exercises and activities for online lessons and 50.8% combine classroom activities with individual home activities (Figure 3).

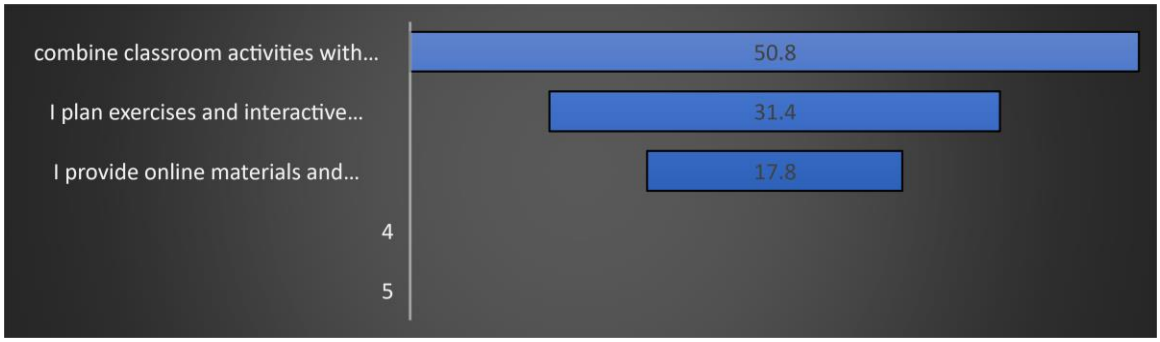

Figure 3. In the context of hybrid education, how would you organize physical education activities for students?

Regarding the assessment of student performance and progress in hybrid education, 37.5% use tools and methods adapted to the online environment, 34.2% rely on observations and individual interactions with students, and 28.3% encourage self-assessment and peer assessment through constructive feedback (Figure 4).

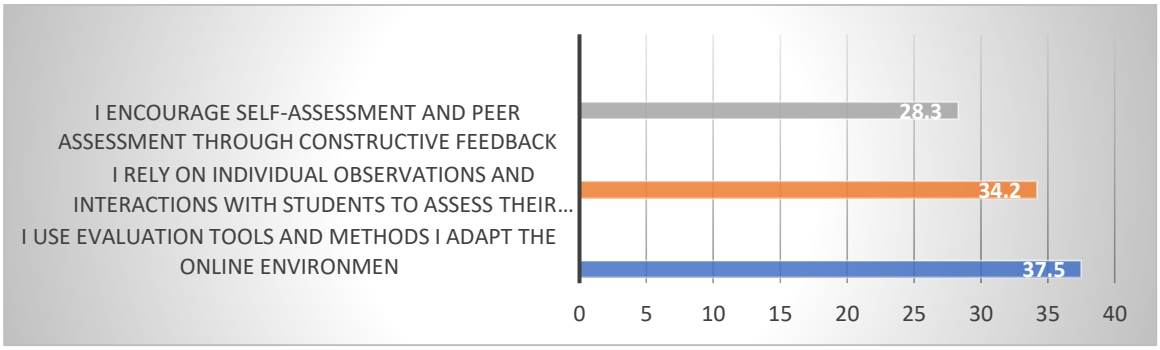

Figure 4. How do you assess student performance and progress in physical education in hybrid education?

The results show that for the integration of technology and digital tools in physical education and sports activities, 29.2% of respondents use physical activity and progress monitoring devices and 70.8% use mobile applications and online exercise platforms (Figure 5).

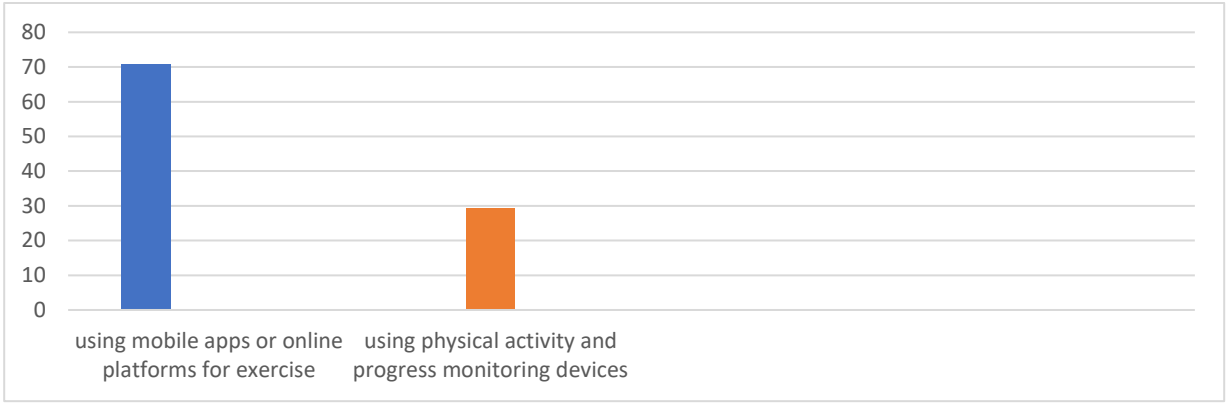

Figure 5. How do you integrate technology and digital tools into physical education and sports activities?

The analysis and interpretation of the results indicate that regarding the health and safety of students during online physical activities, 66.1% of respondents provided clear instructions regarding the correct posture and exercise safety and 33.9% relied on the constant monitoring of students during online sessions (Figure 6).

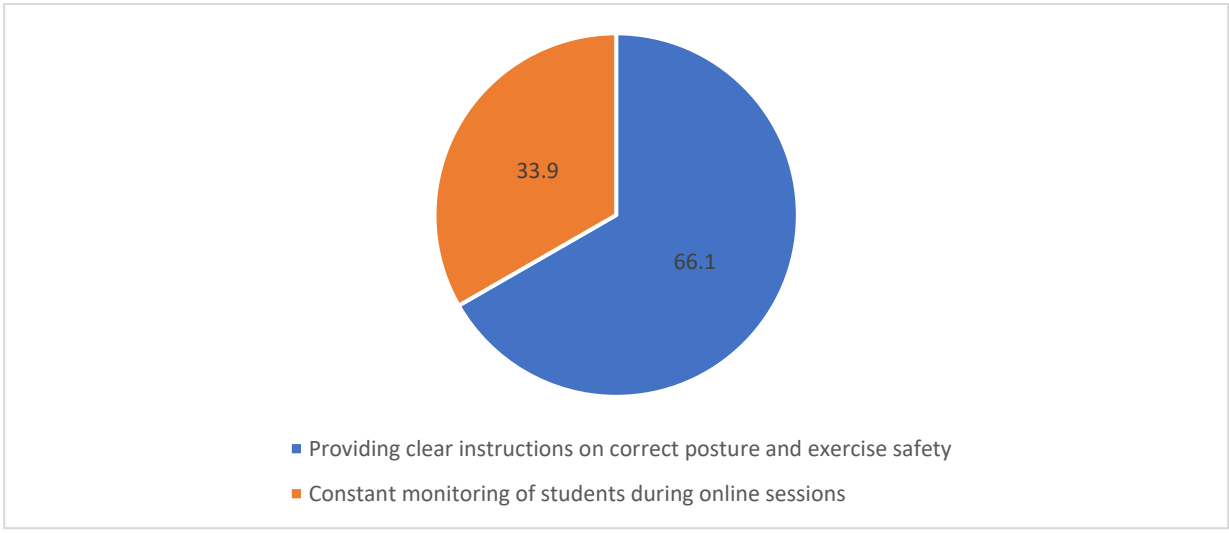

Figure 6. What measures have you taken to ensure the health and safety of students during online physical activities?

4.Conclusions: Continuing professional training study programs ensure the development of the professional skills of specialists in the field. The majority of specialists prefer traditional education as the main form of organization 91.7%, but in special situations between online and hybrid education, 7.4% prefer the hybrid one because we have the opportunity to physically interact with part of the students. The results underline the clear direction of school education specialists towards innovation, adaptability and integration in their continuing education process.

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THE INFLUENCE OF NUTRITION, HYDRATION, AND RECOVERY ON SOMATIC AND PSYCHOMOTOR DEVELOPMENT IN STUDENTS FROM THE SCHOOL'S MINI HANDBALL TEAM

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Abstract
Nutrition, hydration, and recovery play an essential role in the somatic and psychomotor development of students, especially those involved in intense sporting activities such as mini handball. Balanced nutrition, adequate hydration, and proper recovery can significantly contribute to improving athletic performance, promoting growth and harmonious development of the body, as well as maintaining the mental and physical health of students. Therefore, an integrated approach combining healthy eating, proper hydration, rest, and recovery, nutritional status monitoring, and nutrition education can significantly contribute to the somatic and psychomotor development of students in the school's mini handball team.

Keywords: nutrition, hydration, recovery, mini-handball

Introduction

Physical education and sports play an essential role in the holistic development of primary school students, especially when engaged in sports activities such as mini-handball, as it brings multiple benefits both somatically and psychomotorically. However, to achieve maximum potential in sports performance and to support healthy development, adequate nutrition, proper hydration, and efficient recovery are essential.

Purpose This study aims to investigate the importance of nutrition, hydration, and recovery in the context of somatic and psychomotor development of students involved in the school's mini-handball team. We intend to analyze how proper nutrition, adequate hydration, and recovery periods can influence the physical and mental performance of these students, considering the specific rigors and requirements involved in sports practice. Additionally, the study will provide valuable information for physical education and sports teachers, coaches, as well as parents and students, helping them better understand the importance of balanced nutrition, adequate hydration, and the recovery process in the context of sports activities, and encouraging healthy practices that support optimal physical and psychomotor development of children in general.

Nutrition plays a crucial role in sports performance, contributing to energy provision, muscle recovery, and maintaining overall health. For students involved in the mini-handball team, it is essential to have a balanced diet rich in carbohydrates, proteins, healthy fats, vitamins, and minerals. Carbohydrates are the main source of energy for intense physical efforts, while proteins are crucial for muscle recovery and development. Therefore, consuming foods such as whole grains, vegetables, fruits, lean meats, and dairy products will ensure an adequate intake of nutrients for optimal performance.

Proper hydration is vital for students involved in the mini-handball team. Losses of fluids and electrolytes through sweating can affect physical performance and increase the risk of accidents or health deterioration. Students should be encouraged to consume water regularly, both during training sessions and competitions. In addition to water, sports drinks can be beneficial for replacing lost electrolytes during intense exercises.

Proper recovery is as important as training itself. After intense physical exertion, the body needs time to recover and rebuild energy reserves and muscle tissues. Students should pay special attention to recovery and adopt effective strategies to maximize this process. Adequate rest, quality sleep, and nutritious food are key elements of recovery. Moreover, techniques such as massage and stretching can help relax muscles and reduce the risk of injuries.

In conclusion, proper nutrition, adequate hydration, and efficient recovery are fundamental for the somatic and psychomotor development of students involved in the school's mini-handball team. By adopting a balanced diet, a proper hydration routine, and effective recovery strategies, these young athletes can maximize their potential and achieve remarkable performances on the field while maintaining their overall health and well-being.

Material and Method

The research topic focuses on assessing the impact of nutrition, hydration, and recovery on somatic and psychomotor development in the mini-handball team students of Primary School No. 96 in Bucharest.

The objectives of the study include analyzing multiple indicators to guide research and interventions aimed at improving the health and sports performance of students in the mini-handball team, such as:

Evaluating the nutritional status of students in the mini-handball team to identify deficiencies or excesses in food intake that could affect their somatic and psychomotor development;

Investigating the effects of adequate or inadequate hydration on sports performance and the health status of students;

Examining how diet and hydration can influence the recovery rate after training and competitions, contributing to the prevention of overtraining and injuries.

To conduct the research, I selected the students of the third-grade class B from Primary School No. 96 in Bucharest, where I teach, a total of 30 students (17 boys and 13 girls), whom I considered the experimental sample. The results obtained by the subjects in the established control tests were compared with the results obtained by subjects from a similar (control) sample, of the same age and with the same bio-psycho-motor characteristics, students from class A of the third grade - 30 students (15 boys and 15 girls), from the same primary school. The experiment was conducted in several stages, each stage having different tasks, during the period September 1st December 31st.

Research hypotheses assume that students who adopt a balanced diet, hydrate adequately, and recover properly after mini-handball training and matches will have superior somatic and psychomotor performances compared to those who do not follow these practices.

Methods used in drafting this study:

Literature review method - is a mandatory approach in identifying updated information in this dynamic segment, aiming to utilize the most relevant references for the substantiation and elaboration of this study.

Food questionnaire - students responded to a detailed questionnaire aimed at obtaining precise information regarding their dietary habits, including the frequency of consumption of various food groups.

Direct observation - students from the two classes were monitored regarding their eating behavior during breaks, after class hours, before and after training sessions.

Anthropometric measurements - the height, weight, and thoracic elasticity of the students from the participating classes were measured.

Comparison of obtained data - to assess to what extent the students in the two classes adhere to a healthy dietary regimen, the obtained data were compared with a nutrition guide compiled by the Ministry of Health of Romania.

Evaluation tools for the efficiency of the proposed research methods were represented by the following measurements and control tests:

A. Anthropometric measurements

Measurements assessing physical growth and development based on measuring the human body as a whole and its parts. These tests have the advantage of numerical expression of results, which adds objectivity and accuracy.

a. Height - a centimeter tape and a stadiometer were used.

Procedure: For correct measurement of a student's height, it is necessary for them to be barefoot, standing upright (orthostatism), touching their back and head against a vertical wall; the head is oriented forward. Using a stadiometer or a ruler (a graded grid in cm can be stuck on the wall with subdivisions of at least 0.5 cm.), the distance from ground level to the perpendicular projection on the wall of the vertex level (the highest cranial point), determined with an object with at least a 90-degree angle (e.g., a square with a side of 15-20 cm.), placed with one side on the vertex and one on the wall, is measured. The measurement is recorded in centimeters and subdivisions of 0.5 centimeters.

b. Weight - it is an indicator of the quantitative growth of the body that must be related to sex, age, height, and nutritional status. It is a factor that changes quite rapidly, being able to decrease or increase under the influence of factors such as: diet, physical effort, metabolic disorders.

c. Chest elasticity - a centimeter tape and a stadiometer were used.

Procedure: The chest circumference is measured with a centimeter tape or a flexible ruler. The student is in a standing position. The tape is placed horizontally around the chest, subaxillary, just above the nipples in boys and about 3 cm above

the nipples in girls. Students are dressed in a thin tank top or t-shirt. Chest circumference is measured at three moments:

in a normal position;

at maximum inhalation;

at maximum exhalation.

The three values are recorded. Chest elasticity is determined by subtracting the chest circumference value at maximum inhalation from the value at maximum exhalation. The three measurements are recorded in centimeters and subdivisions of 0.5 centimeters.

B. Functional Test

The "Ruffier" test was conducted by measuring the pulse at three different moments.

P1 - resting pulse, before exertion, taken for 15 seconds;

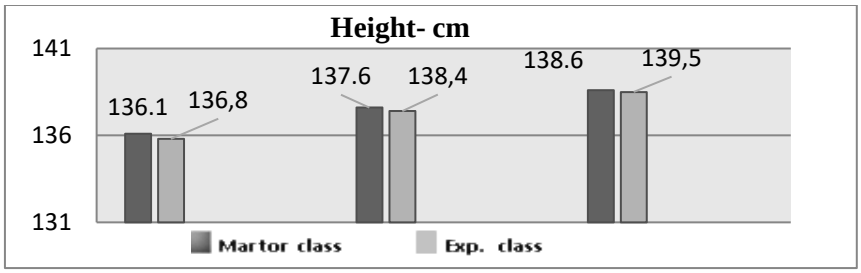
P2 - pulse recorded after performing 30 squats, recorded for 15 seconds, in the seconds immediately following the cessation of effort;

P3 - pulse recorded after 30 seconds from the recording of P2, also for 15 seconds.

Results and Discussions

Following the analysis and compilation of the results obtained by the students of the two participating groups in this pedagogical endeavor during the three assessments – T1 (initial testing), T2 (intermediate testing), and T3 (final testing), the following data were recorded:

Height: For the experimental group, the mean height was 136.8 cm at T1, 138.4 cm at T2, and 139.5 cm at T3, while for the control group, a mean height of 136.1 cm at T1, 137.6 cm at T2, and 138.6 cm at T3 was observed. The table below presents the results obtained during the assessments.



Graphic 1. HEIGHT

Graphic representation of the arithmetic means obtained by the students of the classes participating in the experiment.

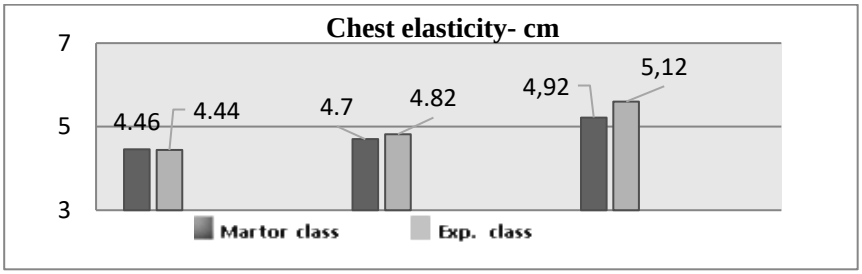
Weight: The second anthropometric indicator analyzed has an average value of 30.4 kg at T1, 31.6 kg at T2 and 32.7 kg at T3 for the experimental class and 31.3

kg at T1, 31.9 kg at T2 and 32.9 kg at T3 for the control class, these results being highlighted below in the synthetic table of the statistical test and in the graphs of the means.

Graphic 2. WEIGHT

Graphic representation of the arithmetic means obtained by the students of the classes participating in the experiment

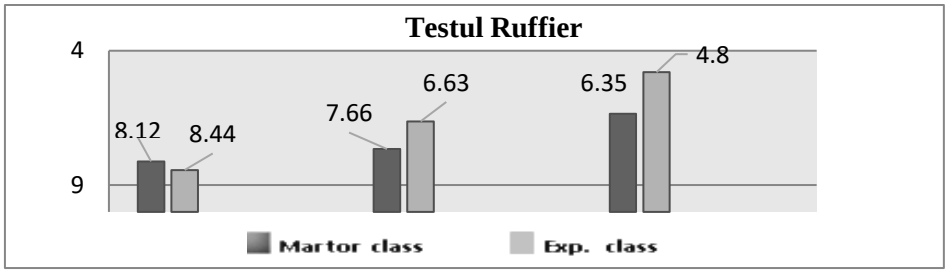
Chest Elasticity: The last parameter measured in these tests shows an average for the experimental class of 4.44 cm at T1, 4.82 cm at T2 and 5.12 cm at T3, while for the control class, the average is given by the values 4.46 cm at T1, 4.70 cm at T2 and 4.92 cm at T3.



Graphic 3. CHEST ELASTICITY

Graphic representation of the arithmetic means obtained by the students of the classes participating in the experiment.

The Ruffier test is a test used to assess physical fitness and is based on the heart rate response to a standard effort (squats), with the application of a formula resulting in an index expressed mathematically, easily traceable in dynamics. It is observed that the average evaluation of the Ruffier test for T1 and T2 falls within the "MEDIUM" category, specifically 8.44 for T1 and 6.63 for T2, and qualifies as "GOOD" for T3 with 4.80 - results obtained by the experimental class. For the control group, all three tests correspond to the "MEDIUM" category (T1- 8.12; T2- 7.66; T3-6.35)



Graphic 4. THE RUFFIER TEST

Graphic representation of the arithmetic means obtained by the students of the classes participating in the experiment.

Conclusions and proposals

The study on the influence of nutrition, hydration and recovery on the somatic and psychomotor development of students in the school's mini-handball team confirmed the working hypotheses and revealed a series of conclusions and generated proposals.

Conclusions

- It was found that a balanced and adequate diet recommended for the students in the experimental class positively influenced the somatic and psychomotor development of the students in the mini-handball team. Following the interpretation of the data from the food questionnaire, it was recommended the regular consumption of foods rich in essential nutrients, such as proteins, complex carbohydrates, healthy fats, vitamins and minerals, this having a positive impact on the performances obtained at the control tests;
- Also, monitoring the compliance with the recommended hydration practices after collecting data from the questionnaire led to the experimental class obtaining higher average values than the control class, this contributing to the awareness among students and parents of the importance of regular water consumption to prevent dehydration, especially during training and competitions;
- The supervision of the recovery and rest periods with the help of the parents proved that the students in the experimental class recorded superior results due to the adequate time allocated to rest which allowed the body to recover and rebuild itself, reducing the risk of injury and exhaustion.

Proposals:

- Implementation of an educational and practical program for students as well as for parents to promote healthy eating, adequate hydration, and proper recovery, aimed at positively impacting their health and performance;
- Establishment of a regular medical monitoring program for students, including nutritional and general health assessments, which could help in early identification of any issues and appropriate interventions.

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STAGES OF MOTOR SKILL TESTING IN FUTURE MILITARY INSTITUTION CANDIDATES

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Abstract

Testing the motor skills of potential candidates of military educational institutions is an essential stage in the selection and training process. This accurate, rigorous, and thorough assessment of the candidates' physical skills ensures that they are prepared to successfully handle the specific challenges of any mission or military education programme.
Motor skill assessments or tests have revealed that a relatively small percentage of the candidates enrolled in the selection process manage to pass the fitness tests without any previous training, while those who train easily pass these assessments, thus emphasising the relevance of preparation and training in the motor skill assessment process. This comes to point out not only individual diversity in terms of skills, but also the significant impact of training in optimising candidate performance.
This holistic approach provides useful information for candidates of military educational institutions and brings to light essential aspects and subtleties necessary for a deep understanding of the motor skills assessment and training process.

Key words: motor ability, obstacle (practical operational) course, candidates, selection, assessment.

1. Introduction

Selection is a thorough assessment of candidates' physical skills which aims at guaranteeing that they are up to the challenges of the military profession. Military personnel must be prepared to cope with various and demanding physical tasks. Regular assessments will ensure the optimal fitness level required for the efficient completion of missions.

Motor ability testing is designed to assess candidates' current level of physical fitness and their ability to withstand the rigours of military training, to respond instantly and effectively to the physical and psychological demands of combat with minimal physical exertion, and to eventually return as soon as possible to an optimal biological and mental state (Băițan, 2020).

The study focuses on testing the level of motor skills and its purpose is twofold: to look into the physical skills of a group of military educational institution candidates and to develop an effective training programme for their adequate preparation.

This thorough investigation aims both at assessing the current skill level and at identifying effective strategies to improve performance.

2. Material and method

Motor abilities refer to a set of mainly motor manifestations (abilities and skills), determined by the level of development of motor qualities, morpho-functional parameters, mental (cognitive, emotional, motivational) and biochemical

metabolic processes, which all come together, are linked to each other and mutually interdependent, resulting in the efficient performance of actions required by the specific conditions in which motor activities are carried out (Dragnea, 1984).

Ability is always demonstrated and demonstrable, unlike motor skill which is a virtuality to be built on. Most of the time, motor skills are not reduced to solving only standard situations, but various situations, and such solving is made possible through structuring and recombination of components, manifesting as an original, strictly and individual response (Dragnea et al., 2006).

The objectives of testing the motor skill level of candidates, carried out in the selection and orientation centres, are the following:

- identifying candidates who have the minimum motor skills, necessary during their future training and education process in the army, individually evaluated, after taking the established tests;
- assessing the level of development of all forms of speed manifestation: reaction (latent time of motor reaction), execution (actual speed of movement), repetition (frequency of movement) and movement. Similarly, the sense of speed (ability to maintain an optimal speed depending on the configuration of the obstacle (practical operational) course) and the speed as part of other motor qualities (in terms of endurance, skill or strength mode, referred to by some specialists as "détente") are also put to the test;
- assessing the level of skill development, particularly the components that relate to spatial and temporal orientation, to the ability to combine or differentiate movements, to the ability to coordinate body segments, to balance, precision, joint mobility (suppleness) and muscle elasticity;
- assessing a specific strength - the ability of the human body to overcome the weight of one's own body through muscle contraction (pull-ups, push-ups);
- assessing the overall resistance (aerobic and anaerobic) to physical demands of a relatively long duration and with a relatively high intensity and over a long period of time, with intense engagement of the respiratory, cardiovascular and central nervous systems of the body. (Băițan, 2016).

Assessment is an essential component of any training and education process, and it is necessary and mandatory; it has well-defined objectives and it must begin and be conducted under value control. Through assessment, we have the opportunity to know the level of motor quality indices, the complexity and variety of the system of motor abilities and skills, the attitudinal manifestation of the military, the efficiency of the means of action used and the teaching capacity of the military physical education specialists. (Băițan, 2019)

The military education and training system under the Ministry of National Defence's authority is structured into educational cycles and levels, as follows:

- university education: upper secondary (4-year military colleges) and post-secondary (2-year training of active petty officers and 1-year training of active non-commissioned officers) military educational institutions;

- university and postgraduate studies (3-6 year higher education for active officers and 2-year postgraduate studies);
- continuous vocational training programmes, career-oriented courses and further training/specialisation courses provided by military education and continuous vocational training educational institutions at non-university level - combined arms schools/training/further training centres (https://dgmru.mapn.ro/pages/invatam%C3%A2nt-militar)

In order for a candidate to be admitted to a military educational institution, the following steps should be taken first:

- recruitment;
- skill-based selection;
- actual entrance examination which consists of taking a multiple-choice test.

The selection includes examinations and specific tests that demonstrate whether or not a candidate can meet the demands of the military profession and requires the mandatory completion of the following qualifying tests which are either "passed" or "failed" after each test: motor skill assessment, which includes:

- motor skill assessment, which includes:
  - physical fitness tests that include the completion of an obstacle (practical operational) course and long-distance run;
- psychological assessment:
  - aptitude test;
  - personality questionnaire;
  - situational judgement test;
- final evaluation interview;
- medical examination.

Testing the level of motor abilities of military education candidates includes (at the moment) two types of tests that take place on the same day, in the following order:

- covering the obstacle course;
- running over a distance of 1000 metres for candidates opting for the existing spots at upper secondary military educational institutions (national military colleges) and over a distance of 2000 metres for the other categories of candidates (universities, academies and military schools). (Băițan, 2020)

The obstacle course has been implemented for many years to test candidates who wish to pursue a military career. It can be very difficult for untrained candidates, because it is made up of a series of challenges, objects and improvised means, which require special skills, mobility, speed and strength. Moreover, mental qualities are also important, such as: will, responsibility, tenacity, courage, intuition, spirit of observation, etc. (Ciapa, 2016)

Physical training with the purpose of completing the obstacle course means acquiring a complex set of motor skills (dexterity, speed, strength and endurance), with the help of exercises that are specific to gymnastics (crawling, balancing,

climbing, lifting and weight carrying) or not specific to gymnastics, but rather to athletics, such as: running, jumping, throwing, etc.

The study was conducted during the period between September and December 2023 as part of the selection process for personnel interested in joining the military system. The assessment took place in the gym of the Air Base 90 Otopeni, and a number of 57 candidates participated in this selection. For assessment, they were subjected to two distinct tests:

- the obstacle course, consisting of 10 elements (two successive broad jumps from a standing position, throwing balls at the target, push-ups, balanced walk, two successive tuck forward rolls, climbing, jumping in designated squares, crawling, lifting and carrying weights, running over a distance of 25 metres), aiming at assessing the physical and technical abilities of the participants in a context relevant to the military activity, all in 1'50".
- running over a distance of 2000 metres, in order to determine the cardiovascular resistance and capacity of the candidates, in 10'30".
- (*Methodology* number H 142/31 January 2023).

3. Results and Discussions

A study carried out on a group of 57 candidates revealed the following: 36 candidates managed to "pass" after taking the obstacle course, and 22 candidates succeeded in "passing" after running the 2000 metres, according to Figure no. 1. These candidates were not put in a special training programme and the study showed that only 38.59% managed to handle the obstacle course without training.

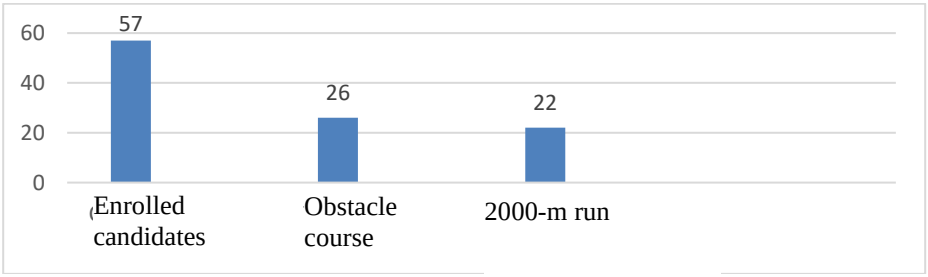

Figure no. 1. *Untrained candidates taking the motor ability test*

30 candidates were put through a special programme, for 3 months, in order to develop their dexterity, strength, speed and endurance, and when the programme ended the following was concluded: 28 candidates "passed" the obstacle course. Candidates who failed to meet the required performance score did not do their push-ups correctly, suffered penalties for their standing broad jumps and their total time was not under 1 minute 50 seconds. 24 of the candidates who "passed" the obstacle course completed the 2000-metre run in 10'30'', according to Figure no. 2.

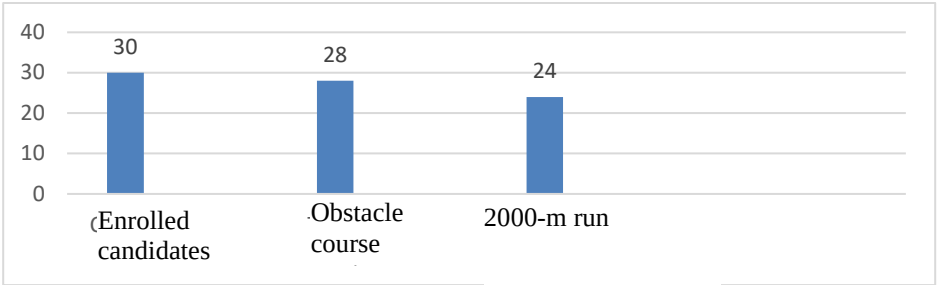

Figure no. 2 *Table of trained candidates taking the motor ability test*

The requirements provided for candidates' fitness assessment for upper secondary education and initial vocational training of active military personnel have undergone changes going from 1'40", to 1'45" and now to 1'50" for the obstacle course, and from 9'40", to 9'45" and now to 10'00" for the 2000-metre run.

Penalties for the obstacle course are 2 or 3 seconds for standing broad jumps, target ball throws, push-ups, jumps in designated squares and weight lift and carry.

A number of 57 candidates who completed the obstacle course got penalties for incorrect execution or failure to meet the markers in standing broad jumps, target ball throws and push-ups, according to Figure no. 3.

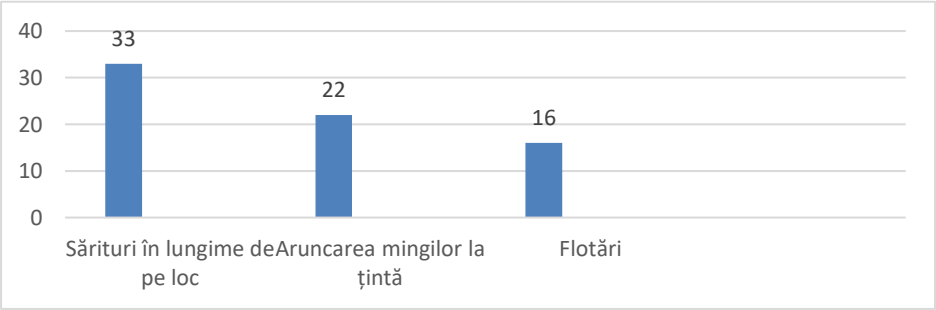

Figure no. 3. ***C****andidate penalties for obstacle course elements*

During the assessment of motor abilities it is essential to take into account the physiological differences between the sexes, including in terms of muscular strength and endurance. Thus, setting different standards for the number of repeated push-ups can ensure a fairer and more accurate assessment of the capabilities of each candidate, considering their individual body characteristics. This can help to avoid discrimination or incorrect assessments based exclusively on a general standard, which could favour a certain sex at the expense of the other.

The Ministry of National Defence should carefully examine and take steps to correct this discrepancy, since the lack of success of any woman in passing the obstacle course may indicate a possible inequity in the assessment criteria or in the specific physical training provided. This could include a review of the assessment

standards to ensure a more gender-equitable approach or providing tailored and customised physical training programmes for female candidates to give them a chance to successfully complete the obstacle course.

4. Conclusions

In order for candidates to achieve their goal of being admitted to a military educational institution, they are required to take certain steps. Enrolling in regional centres and participating in motor ability testing are important stages. Furthermore, meeting the minimum requirements in the two qualifying events, namely the obstacle course and the 1000/2000-metre run, is also key to moving up in the selection process.

Preparatory training is essential in order for candidates to successfully meet requirements and pass selection tests. A dedicated and effective programme can significantly improve the necessary physical and motor abilities. However, it is important that candidates are committed and be disciplined in following the programme. In the absence of personal effort and commitment, even the most effective training programme may not result in the desired outcome.

The recommendation to do the exercises with the appropriate or adequate intensity is essential to avoid the risk of injury and to allow gradual progress. Starting off with exercises that are tailored to a candidate's potential is key to safety in training and to reducing the risk of discomfort or pain. It is crucial that training is a positive and sustainable experience, and if pain occurs, it is vital to stop immediately in order to prevent injury.

Selection of candidates for military educational institutions, be they upper secondary schools, post-secondary schools or universities, is crucial to ensure a minimum base of physical fitness. It helps prepare students for the specific missions and physically demanding activities involved in military study programmes. By assessing candidates' physical abilities, military institutions can make sure that students are prepared to handle the specific physical requirements of a military career.

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ASPECTS OF MOUNTAIN HIKING AND THE EFFECTS ON HEALTH

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Abstract

Walking in the mountains is a complete and natural exercise that involves the whole body. Each step puts a strain on the muscles in your legs, buttocks, and abdomen, improving muscle tone and strength. Moreover, the varied terrain consisting of slopes and descents offers a real outdoor workout without the need for sophisticated equipment. A walk in the mountains is actually more than just a physical trip. It is an experience that engages all the senses and enriches the mind, body, and spirit. The breath of fresh air, the rising heartbeat, the smell of pine: these elements make this practice a true ritual of well-being. In an increasingly hectic world, the mountain offers a natural refuge, a space of simplicity and authenticity from which to draw inspiration and renew your inner balance. Mountain hikes must be done taking into account certain rules: careful planning of the itinerary, appropriate clothing and footwear, what the backpack should contain, the way it should behave on the mountain.

Key words: *mountain, hiking, rules, movement*

Introduction

Hiking is one of the most enjoyable forms of movement and relaxation, with countless positive effects on the body and mind. Walks in nature, regardless of the area explored, are beneficial for maintaining an optimal body shape, but also for an excellent mental tone.

The movement made during hiking requires almost all body regions: legs, knees, ankles, hands, hips, gluteal and abdominal muscles, etc. In addition, this type of physical exercise induces a state of good mood, training the imagination and awakening all the senses (https://www.sfatulmedicului.ro/Sanatate-prin-sport/efectele-pozitive-ale-drumetiilor-asupra-corpului-si-a-mintii_13509).

From a medical point of view, hiking is an excellent aerobic exercise, which has numerous positive effects on health. Regardless of the degree of difficulty of a hike, going to the mountains offers the inspiration of fresh air. The benefits of mountain hiking are mental, cardiovascular, muscle levels increase, a state of well-being that leads to better sleep and, last but not least, a normal body weight is maintained (https://coltisorderomania.ro/2020/12/03/7-beneficii-pentru-sanatate-prin-practicarea-drumetiei-montane/).

Walking in the mountains is not only a stimulus for the muscles, but also for the heart. It promotes blood circulation, reduces blood pressure and improves cardiovascular health. Climbing non-linear paths is a natural way to increase the pulse, avoiding the fatigue typical of more intense workouts (https://www.google.com/search?q=beneficiile+mersului+la+munte&rlz=1C1GCE

A_enRO1084RO1084&oq=beneficiile+mersului+la+munte&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigAdIBCTEzNjI5ajBqNKgCALACAQ&sourceid=chrome&ie=UTF-8)

The mountain is the perfect opportunity to be in the middle of it and enjoy every hidden corner. Moreover, it is the perfect opportunity to escape either for a day, or on a vacation of a few days in a carefree place, with a lot of peace away from the daily hustle and bustle you are used to. The feeling of freedom you get once you've managed to walk a route can't be matched by anything else. Movement and walking in the mountains will help maintain or form an optimal physical condition. We know that the first routes will not be exactly easy to do and comfortable, especially for a beginner. But, perseverance is the key. You will get used to it gradually, so you don't have to choose difficult routes at first. Equipment is also very important. From clothes to boots, everything must be chosen properly.

The mountain disciplines you, teaches you to be a more organized person, but also patient. From the moment you choose the route, you make a well-established plan to follow when you get to the mountain (https://www.oxigentour.ro/beneficiile-mersului-pe-munte).

Climbing the mountain can reduce the risk of various health problems, such as heart disease, obesity and diabetes. This type of cardio movement can reduce cholesterol levels, control or prevent hypertension, increase the speed of blood movement and help eliminate accumulations in your veins. In addition, it helps you get rid of extra calories (a mountain walk that covers 3.2 km/h helps a 68 kg person burn 240 kcal in those 60 minutes, for example).

Moving in the mountains also means improved muscle and bone health. Hiking helps you develop your muscles, strengthen them and get rid of the fat that covers them. Frequent visits to the mountains help your bones to be put to work in a more intense manner than in the case of daily movement, so your bone density will increase (due to the compression put on the bones during the climb), and osteoporosis can be kept at bay more effectively. Mountain trails rid you of negativity and depression (https://sanovita.ro/blog/-iti-ajuta-urcatul-pe-munte-mintea-sufletul-si-corpul/).

Mountain hiking or walking that includes a difference in level (ascent and descent) is considered one of the most complex and beneficial physical exercises that we can do with our body (https://mariuscpopa.ro/2023/02/14/beneficiile-drumetiei-montane/):

- Muscle development.
- Strengthening the bone system.
- It improves the cardiovascular system and significantly reduces the risk of heart disease.
- It improves the respiratory system and reduces the risk of lung diseases.
- Regulates blood pressure.
- It reduces the risk of certain cancers by up to 50%.

- It helps control blood sugar levels and is considered one of the most effective activities in the fight against diabetes.
- Burning a high number of calories and efficiency in the fight against obesity. A caloric consumption is estimated between 300 and 600 kcal / hour.
- Improves sleep and appetite.
- Developing balance and flexibility.

In addition to the physiological benefits, psychological studies in recent years demonstrate the importance that nature and the mountain have on our mental health:

- Reducing stress and anxiety by decreasing the activity of the prefrontal cortex.
- It helps in the fight against depression.
- Increasing the ability to concentrate by paying attention to the senses.
- Relaxation and well-being.
- Frustration tolerance increases – through gradual exposure to difficulty, adverse weather conditions, rough terrain and other risks encountered in nature, desensitization to frustration is created, increasing the level of resilience.
- It increases self-esteem and self-confidence – by successfully completing tour objectives and managing risks responsibly. Often the mountain shows us that we are stronger than we initially thought.

Hiking rules for tourists:

* Suitable for the mountains and not "suitable for the mountain"! Most mountain accidents are due to fatigue and exhaustion. That is why proper training is absolutely mandatory. Sometimes a hike in the mountains can become a problem of survival.

* No hike without careful planning. Every hike requires careful planning, with a guide and a map. Carefully determine the necessary equipment and find out about the chosen route. The map, the compass, a first aid kit, energy food, the flashlight, the raincoat, the description of the place are things that you should not miss, even if the route is marked or you have been there once. Walk a route in winter only after you have travelled it in summer and know it very well.

* After the start, slower walking to warm up the body, after which the speed of movement is set according to the weakest member of the group, his heart rate should not be higher than 130/minute. Don't force the pace, don't cut the serpentines. Spare your strength.

Never travel alone on the mountain! Like any sport, mountain tourism is practiced only in groups. A loner can easily get lost, fall into an abyss or avalanche. A group has a leader and never breaks up.

* After every two hours of walking, ten minutes break Each member of the group will eat and drink something, even if they do not feel the need (especially then). In case of fatigue or exhaustion, take a longer break (or turn around). In the mountains you have to know what, how much and when to eat! The functions of the

body in a mountain march undergo continuous changes. Eat bread, biscuits, chocolate (fructose-free) and drink as many liquids as possible. Rather than conquering the summit with the last of your strength, it is preferable to turn back, because it follows the descent route. In case of exhaustion, do not take medication! Wrong ambitions can cause death!

* During the hike, the basic rule is: drink, drink, drink! That is, on any occasion, before and during the route, on average at least three litters during the day. The consumption of liquids rich in mineral salts is decisive in any hike.

* Appropriate equipment: Make sure you have shoes and clothing suitable for the mountain. Layers of clothes are recommended, so that you can adapt to temperature changes. At the same time, don't forget the light source and spare batteries for your phone and flashlight (https://foaiatransilvana.ro/zece-reguli-esentiale-pentru-drumetie-pe-munte/).

* Do not overload children. Routes with children require careful and diversified planning and must be properly organized.

* After exceeding the altitude of 2000 m, allow the necessary time for "acclimatization". The higher, the slower! Every person has to get used to high altitudes; otherwise, unpleasant surprises may occur. Pay attention to the first signs of disorder (headache, cough, insomnia).

* Do not underestimate the dangers of the weather. The success of a hike increases and decreases depending on the weather. Observe the weather carefully – even before the hike. When the weather changes suddenly, return in good time. In case of a storm, look for safe places and leave ridges and exposed places.

* Do not leave the route. Only walk on marked routes. It is contraindicated to embark on unknown routes. On the mountain, the danger of getting lost is great, especially since there are areas that are not yet marked or with poor tourist markings. If you have lost your way, keep calm and look for safe ground if possible. If you can't find it, stay put. Do not risk anything and do not try, in any way, to "go downhill". Stay put and start the emergency alpine signalling. An optical or acoustic signal six times a minute, then a one-minute pause, and continue until you receive an answer. If you leave directions to the route, you are following everywhere before setting off, you will be found quickly. No panic in case of an accident.

In any backpack, no matter how small, there is enough room for the mandatory emergency equipment: bivouac bag, spare laundry, flashlight with spare batteries, alpine first aid kit, etc.

* On the mountain, tourists met on the route are greeted. Usually, they greet the tourist who is going down and not going up. Help the one in difficulty.

*Light the fire only in specially designed places. Supervise it and turn it off completely at the end. Throw garbage only in specially designed places.

What practical activities can be done in the mountains?

- Climbing
- Hiking
- Orientation

- Adventure Park
- Winter Sports
- Paragliding
- Bungee Jumping
- Bike Rides or ATV
- Horseback Riding

Conclusions

1. The mountain offers, in addition to the special landscapes and clean, unpolluted air, a high degree of satisfaction to those who respect it and adopt an appropriate behaviour.
2. The mountains, with their majestic peaks and breath-taking landscapes, offer much more than a spectacular view. A trip to these places is not only an experience for the eyes, but also an improvement in well-being for the body and mind. The practice of mountain walking, often underestimated, is a path to general well-being, offering benefits that extend far beyond physical appearance.
3. The mountain does not forgive, the mountain demands respect. A good method from which we can draw inspiration to do things on the mountain comes from the army and is discipline. On the mountain it is very important to always do things in a responsible way and with special attention, no matter how trivial it may seem and no matter how knowledgeable you are. Through habits and routine, the risk of unpleasant situations can be greatly reduced.

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THE IMPACT OF SPORTS TOURISM ON THE DEVELOPMENT OF INBOUND TOURISM IN THE REPUBLIC OF MOLDOVA

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Abstract.
In recent years, tourism and sports have become two interdependent sectors, which have created the conditions for sports tourism to become one of the tourism forms on the rise in the national and international tourism market. The fruitful results of athletes from the Republic of Moldova recorded in recent years, as well as the creation of sports infrastructure, led to the organization of friendly competitions with teams from various countries, the organization of tournaments able to highlight the training of athletes, but also the development of the tourism sector in the Republic of Moldova. Sports tourism in recent years has become a form of tourism that is required in the incoming tourism, and this fact is noticeable through the flow of tourists visiting the country. At the same time, the accommodation structures in the rural environment are increasingly interested in the organization of different forms of sports tourism: nautical, pedestrian, mountain tourism, etc., which involve the tourist in capitalizing on the tourism potential of the country, but also increasing the indicators of this sector. In this regard, the present study comes to identify the impact that this form of tourism has on the receiving tourism, but also on other important areas of the national economy.

Keywords: sports tourism, incoming tourism, tourist indicators.

1. Introduction

Now, Tourism for any country represents a sector that annually attracts tourists eager to visit touristic places and objectives, and more recently to practice various sports or visit sports different rank events. This fact implies the development of incoming tourism in the region where the event takes place, which also implies its socio-economic development. Thus, (Patrascu, 2009, Vesca, 2019) are of the opinion that incoming tourism represents the travel of non-residents to a certain country, other than the one of origin. In this sense (Asaftei, 2008) is of the opinion that the impact of incoming tourism on a region of tourist interest, such as the regions where sports events take place, is characterized by a system of indicators that highlight the development of the tourism industry. That is why, in the context of the development of sports tourism in the Republic of Moldova, incoming tourism becomes an essential economic growth factor in the promoting and developing regions, a fact observed by the growing number of tourists who come to support their favorite teams, to be with those who practice sports, or participating as athletes in a certain sports event. This fact was also noted by (Raso & Cherubini, 2024), who mentions that sports tourism is currently subject to more and more studies in the context of its status as the fastest growing form of tourism.

2. Material and methods

The purpose of this study is the analysis of the impact that sports tourism has on the incoming tourism in the Republic of Moldova.

*Research objectives***:**

1. Analysis of the specialized scientific-methodical literature regarding the impact of sports tourism on incoming tourism.
2. The characteristics of the biggest sports events in recent years on the incoming tourism of the Republic of Moldova.
3. The role of sports tourism on the indicators of incoming tourism in the Republic of Moldova in recent years.

Research methods

In order to carry out the research, there were used research methods necessary to solve the proposed goal and achieve the established objectives, such as: analysis of specialized scientific-methodical literature, observation method, comparative method, statistical-mathematical analysis.

3. Results and Discussion

The major lack of sports infrastructure in the Republic of Moldova significantly influenced the contribution of tourism form in the tourism industry until 2015. In this context, the authorities of the Republic of Moldova, through the strategies implemented in this field, initially tried from a tourism form with growth perspectives to bring it among the priority field, resulting from significant investments in the country's sports infrastructure, through the construction of buildings for various sports events (soccer, beach rugby, rhythmic gymnastics, football, etc.). Currently, many tourists who practice sports and attend sports events are interested in new destinations where they take place, because this fact also implies visiting the respective region (Platon, 2017). This is why sports tourism in the Republic of Moldova represents an ideal opportunity for foreign tourists to get to know the country's tourism potential.

The sports events of recent years held in the Republic of Moldova have significantly favored the attraction of foreign tourists, eloquent examples being Chisinau International Marathon, the European Junior and Under-15 Weightlifting Championship, the South-East European Championship for sports (tourist) orientation, etc. which brought together hundreds of athletes from various countries. The conducted research shows that more attend the Chisinau international marathon and more running fans from the Republic of Moldova and abroad, and this fact requires the organizers to identify viable solutions for the organization of this event (Figure 1).

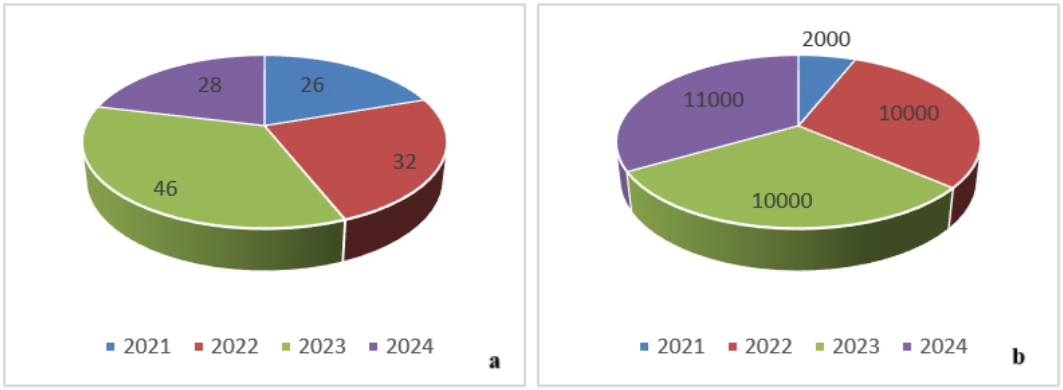

Fig. 1. Number of participating countries (a) and athletes (b) in the Chisinau International Marathon in 2021-2024

From figure 1, it can be seen that the number of those participating in this large-scale event is a significant one, which is constantly increasing, which means that during its implementation the accommodation structures are occupied by participants from countries such as: Bulgaria (BG), Belgium (BE), Brazil (BR), Canada (CA), Switzerland (CH), Czech Republic (CZ), Germany (DE), Denmark (DK), Finland (FI), France (FR), Greece (GR) , Great Britain (GB), Hungary (HU), Italy (IT), Kazakhstan (KZ), Moldova (MD), Malaysia (MY), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Russia (RU), Sweden (SE), Turkey (TR), Ukraine (UA), United States (US), Uzbekistan (UZ) (2).

Another event that had a major impact on the flow of tourists at the national level was the organization in the Republic of Moldova in 2023 of the European Weightlifting Championship for juniors, 2023 EWF European Youth and U15 Championships (Figure 2).

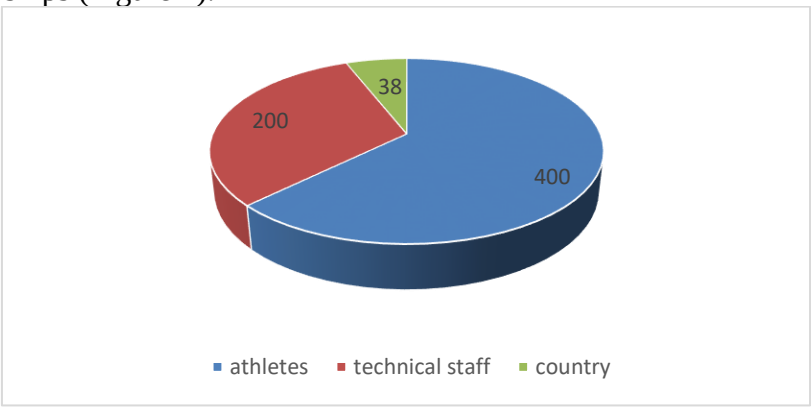

Fig. 2. Number of participants and countries at the European Junior Weightlifting Championship, 2023 EWF European Youth and U15 Championships, Chisinau, Republic of Moldova

Undoubtedly, this fact certainly represents a factor in the development of Moldovan incoming tourism, which in the last five years denotes an increase in the number of tourists, which is also due to the sports events that take place more and more frequently in the Republic of Moldova (Figure 3).

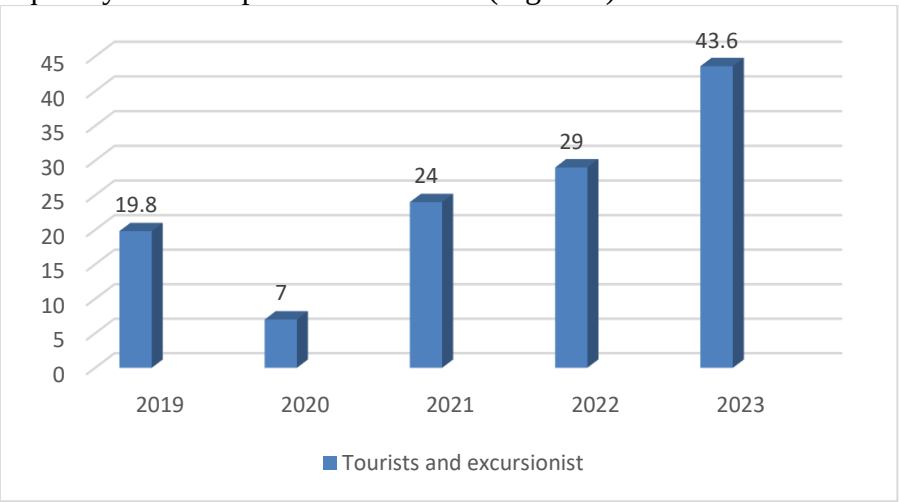

Fig. 3. Number of tourists and hikers in incoming tourism from the Republic of Moldova between 2019-2023 (thousands)

The data presented in figure 2 highlight the fact that the number of tourists and hikers in incoming tourism of the Republic of Moldova after the pandemic period has recovered, and the figures recorded in 2023 prove that it exceeded expectations. A wide range of tourism forms promoted and developed by the state authorities, including sports tourism, influences all this. Or, the good evolution of the national football team, but also of the club teams in recent years, has created eloquent premises for the supporters of different teams to come to the Republic of Moldova to support their favorites, but also to taste the local gastronomy and Moldovan wines. Thus, regardless of the organized sports event, the local accommodation structures also registered a growth trend that implied an increase in both the number of tourists' accommodations (Figure 4).

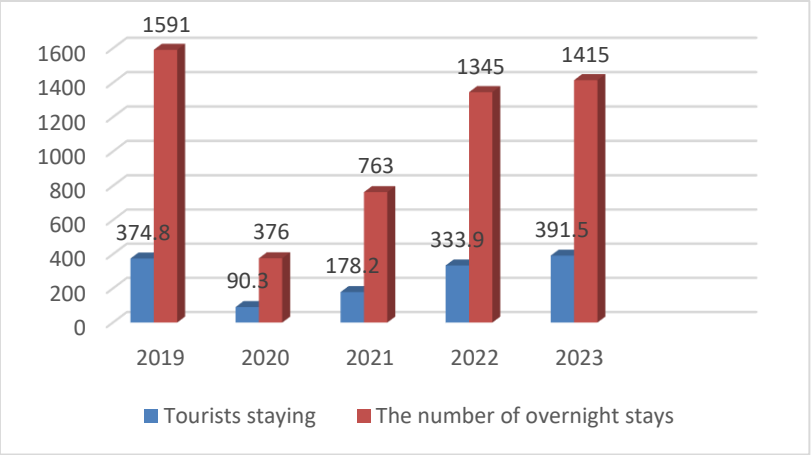

Fig. 4. The number of tourists (thousands) and accommodations in the Republic of Moldova 2019-2023 due to the rise of sports tourism in the last 5 years

The data in figure 4 demonstrate that the accommodation sector represents a key element in the development of sports tourism, which has registered significant progress in recent years and which adapts to the needs of tourists by equipping accommodation spaces with: infrastructure for athletes to relax, areas/halls training, adapting restaurant menus according to athletes' preferences, etc.

Another essential indicator in the monitoring of tourism activity in the Republic of Moldova, which demonstrates the development of the sector and the contribution of sports tourism to this growth, is the financial result of tourism enterprises, including the incoming tourism. Thus, in 2023, compared to 2022, the receipts of tourism enterprises increased - by 865.3 million lei or by 26.1% more, hence from inbound tourism - by 11.1 million lei, which represented an increase of +32.1%. The presence of tourists due to sports tourism demonstrates its contribution to the economy of the country, the region, which is significant, and this fact implies the provision of quality services for accommodation, meals, transport, leisure and, last but not least, the efficient organization and due to the standards of the expected sports events (Figure 5).

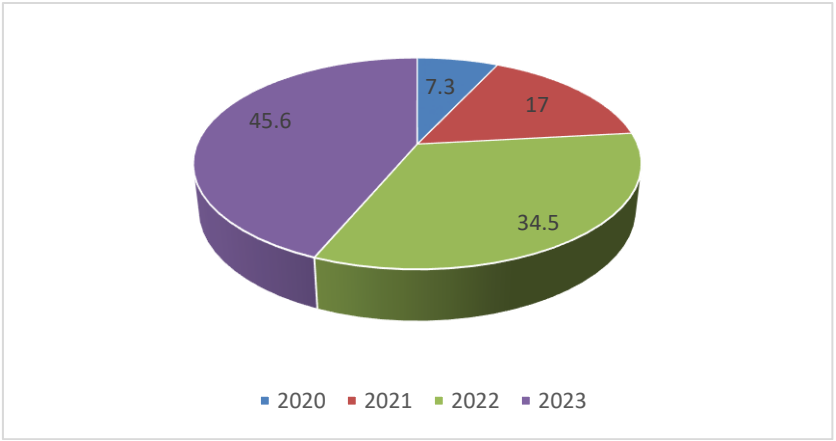

Fig. 5. Incoming tourism receipts in the Republic of Moldova due to the development of domestic sports tourism in 2020-2023 (millions, lei)

The data obtained according to Figure 5 demonstrate that the receipts from tourist activity in the period 2020-2023 in the Moldovan incoming tourism is increasing from 7.3 million lei in 2020 to 45.6 million lei in 2023. Therefore, the authorities in the new tourism development strategy have paid more attention to sports tourism, a fact that will become, through Moldovan athletes recognized at the international level, a key element in the promotion of local socio-cultural values, contributing essentially to the image tourism of the country. The remarkable results of the Moldovan athletes in some sports events, but also the revival of some sports buildings created premises for the specialized international sports forums to offer the Republic of Moldova the opportunity to organize large-scale sports events, which attract hundreds and thousands of athletes, supporters and staff technical in various sports events.

4. Conclusions. In the last period, sports tourism in the Republic of Moldova has begun to stand out both from the point of image view that it forms, but also through its contribution to the development of domestic tourism. The carried out studies demonstrate that in the context of the increase in the number of sports events with an international connotation in the Republic of Moldova, such as Chisinau International Marathon, the European Junior Weightlifting Championship, etc., which attract hundreds and thousands of athletes, technical staff and supporters, sports tourism has influenced the increase in the number of tourists and hikers from 19.8 in 2019 to 43.6 in 2023 and here we refer to the incoming tourism. At the same time, sports tourism in the Republic of Moldova also contributed to other indicators of tourist activity, such as the number of tourists accommodations, which increased from 374.8 in 2019 to 391.5 thousand tourists in 2023, the number of overnight stays, but also receipts from incoming tourism, which had an increase of 38.3 million lei in 2023 compared to 2020. Thus, it can be said that the directions that domestic sports tourism has drawn have been reached, and the next tourism development strategy

makes this form of tourism hold a key position alongside other traditional forms of tourism for the Republic of Moldova, and this fact is nothing more than conclusive proof of the impact it has on the tourism industry.

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ASSESSMENT OF THE LEVEL OF BODY RESISTANCE OF ADOLESCENT ATHLETES TO DIFFERENT LOADS IN BODYBUILDING

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Abstract. *The study purpose*. Determination of the level of body resistance of adolescent sportsmen to different power loads in bodybuilding using the spectral analysis of the heart rate variability method. *Materials and methods.* The study involved 60 adolescents aged 15-16 years who had been engaged in bodybuilding for 18 months. For each group, an experimental model of power load regimes was developed. The adolescent athletes had a low level of resistance to these models. A heart rate monitor "Polar RS800CX" was used to record the parameters of spectral analysis in the study participants. *Results*. The obtained results showed that both group representatives had a high level of very-low-frequency oscillations of cardiac intervals (VLF) in the range of 61.2-66.1% before exercise. After using the power load regimen 1 (R_a=0.58) by one of the groups, the vegetative balance (LF/HF) increased 5 times compared to the state of rest. *Conclusions*. The power load regimen 1 (R_a=0.58) used by adolescent athletes in bodybuilding training promoted the greatest increase in the parameters of VLF and LF/HF indicators, as well as a decrease in the level of LF and HF. These changes in the spectral analysis indicators reflect the priority predominance of the central circuit of heart rhythm regulation due to the activation of neurohumoral and metabolic factors.

Key words: *bodybuilding, adolescent athletes, heart rate variability, resistance, power load.*

1. Introduction

The search for effective mechanisms for improving the bodybuilding training system, taking into account the age characteristics of athletes, is causing a wide range of discussions not only among leading scientists in this sport but also among specialists in medicine and biology (Chen & Nakagawa, 2023). The implementation of this problem requires researchers to conduct several experimental studies using physiological and biochemical diagnostic methods to determine clear criteria for assessing the optimal load limits for a certain age (Chernozub et al., 2023).

Determining the optimal parameters of intensity and volume of loads adequate to the functional capabilities of the adolescent body in the conditions of bodybuilding is one of the most difficult problems in this kind of sport (Chernozub et al., 2018; Latino & Tafuri, 2024). The complexity of this problem is associated with the destabilization of the neurohumoral system of their body caused by the peculiarities of puberty (Korobeinikova et al., 2024).

One of the key factors in solving the problem related to the development of optimal load regimes for adolescent athletes is to determine the limits of their body resistance to the relevant physical stimuli. According to a number of authors (Balakarthikeyan et al, 2023; Grégoire et al, 2023), the use of the heart rate variability

method in the practical implementation of this problem is an effective marker for assessing the state of regulatory mechanisms and neurohumoral regulation of cardiac activity. In most cases, it is the spectral analysis indicators that allow the determination of the level of resistance of the body to the magnitude of the load, based on monitoring the processes associated with the activation of the central circuit and the enhancement of sympathetic regulation of the cardiovascular system.

The study purpose. Determination of the level of body resistance of adolescent athletes to different power loads in bodybuilding training using the spectral analysis of the heart rate variability method.

2. Material and method

The study involved 60 adolescents aged 15-16 years who had been engaged in bodybuilding for 18 months. Two experimental groups of 30 people (A and B) were formed. For each of the groups, we developed experimental models of power load regimens. Adolescent athletes had a low level of resistance to these models as they had not used such loads in bodybuilding before. During the research, group A used power load regimen 1 (R_a=0.58), and group B – power load regimen 2 (R_a=0.70).

The spectral method of heart rate variability analysis was used to provide information on the power distribution depending on the frequency of oscillations. The following indicators were studied: high-frequency spectrum of cardiac intervals (HF, %), low-frequency spectrum (LF, %), very-low-frequency spectrum (VLF, %), and the index of vagosympathetic interaction (LF/HF). These parameters were evaluated at rest and after exercise under the conditions of using the proposed modes by the participants of the study. A heart rate monitor "Polar RS800CX" (Finland) was used to record the parameters of spectral analysis in the examined adolescent athletes.

Statistical analysis of the study results was performed using the IBM *SPSS*Statistics 26 software package (StatSoftInc., USA).

3. Results and Discussions

Table 1 presents the experimental models of power load regimens used by adolescent sportsmen in bodybuilding.

The main difference between the presented models of power load regimens is the value of the used parameters of the work amount. At the same time, the parameters of the work amount, in the given conditions of muscular activity, depend on the features of the exercises used and the recruitment of certain types of motor muscle units. The variability of the combination of the above load components has a significant impact on the parameters of the projectile working mass and the work amount in each set.

Table 1 *Models of power load regimens used by the examined groups during the research*

Models of power load regimens	Main characteristics
Power load regimen 1 (R_a=0.58)	Priority usage of loads with a large amount of work. The main energy source is muscle glycogen. Exercises are performed with full amplitude with an emphasis on increasing the duration of the negative phase of the movement. The predominant involvement during muscle contraction of fast contractile muscular motor units of type A. Exercises with a wide range of simultaneous involvement of a large number of synergists and stabilizers are used together with muscle agonists. In the main sets, the projectile working mass is 62-65% of 1RM.
Power load regimen 2 (R_a=0.70)	Prioritizes the use of exercises with a low amount of work. A combined mechanism of ATP resynthesis is used through creatine phosphate and muscle glycogen. The activity of fast contractile muscle units of type B is increased. Exercises with a wide range of simultaneous involvement of a large number of synergists and stabilizers along with muscle agonists are used. Isolated exercises with preliminary exhaustion of synergist muscles are used. The indicators of the projectile working mass in the main sets are 71-76% of 1RM.

The results of changes in the indicators of spectral analysis of heart rhythm in the examined adolescent bodybuilders during the research are presented in Table 2.

The analysis of the results obtained at rest before exercises indicates that there was no difference in the indicators of low-frequency oscillations of cardiac intervals (LF) and vegetative balance (LF/HF) in participants of both groups. However, there was a significant intergroup difference between the parameters of cardiac interval power (Total).

The study showed that representatives of both groups had a high level of very-low-frequency cardiac interval fluctuations (VLF) in the range of 61.2-66.1% before exercise. The reference values of this indicator range from 15-30%. This fact testifies to the tension of all regulatory systems (hyper adaptive state of the organism) in adolescents of both groups engaged in bodybuilding.

Table 2 *Parameters of spectral analysis of the heart rate of the representatives of the examined groups during the study, (median, interquartile range (IQR), n=60*

1. 2. Indicators 3.	4. Groups 5.	6. Before exercise 7. (at rest)	8. After exercise
9. Very-low frequency spectrum, % (VLF)	A	61.20 (15.7)	96.50 (4.7) *
	B	66.10 (10.6)	85.25 (5.8) *
10. Low-frequency spectrum, % (LF)	A	23.60 (12.1)	3.10 (4.9) *
	B	23.70 (13.2)	11.92 (6.1) *
11. High-frequency spectrum, % (HF)	A	15.20 (4.2)	0.40 (0.4) *
	B	10.20 (7.9)	2.83 (0.9) *
12. Total, мс^2	A	4486.15 (2882.13)	1379.00 (739) *
	B	2322.49 (2509.82)	1072.00 (136) *
13. LF/HF ratio, ms^2	A	1.55 (2.11)	7.75 (1.21) *
	B	2.32 (1.99)	4.21 (1.42) *

*Note: *is p<0.05, compared to the state of rest (before exercise)*

At the beginning of the study, the athletes of group B had the index of high-frequency oscillations of cardio intervals (HF) of 10.2% of the total spectrum power at a norm of 15-25%. This fact indicates a shift in the autonomic balance towards the predominance of the sympathetic system in representatives of group B before exercise.

The results of the spectral analysis after using the developed power load regimens demonstrated different trends of changes. The advantage of the very-low-frequency spectrum of heart rhythm oscillations was revealed, especially in the group of sportsmen after using the power load regimen 1 (R_a=0.58). The most pronounced decrease (by 3.2) in the total power of the spectrum of cardio interval oscillations was observed in athletes of group A who used the load with a large amount of work. This fact testifies to the decrease in the total level of activity of different links of the regulatory mechanism.

After using the power load regimen 1 (R_a=0.58) by one of the groups, the vegetative balance (LF/HF) increased 5 times compared to the state of rest. This fact indicates the strengthening of the central mechanisms of neurohumoral regulation of heart rhythm due to a decrease in the parasympathetic activation of the autonomic nervous system to the sinus node.

4. Conclusions

Application of the power load regimen 1 (R_a=0.58) by adolescent athletes in bodybuilding promoted the greatest increase in the parameters of VLF and LF/HF indicators, as well as a decrease in the level of LF and HF. These changes in the spectral analysis indicators reflect the priority predominance of the central circuit of heart rhythm regulation due to the activation of neurohumoral and metabolic factors.

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DYNAMICS OF ADAPTIVE CAPABILITIES OF FEMALE STUDENTS WITH VARIOUS LEVELS OF PHYSICAL ACTIVITY DURING OVARIAN-MENSTRUAL CYCLE,

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Abstract
In the conditions of modern life with its rapid pace of inconstancy, growing requirements to people, one of the important problems is the problem of adapting the body to constant social, economic and environmental changes. The complexity of this process for women is also determined by a specific biological cycle – the ovarian-menstrual cycle. Recent scientific studies emphasize the need to assess women's adaptive capacities based on the ovarian-menstrual cycle.
58 female students of the Ushynsky University who had had no any cycle disorders during the previous three cycles, participated in the research.
Using the methodology of R. M. Bayevsky and the relevant criteria, we evaluated current adaptive capacities of the female students' body in each phase of the ovarian-menstrual cycle. Low health indicators indicating unsatisfactory adaptive capacities of female students were found in the group of girls with insufficient physical activity. Cycle ergometer studies, according to average statistical data, revealed the highest manifestations of physical performance in the premenstrual phase of the cycle. At the same time, an individual analysis shows that a significant number (30-32%) of the tested demonstrated an increase in physical performance in the postmenstrual and postovulatory phases of the cycle.
A credible close interrelation between the level of physical performance of girls and the index of functional changes has been established.
Key words: *adaptive potential, girls, level of physical activity, ovarian-menstrual cycle.*

1. Introduction

For many years, cyclical fluctuations in the intensity of physiological and biological processes have attracted scientists of various fields. Numerous studies have shown that the functional state, performance, and reactions of the body to stimuli depend on rhythmic changes. Specifying the mechanisms of individual organization of the body's homeostasis is of great theoretical and practical importance in predicting, monitoring and correcting human health.

The female body requires special attention in this matter. The clearly expressed cyclicity of the reproductive system affects all components of women's vital activity.

The main criterion for adaptation of the human body to various factors of external or internal influence is the adaptive potential or adaptive capacities. They are important physiological indicators of the body's vital activity, in the formation of which a complex of physiological systems of the body takes part.

Among the variety of methods for testing adaptive capacities, it is difficult to

distinguish those that can quantify the level of health. When analyzing adaptive capacities, foreign experts use the concept of "physical fitness" and make difference between the health and the ability to perform specific aspects in sports or in the profession [5].

Today, the methods of R. M. Baevsky [3], K. Cooper [7], and H. L. Apanasenko [1] are most often used to assess individual health. The volume of research on quantitative assessment of adaptive capacities based on donosologic diagnostics [2, 4, 6] is growing. The so-called functional change index (FCI), proposed by A. P. Bersenova to determine the levels of adaptation according to R. M. Baevsky, is very popular.

The purpose: to define dynamics of adaptation possibilities of 17-22 years old girls with different levels of physical activity during the ovarian-menstrual cycle (OMC).

2. Material and method

The research was conducted at the Department of Physical Rehabilitation, Biology and Health Care of the State Institution "South Ukrainian National Pedagogical University named after Kostiantyn Ushynskyi" at the Laboratory of Functional Diagnostics named after Professor T.M. Tsonieva. All participants were familiarized with the terms of the study in accordance with Articles 5 and 6 of the Universal Declaration of Bioethics and Human Rights (2005).

During one full cycle 58 female students were examined, including 30 girls – students of the Faculty of Physical Education, who trained in accordance with the schedule of the educational process and had a level of sports qualification from III to I category. They made up the first group of subjects – with high motor activity (HMA). The second group of girls (n=28) with low motor activity (LMA) were students of the Institute of Primary and Humanitarian and Technical Education who did not go in for any sport, did not attend sports clubs or fitness clubs.

Before each test, a questionnaire took place to find out how they were feeling, at what time they were eating, their emotional condition, readiness for the study, etc. The studies were conducted in standard conditions, in the first half of the day.

The menstrual cycle is a specific biorhythm of the female body and is represented by the period from the first day of the previous menstruation to the first day of the next. Cyclical changes in the concentration of female sex hormones in the blood enable to conditionally divide the menstrual cycle into phases. There is still no single classification of the phases of the menstrual cycle. According to the classification of the Endocrinology Laboratory of the Institute of Gerontology of the Academy of Medical Sciences of Ukraine, the menstrual cycle is divided into five phases: menstrual, postmenstrual, ovulatory, postovulatory, and premenstrual [8]. All girls had regular menstrual cycles, which made it possible to determine the phases of the menstrual cycle using the calendar method and the results of a special questionnaire. The examined persons had no surgeries or injuries, did not take contraceptives or medications that in any way affected their functional capabilities.

To study girls' physical performance, we used the method of dosed cyclic load testing with reverse [6]. This technique enables to identify not only indicators of physical performance and the reaction of the cardiovascular system, but also to establish the regulatory and energy components of the systemic response of the human body. Compared to the well-known method of physical performance assessment PWC_{170}, it is regarded as more informative, takes less time and does not require high stress on the supporting and regulatory systems.

The group of physical performance indicators was accepted as the main one for solving the purpose and included 8 criteria: load reversal power (Wrev, W), total work time (Ttot, min), total work performed (Atot, kJ), absolute and relative indicators of general physical performance (PWC_{170}, W; PWC_{170}/kg, W/kg) and maximum oxygen consumption (MOC, ml/min; MOC/kg, ml/min/kg).

Adaptive potential (AP) is determined without conducting stress tests and allows for a preliminary quantitative assessment of the health level of the subjects. AP is calculated by the formula:

AP=0.011HR+0.014sBP+0.008dBP+0.014A+0.009BW-0.009BL-0.27,

where: AP - adaptive potential, units; HR - heart rate, beats/min; SBP - systolic blood pressure, mm Hg; DBP - diastolic blood pressure, mm Hg; A - age, years; BW - body weight, kg; BL - body length, cm. The analysis and conclusions concerning the level of adaptive capacities of female students were determined by the scale of the index of functional changes [3, 6].

The results of experimental researches were processed by means of the statistical package Microsoft Excel with the calculation of the following indicators: arithmetic mean (M); mean square deviation (δ); error of the arithmetic mean (m); coefficient of variation (CV); Student's reliability criterion (t).

3. Results and Discussions

The level of physical development is generally accepted [6, 11] to be determined by a set of characteristics, which primarily includes body length, chest circumference (CC), vital capacity of lungs (VCC), body weight, and dynamometry (Table 1). Anthropo- and physiometric measurements were performed once before the examination.

Table 1 *Indicators of physical development of girls aged 17-22 years with different levels of physical activity (M±m).*

Indexes	I group (HPA) (n=30)			II group (LPA) (n=28)		
	M±m	δ	CV (%)	M±m	δ	CV (%)
Body length standing, cm	164.6±0.65	3.55	2.15	163.5 ±0.96	5.09	3.11
Body length sitting, cm	87.65±0.47	2.57	2.93	86.5±0.45	2.36	2.73

Body weight, kg	60.25±1.16	6.36	10.55	53.77±1.08***	5.71	10.61
CC calm, cm	85.9±0.89	4.89	5.69	82.84±0.61**	3.23	3.89
CC breathe in, cm	91.88±0.85	4.65	5.06	87.7±0.94**	4.96	5.66
CC breath out, cm	83.17±0.85	4.65	5.59	80.05±0.52**	2.73	3.41
VCC, **ml**	3236.67±75.89	415.65	12.84	3014±93.79*	496.28	16.46
Hand grip dynamometry, leading hand, kg	28.63±0.98	5.38	18.79	24.61±0.94**	4.96	20.17
Static dynamometry, kg	74.27±2.9	15.89	21.4	48.04±1.88***	9.93	20.66

Notes: * – $p<0.05$, ** – $p<0.005$, *** – $p<0.001$ for HPA – LPA

Most of the criteria of physical development of female athletes, with the exception of body length, dominated the similar indicators of their peers with the low level of physical activity. This confirms the existing ideas about the higher development of some indicators on the background of the overall improvement of the physical condition of girls specializing in a particular sport. Physical development of girls of both groups corresponded to age and sex norms (standards) [11] and results of researches previously conducted by the authors in Odesa and Odesa region [6, 11].

In the sitting position on the cycle ergometer with the beginning of work, when the load power was still equal to zero, the initial heart rate of the examined girls was recorded, that of the HPA individuals on average during the menstrual cycle ranged from 69. 13±1.12 bpm (ovulatory phase) to 73.47±1.38 bpm (menstrual phase), and in respondents with LPA – from 74.89±1.27 bpm (menstrual phase) to 79.18±1.41 bpm (premenstrual phase). According to the authors of the methodology, the HR onset characterizes the pre-work stress of the body and affects the further dynamics of the heart rate and other adaptation criteria.

The higher values of HRini during this period are not typical for the initial resting state, since registration thereof occurred in the first seconds of work. Significantly lower values of heart rate at this stage of the study in case of the trained girls were noted in the postmenstrual and the ovulatory phases ($p<0.05$) and higher in case of the untrained girls – in postovulatory and premenstrual phases ($p<0.05$) in relation to the menstrual phase of the cycle.

Comparative intergroup analysis of initial HR dynamics revealed significant changes ($p<0.05$) towards its decrease in each phase, except menstrual, which may indicate an increase in the tone of the parasympathetic division of the nervous system and lower reactivity of the cardiovascular system (CVS) of girls with a high level of motor activity at the beginning of muscle activity.

Several approaches to the assessment of adaptive potential are circulating in the scientific literature with references to the work by R. M. Bayevsky [2, 4, 5, 10, etc.] and the use of different normative limits to characterize the same level of adaptation in different segments of the population: children, schoolchildren, students, people involved in sports, physical or mental activity. However, there are no data on the dynamics of fluctuations in adaptive potential under the influence of the ovarian-menstrual cycle.

According to the traditional grading of the index of functional changes (or Bayevsky index), we found that the adaptive potential of the CVS, determined by the formula of R. M. Bayevsky, did not have significant fluctuations throughout the menstrual cycle and was at a sufficiently high level in both groups (Table 2). That is why for this criterion we used assessment of the levels of adaptation proposed by Arabadzhi L. I. [2], Baev O. A. [4]. In the premenstrual phase, characterized as the phase of optimal manifestation of physical performance, the tension of adaptation mechanisms was noted only in 16.7%, and in the postmenstrual phase (phase of low physical performance) – 13.3% of the examined HPA girls. A more detailed analysis of these data revealed significant increases in diastolic (dBP) and systolic (sBP) blood pressure and HR, which usually indicates intense activity of the CVS. In the group of untrained girls, during the OMC, none of the examined ones showed significant fluctuations in the index of functional changes, but in the pre- and postmenstrual phases there was a tendency to more intense work of the CVS.

One of the main criteria for the manifestation of the functional capabilities of the human body is the data of general physical performance – the time and volume (absolute and relative) of work performed. Scientists define physical work capacity as the ability of a person to perform a certain job with the lowest cost and the highest result and characterizing the optimal level of development of organs and systems of the body and the effectiveness of their interaction [1, 3, 6, 7, 10].

Table 2 *Dynamics of adaptation potential of 17-22 years old girls by OMC phases in relative muscle relaxation (M±m)*

Index \ Phase		I	II	III	IV	V
HR, bpm	**HPA**	73.47±1.38	73.1±1.21*♥	69.13±1.12*#	72.17±1.38*	73.2±1.34*
	LPA	74.89±1.27	77.18±1.13	78.14±1.13	78.93±1.92	79.18±1.41♥ #
sBP, mmHg	**HPA**	100.0±1.8	101.83±2.0	100.83±1.34	100.17±1.34	103.17±2.23
	LPA	99.1±1.64	99.46±1.4	98.39±1.64	100.18±2.1	101.96±2.1
dBP, mmHg	**HPA**	57.8±0.89	61.17±1.12	60.83±1.34	61.17±1.34	60.33±1.56
	LPA	58.75±1.2	59.1±1.41	58.75±1.41	60.54±1.17	61.07±0.94
AP, cu	**HPA**	1.73±0.04	1.78±0.05	1.72±0.04	1.75±0.05	1.79±0.04
	LPA	1.69±0.04	1.72±0.04	1.71±0.04	1.76±0.05	1.79±0.05

Notes: * – $p<0.05$ for HPA – LPA; # – $p<0.05$ in relation to the first and ♥ – previous phases of OMC

The analysis of the obtained results of the research of physical work capacity of 17-22 years old girls (Table 3) shows absence of single and general regularity of its dynamics in relation to OMC phases that is consistent with the data of other authors [9].

Table 3 *Dynamics of physical work capacity of 17-22 years old girls during the menstrual cycle (M±m)*

Index \ Phase		I *	II *	III *	IV *	V *
Ttot, min	**HPA**	8.83±0.19	8.62±0.18	8.8±0.23	8.78±0.19	8.92±0.19
	LPA	6.47±0.16	6.57±0.17	6.48±0.21	6.48±0.18	6.66±0.16
Atot, kJ	**HPA**	39.34±1.75	37.38±1.53	39.28±2.07	38.13±2.26	39.98±1.66
	LPA	21.14±1.01	21.86±1.09	21.32±0.94	21.22±1.13	22.33±1.13

Note: * – $p<0.001$ for all indexes HPA – LPA

In the examined persons with HPA, the overall physical performance, according to all characteristics, is logically significantly higher ($p<0.001$) than in case of girls with LPA in each phase of the menstrual cycle. The analysis of the data of persons with HPA showed an insignificantly higher time and amount of work performed by them in the pre- and menstrual phases. Lower rates were recorded in the postmenstrual and postovulatory phases ($p>0.05$). It should be noted that the remaining 33.3% of the examined persons have their maximum work capacity manifested in other phases (I - V phases) of the cycle.

As a result of the examination of the female students who did not go in for sports, it was found that, according to the average group data, higher indicators of time and volume of cycle ergometric work performed were registered in the pre- and postmenstrual phases, and low ones – in the ovulatory and menstrual phases of the OMC ($p>0.05$). At the same time, the individual analysis revealed the maximum physical performance in girls with LPA (28.6%) in other phases of the cycle (I - IV).

4. Conclusions

1. Modern scientific literature indicates the relevance of monitoring the dynamics of adaptive capacities of female students, specifying the mechanisms of individual organization of the body's homeostasis – the basis for predicting, monitoring and correcting human health.

2. The results of the study show that, according to the average group data, the physical development of the examined female students with different physical activity corresponded to age and sex norms and the results of studies conducted by

the authors earlier. There is a tendency of prevalence of physical development of girls with higher physical activity.

3. The obtained data, under conditions of testing with bicycle ergometric load with reverse, general physical performance of girls with high physical activity demonstrate significantly higher ($p<0.001$) than persons with low physical activity in each phase of the ovarian-menstrual cycle. Insignificantly higher performance in subjects with high physical activity was recorded in the pre- and menstrual phases. Respondents with low physical activity – in the pre- and postmenstrual phases of the menstrual cycle. The individual analysis shows the absence of a single general regular dynamics of physical performance by cycle phases.

4. Physical activity is accompanied with tension of adaptation mechanisms in both groups of examined girls in a more expressed manner, according to our data, in the pre- and postmenstrual phases. The fact of tensed activity is confirmed by an increase in hemodynamic parameters - diastolic and systolic pressure and heart rate.

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CORRELATION STUDIES BETWEEN HAND-TO-HAND COMBAT TRAINING AND PHYSICAL TRAINING OF SPECIAL FORCES UNIT STAFF FROM ROMANIA SIMILAR TO THOSE OF EU AND NATO PARTNERS

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Abstract

The present work proposes the aspect of efficient interest, being the result of our days in the military field, which oriented us towards a detailed analysis through specific tests, to the extent of using some means from judoka, to determine quantitative and qualitative acquisitions and finally to achieve a higher level in the military-applicative physical training of the special forces unit staff.

Our research emphasizes the process of applied - military physical training based on an experimental program of applying judo means in the process of developing the resistance capacities of the special forces' unit staff within the military physical education lessons.

More than that, in the current context of the European and Euro-Atlantic integration of Romania, this paper proposes a new orientation in the process of optimizing the training of law enforcement and public security staff through a model appropriate to the current requirements and standards aimed at correlating combat training - including "hand-to-hand" one - with the training of similar troops of EU and NATO partners.

We also propose as an innovative element the experimental design of a specific training track for law enforcement and public security.

Key words: *process, military-applicative physical training, Special Forces units, program*

1. Introduction

Throughout the military career, the fighter's body undergoes major changes and adaptations. These transformations are strongly influenced by a series of factors that can have a series of consequences regarding human development: environmental (the geographical area on the globe, relief, climate), social (the level of cultural development of the area, religion, the specific country), educational (from the perspective of those who intervene regularly on the individual in an institutionalized system - formal education, as well as those who influence him in another frameworks, other than the organizational one - non-formal education), psychological (emotional state, upsets, stress, etc.). The changes due to external and internal influences, in some cases independent of man's will, will be found in his evolution, in different stages of his development and are both physical and psychological in nature (Dulea G., 2008; Epuran M., Holdevici I., Tonița F., 2022).

The ways in which the physical and mental undergo profound adaptations are among the most diverse and take on forms that apparently do not attract attention, are viewed with skepticism or even treated as unimportant. One way to create

adaptive conditions for humans is given by the practice of physical exercises, structured in acts and similar motor actions as technical mechanisms and purposes, carried out in a clear framework of ideas, rules and forms of organization.

Physical training should not be approached as a summary of technical procedures and sports disciplines carried out independently of each other, with applicability in different situations, but as an integrated and integral component to the training needs of fighters, with a preventive role and as a solution for certain situations in military conflicts.

Approached from the perspective of the military environment and support for the accomplishment of combat missions, physical training offers possibilities to accomplish the missions. For example, elements of self-defence training offer solutions to eliminate the enemy using a wide range of weapons (knives, firearms or anything else at hand at the time of the conflict) and techniques of a much more offensive nature than usual.

In real combat situations, in the theatres' operations, most of the time the aggression occurs in a foreign environment, unknown to the military, trying to surprise them, not respecting any rule of any competitive system or combat regulation. In such moments, the aggressor aims to control the actions of the military and to remove them from the battle by bodily injury or even killing, using a multitude of lethal or non-lethal means, most of the time improvised. The stake for soldiers, in such situations, is no longer highlighted by obtaining a champion title or a coloured belt that attests to their level of training, in conditions of maximum safety and emotional stability, but survival itself and avoiding being taken out of battle as a result of physical injury, which is equivalent to not fulfilling military objectives.

Physical training represents the quintessence of training, namely a foundation on which other military specialties can be supported. Physical training is a long-lasting, very dynamic and complex process, which intertwines with the human psychic component, in which the body is totally involved, whose subsystems participate unequally in supporting the activity.

The line of passage between the fighter's physique and psyche is very subtle, the reactions of the psyche leading to physical responses. In order to understand this display, we come up with a suggestive example: the lack of determination, of determination in a real hand-to-hand fight, leads to non-execution of those motor gestures, technical procedures that would have the purpose of removing the enemy from the fight; a slight injury due to a gunshot can trigger a state of excessive fear, the fear of death inhibiting the ability to reason correctly and logically in relation to the given situation (Radoslav R., Pavel S., 2002; Stoica M., 2002).

Moreover, in 2009, the USA introduced a program to increase the resistance to operational stress of fighters - "Comprehensive Soldier Fitness Program", which aims to increase the fighting capacity of the military following five fundamental directions: "physics (aerobic training, resistance, strength); emotional (approaching life's challenges in a positive, optimistic manner, by developing self-control); social (developing and maintaining interpersonal relationships based on trust, good

communication, comfortable exchange of ideas, opinions and experience); family (the feeling of belonging to the unit, as a safe, emotionally balanced, healthy environment); spiritual (the development of a set of beliefs, principles and values that support the person, beyond the institutional, societal and family sources)" (Popa M., 2012, p. 158) and this example is a proof of the intersection of the physical and mental components in military training.

The conditions under which a real engagement in combat, in military actions, can take place are among the most diverse and the military can encounter extremely difficult situations. The success of the mission, in such situations, depends on the military's capacity for self-management and self-regulation, through the precise organization of actions, by controlling and balancing mental states and adapting them to the newly created states. Psychic states are "forms of psycho-behavioural manifestations" (Epuran M., Holdevici I., Tonița F., 2022, p. 31), having as a trigger point the concreteness of the created situation. The ability to adapt the psyche and develop correct responses vis-à-vis the situations in which the military may find themselves is conditioned by a higher level improvement of mental qualities through participation in training or training programs, carried out systematically, continuously and gradually, specific to physical training. Psychic qualities such as will, responsibility, boldness, courage, intuition, observational spirit, etc. there are evidences that can be found in everything that means physical training, qualities necessary for fighters in real combat situations.

Courage, initiative, perseverance, determination are mental qualities with a major impact in the military field. They should also constitute defining elements for the selection of those who wish to join the military. In training, it often ends up that the soldiers are subjected to efforts of maximum intensity, on a background of very high fatigue, efforts that, without the education of these mental qualities, could not be carried out. Their education can be achieved by designing training programs with elements from all sports disciplines applicable in the army and with a high degree of difficulty. Examples in this sense could be fights with partners who are larger than the mass and with a high strength index, fights with different partners, placing the military in difficult situations to which they should find solutions, as well as the execution of techniques and some rounds of fight in difficult training conditions other than the training room (blizzard, rain, snow, sea, etc.) (Bâsceanu D., 1997; Oprița C., Atanasiu D., Atanasiu V., 1986).

2. Material and method

Research hypothesis. It was assumed that an essential contribution will be made to: the integral training of the future personnel of the units with special physical destination; the improvement of technical systems and inherent techno-tactical associations, in order to develop and use them efficiently within set Randori, Shiai and contest parameters.

The purpose of the research is to improve the level of applied-military physical training of the personnel within the special purpose units by applying the means of judo to the military physical education lessons.

The objectives of the research is the investigative analysis of the correlational contents between hand-to-hand combat training and physical training

In accordance with the purpose of the research, the tasks were identified, among which the most important were the particularities, the factors of the correlational perception between "hand-to-hand" combat training and physical training, which is intended to be implemented

Research methods: Analysis and generalization of data from the scientific-methodical literature; Statistical data study; Questionnaires; Graphics; Tabulation;

The organization of the correlational research between "hand-to-hand" combat training and the physical training of personnel from special purpose units in Romania similar to those of EU and NATO partners, which was carried out within the Bucharest Military Police Battalion with the participation of 20 soldiers, of which 4 are female and 16 are male. The 20 soldiers, who were the basis of the pedagogical experiment within the research, are part of the staff of the special purpose units, the periods of the training study were the years 2023 - 2024.

So that our experiment could be carried out further, we carried out a sociological-pedagogical survey, where we received answers from specialist respondents in the field, regarding the research problem, constituting also the result of the actual research.

3. Results and Discussions

As a form of interpretation of the results of the conducted study, several aspects were researched: 1. The most effective martial art for special forces. 2. When should fitness checks take place? 3. When should training take place? 4. Should physical training also take place outside of program hours?

Through the questionnaire survey, useful information/opinions were obtained from specialists regarding the assessment of the level of applied military physical training, the effectiveness of the application of judo means (procedures) in this process.

The responses were anonymous (survey respondents did not enter their names) which led to honest and constructive collaboration. The purpose of the questionnaire-type investigation was to assess the way of applying judo means compared to others, the frequency of checks, the time of day when it is considered more appropriate to do it, and the continuity of the process and outside the program hours. The results are centralized in Table 1.

Table 1 *Questionnaire centralizer*

No	The most effective martial art for special troops		When should fitness checks take place?		When should training take place?		Should physical training also take place outside of working hours?	
	Judo	Others	Once a month	Other options	In the morning	Afternoon	Yes	No
1	88		65		94		100	
2		32		55		26		20
Total participants	120		120		120		120	

The results of the theoretical and experimental approach carried out in the present research show us that the study and theoretical generalization of the applied - military physical training process of the personnel of the special purpose units within the military physical education lessons can be ensured by complying with the following requirements: developing the content of the techniques and its succession based on common, repeatable acts, in the case of as many technical procedures as possible; the systematization of the procedures based on the criteria of the trajectory and the direction of impact; establishing for each group of techniques the procedures and then practicing them as such; establishing, finally, the ranking of means and procedures, according to the applicability index.

4. Conclusions

The analysis and generalization of the theory and practice of the applied - military physical training process of the personnel of the special purpose units proves to us that, currently, there is a lack of a well-defined conception, whose methodological orientation would seek to imitate the basic factors of pedagogical and psychological success, in which to the integrative psycho-physiological attitude of the military personnel from the special purpose units and the didactic strategies appropriate to them should be taken into consideration.

The results of the analysis of the questionnaires and the analysis of the actual state of the investigated samples, a fundamental factor in the integral training of the personnel of the special purpose units, allowed the development of the program that influences the efficiency of the applied - military physical training process of the personnel of the special purpose units.

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THE TOP 100 MOST CITED ARTICLES ON SPORT ANXIETY: A CITATION ANALYSIS

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Abstract

Sport anxiety is a significant concern in the field, pivotal for achieving optimal performance. Despite garnering attention from researchers, athletes, and coaches over time, no citation analysis has been conducted on this topic. Each year, numerous articles are published, but only a few of them have a substantial impact on the development of sport psychology. The number of citations an article, subject, or author receives is often used as a measure of its quality and impact within this particular field. Therefore, the objective of this study is to identify the top 100 most cited articles related to sport anxiety publications and to determine the leading 10 articles influential in sport anxiety research. Our study reveals a significant undercitation of recent articles in sport anxiety research and a tendency among scientific writers to very much cite sport anxiety papers published decades ago. The shortage of important citations on new articles investigating sport anxiety is one aspect that contributes to explaining the reported gap in sport anxiety literature. Implications and recommendations for future research are discussed.

Key words: *sport anxiety, citation analysis, metrics, top 100*

1. Introduction

"What goes on in an athlete's head is just as, if not more, important than are physical talent and skill in determining success and enjoyment in competitive sport" (Marten, Vealey, Burton, 1990, p. 4). According to Weinberg and Gould, D. "all sport and exercise participants fall victim to mental letdowns and mistakes" (2015, p. 243). When it comes to preparing an athlete for competition, we focus not only on their physical readiness but also on their psychological readiness (Gabrys & Wontorczyk, 2023, p. 6084). Identifying the initial indicators and symptoms of anxiety often rests with professionals who regularly deal with athletes (Ford, Ildefonso, Jones & Arvinen-Barrow, 2017, p. 210). Regrettably, a significant disparity remains between the practice of sport psychology, which primarily addresses mental and emotional elements of performance, and athletes and coaches who solely concentrate on the performance process (Hanin, 2010, p. 13). In order to facilitate the work of researchers and sports professionals, we need to see where we are currently standing in terms of academic literature. To ensure a thorough analysis of the literature we accessed Google Scholar, Crossref and Semantic Scholar, three of the most important multidisciplinary bibliographic data sources. These ones

provide metadata on scientific documents and on citation links between these documents. Google Scholar is a freely accessible web search engine that provides users with access to a comprehensive and multidisciplinary citation index at no charge (About Google Scholar, 2024) and "provides unique citing material" (Bakkalbasi, Bauer, Glover & Wang, 2006, p.7; Yasin, Fatima, Wen, Afzal, Azhar & Torkar, 2020, p. 36226).

1. Crossref is a non-profit organization (Hendricks, 2001) that provides a digital infrastructure for scholarly content and has "a similar or better coverage of citations than Scopus and WoS" (Harzing, 2019 apud Visser, van Eck & Waltman 2021, p. 24). Hendricks, Tkaczyk, Lin & Feeney (2020, p. 414) consider Crossref to be "a valuable source for research in scientometrics, including measuring the growth and impact of science and understanding new trends in scholarly communications". Semantic Scholar is an AI-powered academic search engine developed by the Allen Institute for AI (Semantic Scholar About Us, 2024) an open data platform that serves as a research tool for scientific literature, utilizing artificial intelligence to enhance its functionality (Hannousse, 2021, p. 126). In all three databases, indexes play a crucial role enhancing the efficiency of data retrieval operations on database tables.
2. The Institute for Scientific Information (ISI) introduced the first scientific citation indexes. The SCI - Science Citation Index was launched in 1964, and later the Social Sciences Citation Index followed in 1973, with the Arts & Humanities Citation Index being introduced in 1978 (Thelwall, Orduna-Malea & Delgado López-Cózar, 2020, p. 872). "In 2005, Jorge Hirsch, a physicist at the University of California, San Diego, proposed the h-index, popularizing citation counting for individual researchers. Interest in the journal impact factor grew steadily after 1995" (Hicks, Wouters, Waltman, De Rijcke & Rafols, 2015, p. 429). The Hirsch index, also known as the h-index, is a method used to assess the impact of scientific articles based on their citation count. It is described by his author "as a particularly simple and useful way to characterize the scientific output of a researcher" (Hirsch, 2005, p.1). "Publications that are hardly ever cited do not influence the h-index. In this way, the h-index discourages publishing unimportant work" (Jin, Liang, Rousseau & Egghe, 2007, p. 856).
3. The g-index was proposed by Leo Egghe and its objective was to enhance the h-index by assigning greater significance to articles with higher citation rates. Egghe studied "the g-index being an improvement of the h-index" (Egghe, 2006, p. 144). Fassin (2023, p. 756) proposed the new ha-index, that "offers more consistency, increased selectivity, and fairer treatment of younger scholars compared to the classic h-index". Based on the academic literature referenced, we can infer that evaluating the impact of an article is determined by tallying the instances in which other authors cite it in their own work. In the provided context, the aim of this study was to utilize citation analysis to

identify the first 100 pivotal publications in sport anxiety. The study also intended to determine the top 10 articles that have significantly influenced citations within the field of sport psychology research, specifically focusing on sport anxiety.

2. Material and method

Citation analysis was conducted by searching for articles with "sport anxiety" in their titles across Google Scholar, Crossref and Semantic Scholar databases using the Publish or Perish (Harzing, 2007) software. The software was instructed to retrieve a maximum of 100 items. The first 100 articles with the highest number of citations were selected from each digital library, without imposing a time limit on publication years. The program generated an extended search report for each database to provide comprehensive data on the retrieved articles, and we examined any differences among the data sources in terms of coverage of articles with "sport anxiety" in their titles. In the second phase, references exported as CSV files (N=300) from Google Scholar, Crossref and Semantic Scholar were tabulated in Microsoft Excel. A descriptive analysis of the top 100 most cited articles on sport anxiety was performed using PSPPIRE statistical software (PSPP - GNU Project - Free Software Foundation, 2018).

3. Results and Discussions

A total of 300 papers (N=300) pertaining to sport anxiety returned from Google Scholar, Crossref and Semantic Scholar (Table 1) in reply to our query. Publication years for all three databases were identified by the Publish or Perish software **(**Harzing, 2007) in the interval 1977-2024 (the last 47 years). "Sport anxiety" as in title search term across Google Scholar had the most citations (C=15134) in Google Scholar, C=3093 in Semantic Scholar and the less in Crossref (C=1333). The *average number of citations per year* showed, as a result of the report, that the most number of citations per year of "sport anxiety" in title search were across Google Scholar (C/year=322), followed by Semantic Scholar (C/year=90.97), and the less were found across Crossref (C/year=28.36).

The *highest average number of citations per paper* reported by the software was C/paper=151.34 for Google Scholar, C/paper=30.93 for Semantic Scholar and C/paper=41.33 for Crossref. The most *number of citations per author* were C/author=7624.28 for Google Scholar, C/author=98.33 for Semantic Scholar and the less for Crossref (C/author=41.33). The Publish or Perish software manual mentions that "for each paper, its citation count is divided by the number of authors for that paper to give the normalized per-author citation count for the paper. The normalized citation counts are then summed across all papers to give the number of citations per author over the result set" (Citation Metrics, 2016-a).

The highest *number of papers per author* reported was C=48.77 for Google Scholar, followed by Crossref (C=41.33), while Semantic Scholar had the lowest score reported C=34.88. The Publish or Perish software manual mentions that "for

each paper, 1/author_count is calculated to give the normalized author count for the paper. The normalized author counts are then summed across all papers to give the number of papers per author" (Citation Metrics, 2016-b). The *average number, median and mode of authors per paper* were Mean=3.50/ Median=3.0/ Mode=3 for Semantic Scholar, Mean = 2.64/ Median=3.0/ Mode=3 for Google Scholar and Mean 1.35/ Median = 1.0/ Mode=2 for Crossref.

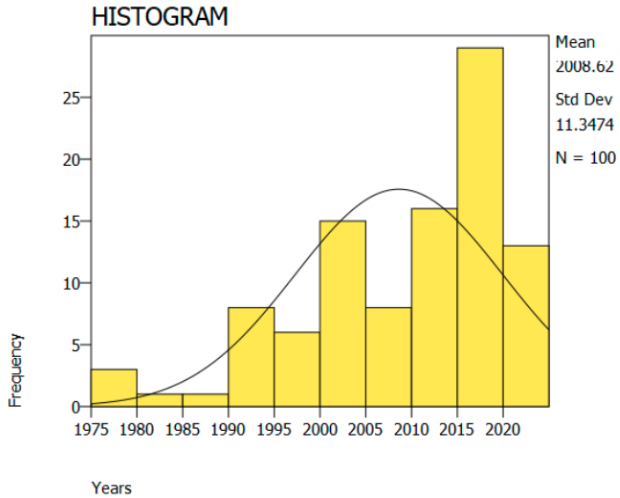
Table 1 - "*Sport anxiety" bibliographic data search metrics*

Data source	**Google Scholar**	**Crossref**	**Semantic Scholar**
Publication years	1977-2024	1977-2023	1990-2023
Citation years	47 (1977-2024)	47 (1977-2024)	34 (1990-2024)
Papers	100	100	100
Citations	15134	1333	3093
Citations/year	322	28.36	90.97
Citations/paper	151.34	13.33	30.93
Citations/author	7624.28	645.33	988.33
Papers/author	48.77	41.33	34.88
Authors/paper	2.64/3.0/3 (mean/median/mode)	1.35/1.0/2 (mean/median/mode)	3.50/3.0/3 (mean/median/mode)
Age-weighted citation rate	1005.87 (sqrt=31.72), 421.59/author	74.87 (sqrt=8.65), 33.61/author	422.78 (sqrt=20.56), 128.16/author
Hirsch h-index	47 (a=6.85, m=1.00, 14432 cites=95.4% coverage)	9 (a=3.69, m=0.40, 1085 cites=81.4% coverage)	29 (a=3.68, m=0.85, 2311 cites=74.7% coverage)
Egghe g-index:	100 (g/h=2.13, 15134 cites=100.0% coverage)	36 (g/h=1.89, 1315 cites=98.6% coverage)	52 (g/h=1.79, 2768 cites=89.5% coverage)
PoP hI,norm	34	15	15
PoP hI,annual	0.72	0.32	0.44
Fassin hA-index	18	5	10

Google Scholar had the highest *Hirsch h-index*=47 and the highest citation rate, C=95.4% coverage, followed by Semantic Scholar, h-index=29, C=74.7% coverage, and Crossref, h-index=9, C=81.4% coverage. For the three studied databases, Google Scholar had the *highest age-weighted citation rate* AWCR=1005.87 (sqrt=31.72), 421.59/author, Semantic Scholar AWCR=422.78 (sqrt=20.56), 128.16/author and Crossref AWCR=74.87 (sqrt=8.65), 33.61/author. AWCR represents the citation count for a specific paper and is divided by the age of the paper to calculate this metric.

Egghe g-index for Google Scholar had the highest score in the report g-index =100 (g/h=2.13, 15134 citations=100.0% coverage), on second place was the g-index=52 (g/h=1.79, 2768 citations =89.5% coverage) for Semantic Scholar, and on third place Crossref with g-index=36 (g/h=1.89, 1315 citations =98.6% coverage). The individual *Hirsch h-index norm* "normalizes the number of citations for each paper by dividing the number of citations by the number of authors for that paper" (Citation Metrics, 2016-c). In our generated report, the hI,norm=34 for Google Scholar, hI,norm=15 for Crossref and hI,norm=15 for Semantic Scholar. The *hI,annual score* for Google Scholar was hI,annual=0.72, for Semantic Scholar hI,annual= 0.44, and for Crossref the hI,annual=0.32. *Fassin ha-index*=18 for Google Scholar, for Semantic Scholar hA-index=10, and hA-index=5 for Crossref.

4. Based on this dataset, the initial results of our study indicate that Google Scholar emerges as the most comprehensive academic search engine, corroborating the findings of recent research (Martín-Martín, Thelwall, Orduna-Malea & Delgado López-Cózar, 2020, p. 871; Gusenbauer, 2019, p. 199; Giustini & Barsky, 2005, p. 87; Henderson, 2005, p. 1549). Furthermore, the report points out that, of the three databases studied, Google Scholar recorded the highest number of citations on the topic of "sports anxiety".
5. In the second part of this study, the articles selected from all three databases (N=300) were exported as CSV files. The top 100 articles related to sport anxiety, based on their title citations, from all three databases were then ranked from the highest to the lowest number of citations (with the first author(s)/article having the highest number of citations and the last having the lowest), tabulated and subjected to statistical analysis. Our results showed that the top 100 articles selected (N=100) were published between 1977 and 2023, with the highest frequency distribution of years of publication (Figure 1) situated between 2005-2015.



6. **Figure 1 -** *"Sport anxiety" -Years of publication distribution*

The top 100 most cited sport anxiety articles have an average publication age of 15.54 years (Figure 2) and total citations sum=16269, with max citations /paper=2841 and min citations /paper=16. The number of authors/paper were min=1 with a frequency of 11%, max=7 with a frequency of 1%. The highest frequency of authors/paper was 2 authors/paper, with a frequency of 33% and 3 authors/paper, with a frequency of 34%. The citations/Author were max=1552 and min=2.

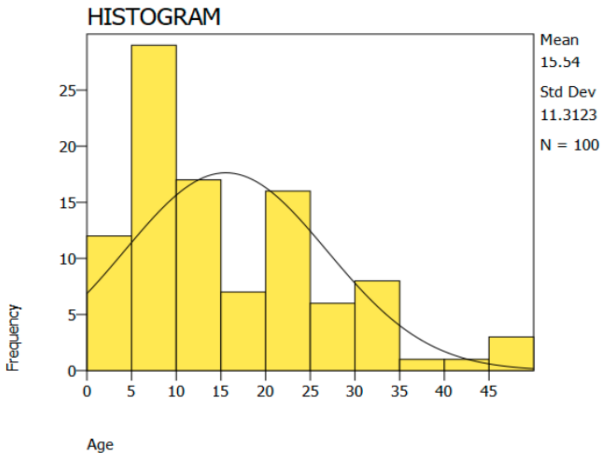


Figure 2 - *"Sport anxiety" Age of publication distribution*

Fifty percent of the top 100 most cited sport anxiety articles had a range of publication age between 12 and 47 years; the other 50% had a range of publication age between 1 and 11 years. The analysis also showed that 35% of top 100 most cited articles were over 20 years old.

Table 2 - *Top 10 "Sport anxiety" most cited authors*

Cit.	Authors	Year	Age
2832	Martens, R., Vealey, R.S. & Burton, D.	1990	34
1552	Martens, R.	1977	47
1001	Woodman T. & Hardy L.	2003	21
872	Smith R.E., Smoll F. L. & Schutz R.W.	1990	34
845	Jones, G.	1995	29
663	Smith, R.E., Smoll, F.L, Cumming, S.P. & Grossbard, J.R	2006	18
450	Mellalieu, S.D, Hanton, S. & Fletcher, D.	2009	15
415	Martin, J.J & Gill, D.L.	1991	33
384	Pluhar, E & McCracken, C., Griffith, K.L., Christino, M.A, Sugimoto, D. & Meehan, V.P.	2019	5
331	Baker, J., Côté, J., & Hawes, R.	2000	24

Also, the top 10 most cited sport anxiety articles highlighted the citation

sum=9345 that represented 10% of top 100 (N=100) most cited sport anxiety articles. Thus, it had the dominant position over the rest of 90 articles selected for our study, citation sum=6924.

Table 3 - *Top 10 "Sport anxiety" most cited articles*

	Authors	Title	Cit./Author	Cit./Paper
1	Martens, R., Vealey, R. S., & Burton, D.	Competitive anxiety in sport	944	2841
2	Woodman T, Hardy L.	The relative impact of cognitive anxiety and self-confidence upon sport performance: A meta-analysis	501	1003
3	Martens, R.	Sport competition anxiety test.	1552	981.5
4	Smith, R. E., Smoll, F. L., & Schutz, R. W.	Measurement and correlates of sport-specific cognitive and somatic trait anxiety: The Sport Anxiety Scale	291	876
5	Smith, R. E., & Smoll, F. L.	Sport performance anxiety	74	876
6	Jones, G.	More than just a game: Research developments and issues in competitive anxiety in sport	845	847
7	Smith, R. E., Smoll, F. L., Cumming, S. P., & Grossbard, J. R.	Measurement of multidimensional sport performance anxiety in children and adults: The Sport Anxiety Scale-2	166	670
8	Mellalieu, S. D., Hanton, S., & Fletcher, D	A competitive anxiety review: Recent directions in sport psychology research	150	451
9	Mellalieu, S.D., Hanton, S., & Fletcher, D.	A Competitive Anxiety Review: Recent Directions in Sport Psychology Research	60	451
10	Martin, J. J., & Gill, D. L	The relationships among competitive orientation, sport-confidence, self-efficacy, anxiety, and performance	208	416

The top 10 most cited articles on "sport anxiety" topic were published between 1977 and 2019 (Table 2). Our study highlights that 5 of 10 most cited "sport anxiety"

papers were published between 1977-1995 and 5 between 2003-2009. The max. publication age=34, min. publication age=5, average age of publication =26. According to Verstak, Acharya, Suzuki, Henderson, Iakhiaev, Lin and Shetty (2014, p. 10), in the early 2000s, numerous fields underwent retrospective digitization, leading to a notable increase in the prevalence of older citations.

The most cited authors from the top 10 "sport anxiety" articles (Table 3) in our study were: Martens (1990, 1997), citation/author =2496; Vealey (1990), citation/author =944; Burton (1990), citation/author =944; Jones (1995), citation/author =845. The Cronbach's alpha data reliability value was 0.70.

4. Conclusions

The study provides a comprehensive overview of the most cited publications on sport anxiety, including authors and publication ages. Examining the results of our citation analysis, we noted that sport anxiety research has limitations such as scarcity of important citations on new articles investigating sport anxiety. It reveals a tendency among scientific writers to heavily cite sport anxiety papers published decades ago, despite the current volume of scientific literature that continues to surge (Färber & Jatowt, 2020, p. 375). At the same time, we have to take into account that publications with minimal citations hold no sway over the calculation of the h-index, resulting in a prioritization of articles with higher citation rates.

From this viewpoint, emerging researchers may find themselves caught in a vicious cycle, making it challenging for their work to rise to the top of the most cited articles in sport psychology field. Our study suggests that the significant gap identified in sport psychology literature can also be attributed to under citation of younger papers and underscores the necessity for reassessing the evaluation of scientists' rankings (Koltun & Hafner, 2021, p. 1; Bradshaw et al., 2021, p. 1). It is important to acknowledge any potential limitations of this study. While we utilized the Google Scholar, Crossref and Semantic Scholar databases for our search, which are widely utilized for academic inquiries, it is important to concede that our investigation may not have captured all relevant papers.

Our findings offer a different perspective on how citation counts contribute to the decline or enhancement of scientific reputation in sport psychology. Future studies should investigate how new researchers perceive current methods of calculating citation indices and the editorial requirements imposed by "key gatekeepers of the literature" (Keegan, Cotteril, Woolway, Appaneal, & Hutter, 2017, p. 77), demands that may appear disconnected from real-world applications in sport psychology (Ely, O. & Munroe-Chandler, 2020, p. 101), and whether these perceptions influence their publishing behavior.

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