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EDITORIAL

General Notions About the Integrated Computer System for Researching Biomotrocity Parameters at the Young Population from Romania – Biomotric

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Between 1970 and 1980, the project "The biomotric potential of the school population" started, in which Alexandra Foşneanu, Virgil Mazilu, Virginia Paraschiv and Nicu Alexe (coordinator) participated and whose purpose was to assess the state of health, the average values of the evolution of the waist, the level of the weight of the youth and the level of the motor qualities determined by the biological and functional substrate. To carry out this fundamental research, unique at European level, the C.C.P.S team determined and collected every 10 years the anthropometric measurements and the basic motor values from a total of 100,000 subjects from primary, secondary and high schools.

In 1969-1996 period, a "Comparative study of the biomotric potential of the school population" was carried out in three stages (1969 -1972; 1980-1984 and 1991-1996) for preschoolers, students in grades I-IV, students in grades V-VIII, students from grades IX-XII. Thus, three comparative studies appeared at an interval of about 10 years.

Based on these studies, the "unitary system for checking and assessing the level of physical training of students" (SUVA) was taken over and applied by the school programs for grading students and subsequently transformed into "the unitary system for checking and assessing the level of training physics of students and the detection of talents for performance sports activity "(SUVAD) as a unique selection system, final battery, in order to improve the content of sports activities and to make the profile activity more efficient in the educational units. Its data were taken over and used by the sports federations on sports branches and included in the methodical guidelines of the sports federations. They were also used by school sports clubs, children's and junior sections.

Numerous works from European and US countries have been the basis of modern studies: the AAPER test, Barow's physical fitness test, the "Indiana" fitness test, and after 1988, the new battery of motor tests is applied in all European countries. EUROFIT, which presents physical capacity as an important component of physical education and sports and equally of health, health education, ensuring general well-being. The difficulty with which the primary information was obtained from the territory and then processed to obtain significant results, difficulty found in all three comparative studies mentioned, can be overcome today by computerizing the process and creating a communication network and a high-performance processing base, as it is presented below.

The interpretation of the data of each edition and the conclusions of each previously mentioned paper were known by the factors interested and involved in the field, mainly by the physical education teachers and by the decision-makers at ministerial level, at the end of each edition. Periodically, new conclusions were drawn about the evolution of the biomotor potential, or the causes were analyzed to justify some decreases in the results of some tests, which also attracted changes in the school curriculum.

After 1990, there is a regression of the biomotric potential of pupils in I-st and II-nd years, a situation with major implications in terms of health in the medium and long term. The poor results recorded in 1992-1996, for the third edition in grades V-XII, deter-

mined the continuation of investigations on other samples of students, making recordings with a new battery of measurements and motor tests, whose processing with reference tables of the intervals of values for grades IV, offers the possibility to quickly evaluate, follow for short periods of time, the progress of students, from one stage of preparation to another.

The third stage of the study of the biomotric potential of the school population, completed in 1996, brought special information about the biological and motor evolution of the young population in Romania, with possibilities for use in medium and long term forecasts.

In this third stage, the regression of the biomotric potential of the pupils from I-st and II-nd years is ascertained, a situation with major implications in terms of health in the medium and long term. The poor results recorded in 1992-1996, for the third edition in grades V-XII, determined the continuation of investigations on other samples of students, making recordings with a new battery of measurements and motor tests, whose processing with reference tables of value ranges for grades IV, offers the possibility to quickly evaluate, track for short periods of time the progress of students, from one stage of preparation to another.

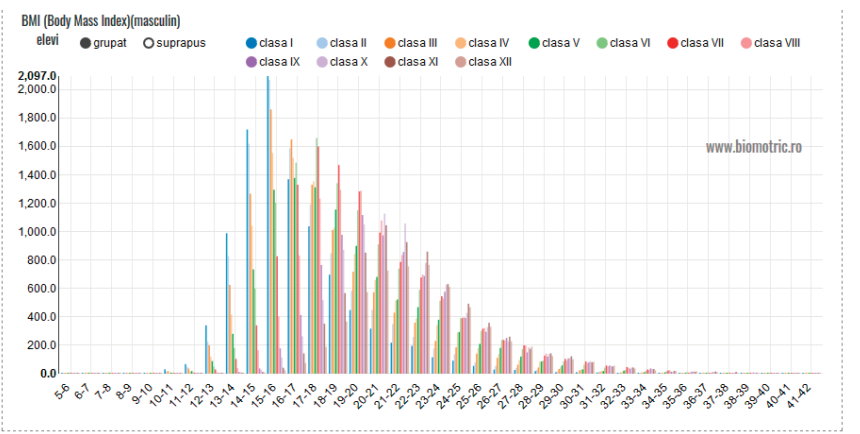

Fig. 1. Graph representing the BMI of a group of students (boys) evaluated, from all classes, generated by the biomotric programme.

Starting with 2016, the steps regarding the National Biomotor Program are resumed, and an agreement was signed between the Ministry of National Education and the Ministry of Youth and Sports regarding the application of this program.

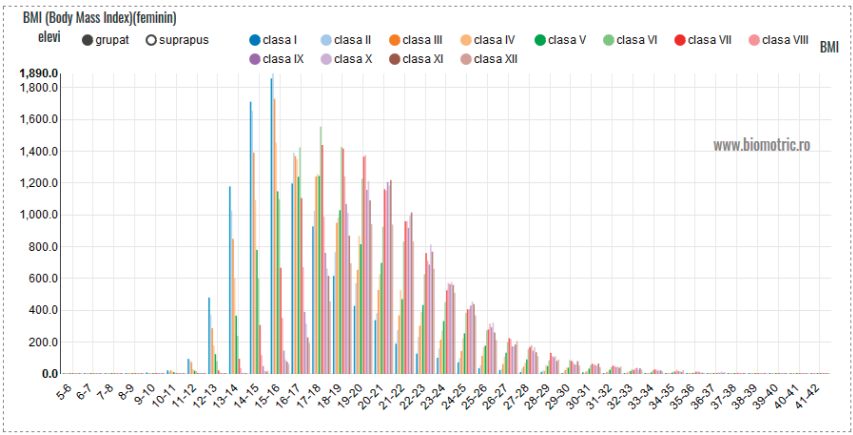

Fig. 2. Graph representing the BMI of a group of students (girls) evaluated, from all classes, generated by the biomotric system.

In the 2016-2017 school year, the pilot stage is carried out, which proposes a number of 10 anthropometric measurements and 10 motor tests.

As an evaluation of the possibility of applying the battery of anthropometric measurements and motor tests, based on the information provided by teachers, as well as for the alignment of measurements and tests to the school curriculum, a number of 6 anthropometric measurements were selected (height, weight , sole length, trunk / back height, waist circumference, arm span) and respectively a number of 7 motor tests (mobility, long jump, trunk lifts, balance, touching the plates, speed running, endurance running).

In the 2017-2018 school year, the first stage of anthropometric measurement and motor testing is performed at national level, using an integrated computer system for data collection and processing, offering all stakeholders an extremely important and useful

database in terms of the level of somatic development or of some qualities or deadly habits among the school population in Romania or in different counties / localities. General data and information can be accessed on the website: http://www.biomotric.ro/, and by creating a user account, it has access to much more detailed data or numerous search or comparison filters.

This test was attended by over 3000 teachers from Romania and the technical support and the interface is administered by the team of specialists of the National Research Institute for Sports, Bucharest.

We consider this programe of crucial importance for physical education and sports teachers, for coaches but also for government authorities to have a useful database in order to adapt and improve policies in the education and health system, that may be influenced by physical activity of the population.

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Strength Capacity and Body Mass Index Evaluation of Swimmers

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Abstract

Purpose. Muscle strength is an important component of physical ability. In sports such as swimming, this physical capacity has been increasingly evident in training programs, thus becoming important for the performance of aquatic practices. In this context, the aim of this study was to evaluate the strength capacity and the body mass index (BMI) of swimmers. **Methods.** For this, 20 swimmers of both sexes with a mean age of 38 ± 2 years were evaluated. The handgrip strength (HS) was assessed using a dynamometer and weight and height for calculating BMI. **Results.** There were no differences in BMI be-

tween genders (men (M): 25±1 kg./cm2; women (W): 24±0.9.kg./cm2. Men had a higher HS (M: 42±2; W: 29 ± 2 kgf.) There was no correlation between the HS and the BMI of the swimmers (M: *r*: 0.44; *p*: 0.19; W: *r*: 0.34, *p*: 0.30). However, the behavior of the relation of the variables differs between the sexes, in men the HS is higher according to a lower BMI, and in women, the HS is higher according to a higher BMI. referring to HS (M: 8.0±0.2; W: 8.4±0.6). **Conclusions.** Thus, the results of the present study show that the handgrip strength in swimmers is greater in males and does not present correlation with BMI, however it is possible to observe a different behavior between HS and BMI between genders, in men the relationship behavior is negative and in women the relationship behavior is positive.

Keywords: Muscle strength; Body mass index; Swimming.

Introduction

Muscle strength is an important role in maintaining and performing daily activities, as well as in sports performance. Therefore, the practice of strength exercises has the function of promoting metabolic and structural changes in the skeletal muscle (Bacurau, et al., 2011). Accordingly, the same authors treated anaerobic breakdown of glucose and hydrolysis of high energy (creatine phosphate) as the metabolic pathway of the predominance mechanisms wrapped in adaptations and increase muscle strength. Other studies point out that such a change in the functionality of the metabolic pathways occurs due to the regular practice of exercises, as strength is the maximum vigor that a muscle or muscle group can generate (Robergs, et al., 2002). Thus, the evaluation of muscle strength becomes important, among other factors, due to the fact that the amount of strength exerted by the muscle directly reflects on motor performance, since muscle atrophy and weakness may be associated with deficits in balance and motor coordination, directly impacting physical performance (Carvalho, et al., 2004; Shumway, et al., 2003).

Muscle strength is understood as the muscle's ability to generate tension, it is one of the fundamental components for the assessment of physical fitness. Handgrip Strength (HS) is not simply a

measure of hand strength or just a form of assessment of the upper limb. Studies have shown that it is an efficient indicator of health and general physical strength and in this sense it is used in physical fitness tests in the sports and rehabilitation programs (Balogum et al, 1991; Durward et al, 2001; Rantanen et al, 2003 ; Bertuzzi et al, 2005; Ikemoto et al, 2007).

HS is one of the basic elements in the analysis of manipulative abilities, strength and hand movements. The movements that the hand performs are controlled by the contralateral cerebral hemisphere and its innervation originates in the brachial plexus, in the roots from C5 to T1 (Machado, 2000). HS causes activity in the superficial flexor of the fingers and deep flexor of the fingers. Contraction of the deep flexor of the fingers exerts traction on the proximal fixation of the lumbrical. The simultaneous flexion of the interphalangeal joints places the intrinsic muscles under distal stretching, thus producing flexion of the phalangeal metacarpal joints (Smith et all, 1997).

According to Novo Jr. et al. (1998) the human hand produces apprehensive movements in different footprint patterns and they can be classified as: "Power Grip" (with inhibition of the action of the thumb); "Key Grip" (when the force is exerted by the thumb on the same side of the index finger) and the "Pinch Grip" (when the force of the thumb is opposite to the other fingers). The HS is normally measured using dynamometer devices, it is equipment that allows the measurement of the applied force, having its record measured in kilograms force or in pounds. They are divided into isometric and isokinetic types, and for HS measurements, traditionally, isometric dynamometers are used, with analog or digital characteristics (Massy-Westroop, 2011). Manual dynamometry is a reliable, accurate and validated measure in the literature, when the equipment is properly calibrated and the standardized collections, the tests are reliable even when performed by different evaluators (Mathiowetz, 2002; Shechtman et al., 2005).

There are different factors that can influence the HS values, among them, they are directly related: Age; Sex; Limb dominance (right and left), (Nicolay et al., 2005); Body positioning (Watanabe,

et al., 2004; Su et al., 1994); Anthropometric characteristics (hand width, hand circumference and longitudinal length of fingers), (Neu, et al., 2002; Clerke, et al., 2005; Fernandes, et al., 2011) and the size of the handle used on the dynamometer , because there is a need to adjust the device to different hand sizes (España-Romero, et al., 2008; Blackwell, et al., 1999; Ruiz-Ruiz, et al., 2006).

Other factors may interact with strength gain, among them, it is worth mentioning the Body Mass Index (BMI), which by default is used in several countries by health professionals as a parameter to assess individuals with malnutrition, normal weight, overweight and grade I, II and III obesity (WORLD HEALTH ORGANIZATION, 2004). Thus, the regular practice of physical exercises and sports is at the center of numerous scientific investigations for its benefits associated with physical, psychosocial and health physical capacities.

Thus, the practice of swimming as an aerobic activity allows changes in body composition, such as the reduction of adipose tissue and increase in lean mass, as well as morph functional changes, promoting a better quality of life and an efficient option in improving cardiovascular conditions (Lazar, 2013).

In this context, this study guides the BMI as an interaction factor in the development of strength in swimmers. However, the aim of the present study was to verify the handgrip strength by dynamometry and its correlation with the body mass index of swimmers.

Method

The sample consisted of 20 individuals, 10 male subjects and 10 female subjects, aged between 18 and 60 years, who have been swimming for more than two years. The subjects trained 45 minutes a day, twice a week. All participants filled out the free and informed consent form, agreeing to voluntarily participate in the research. Among the procedures for data collection, all ethical research care was taken, following the ethical principles of Helsinki 2008.

At the beginning of the process, interviews were conducted

with those evaluated and an anamnesis was carried out, containing information on the level of physical activity, health, food and objectives intended for the practice of physical activity (Cunha & Barros, 2005).

Afterwards, body mass evaluations were performed, which were measured using a mechanical scale (Welmy), with 100g precision and maximum capacity of 150kg. The subjects were instructed to remain standing, barefoot and wearing light clothing. Height was measured (in meters, m) with a stadiometer (Welmy), and the reference points were the vertex and the plantar region. The BMI was calculated using the formula: BMI (Kg/ m^2) = WEIGHT (Kg.) / $HEIGHT^2$ (meters) and the groups were classified as Eutrophic, Overweight and Obesity (Godoy-Matos et al., 2009).

For the evaluation of the handgrip strength (HS), the instrument used to measure was the JAMAR® analog hydraulic dynamometer (Asimow Engineering®, USA), with an accuracy of 0.5 Kg/force and a maximum capacity of 100 Kg/f. We followed the protocol proposed by Matsudo (2004) where the subject was instructed to put himself in the orthostatic position and after adjusting the dynamometer loops to the size of the hand and with the digital marker on the zero scale, the device was held comfortably, remaining parallel to the longitudinal axis of the body. During handgrip, the arm remained immobile, with only flexion of the interphalangeal and phalangeal metacarpal joints. Two measurements were taken in each hand, alternately, waiting 15 seconds between the limbs and the highest value was considered between attempts (Matsudo, 2004).

To correlate this protocol with body mass indexes, measurements of height (measured in centimeters) and body mass (measured in kilograms) were used. The measurements were performed with the students in the anatomical reference position: vertical position, with the gaze directed forward, upper limbs suspended and parallel to the trunk, palms oriented forward and lower limbs united and in extension. The height, or total height of the body, was measured, between the vertex and the plantar plane, being at the head with the Frankfurt plane parallel to the ground and the

body in the anatomical position (Ribeiro, 2002). The Borg Scale (Borg and Noble in 1974) was applied to ascertain the effort perception index.

The results are presented as mean, standard deviation error of the mean. For comparison and correlation of results, Student's t test and pearson's correlation "*r*" were used. As well as the Kolmogorov-Smirnov normality test by Instat software, version 3.0 for Windows.

Results

The age, height, weight and BMI data, as well as their classification according to the Brazilian Obesity Guidelines (Godoy-Matos et al., 2009) can be seen in Table 01. There were no differences between genders in BMI. In addition, the mean among men showed BMI classified as overweight, and women had mean BMI with eutrophic classification (Table 01).

Table 01: Distribution of mean BMI values, age, height and weight of students separated by gender.

	Nº	AGE	HEIGHT	WEIGHT	BMI	CLASSIFICATION
M	10	44±3	1.74±0,02	77 ±4	25±1	Overweight
W	10	33±2	1.63±0,02	64±3	24±0.9	eutrophic

Data presented as mean ± standard error of the mean. M: men; W: women; BMI: body mass index.

The results of HS in both genders can be seen in Tables 02. It is important to note that all evaluated subjects reported high perception of effort during attempts through the subjective perception of effort (Borg Scale), referring to HS (men: 8.0±0.2; women: 8.4±0.6), demonstrating the effectiveness of the test. According to the handgrip tests of the dominant limb, men showed higher values

of manual strength compared to the values observed in women.

Table 02: Manual pressure force of the dominant limb on the dynamometer (HS).

	N	HS 1	HS 2	HS 3	Mean (Kgf)
M	10	43±2	41±3	42±2	42±2
W	10	29±2	29±2	29±2	29±2*

Data presented as mean ± standard error of the mean. * $p \leq 0.05$. M: men; W: women; HS: Handgrip Strength; Kgf.: kilogram-force.

The tables below show the values of HS and BMI in men (Table 03) and women (Table 04). Analyzing the average among men, the table shows higher BMI values and lower HS values. The average among women, in turn, has a higher BMI index and a higher HS.

Table 03: Handgrip Strength (HS) and BMI in males.

Men	Nº	BMI (Kg/m²)	HS (Kgf.)
eutrophic	05	22±0.9	43±3
Overweight	03	26±0.4	44±6
Class I Obesity	02	33±0.4	38±4

Data presented as mean ± standard error of the mean. BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

Tabela 04: Força de preensão manual e IMC no gênero feminino.

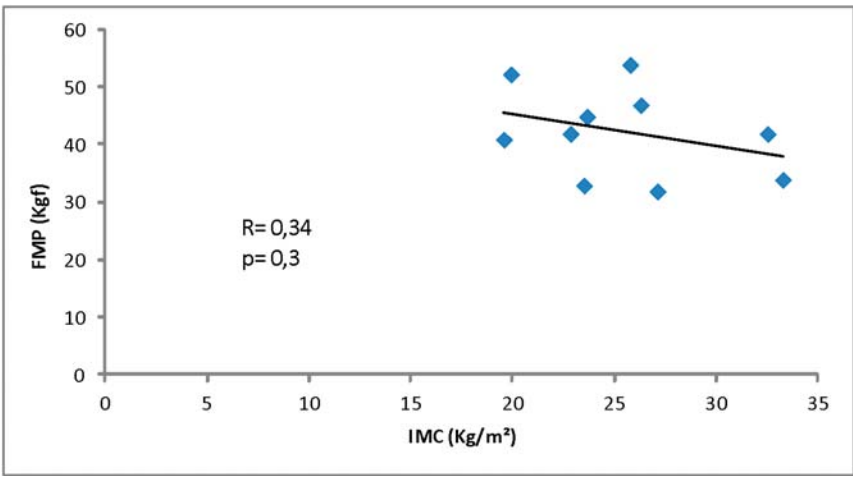
Women	Nº	BMI (Kg/m²)	HS (Kgf)
eutrophic	06	22±0.9	25±1
Overweight	04	26±0.6	35±2

Data presented as mean ± standard error of the mean. BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

The correlations between HS and BMI in both genders did not

show a value of $p<0.05$ to be considered significant (Figures 02 and 03). However, women had an *r*-value for the correlation between HS and BMI higher than men. Suggesting a better correlation between these variables in the female (Figure 03).

Figure 02: Correlation between KS and BMI in males.



BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

Discussion

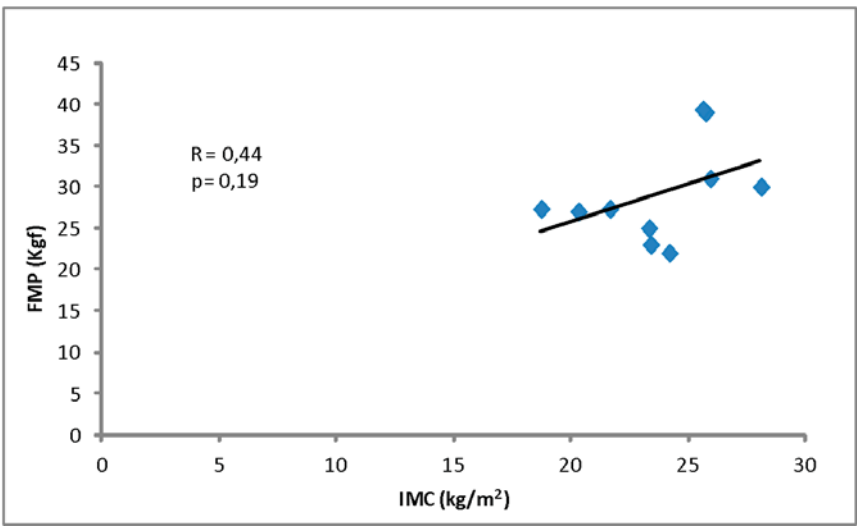


Figure 03: Correlation between HS and BMI in females.
BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

The aim of this study was to assess the possible correlations between BMI and HS using the dynamometer device. A total of 20 subjects were evaluated, 10 men and 10 women, being selected in the eutrophic, overweight and obese categories, with an average age of 44±3 and 33±2, with mean BMI values of 25±1 and 24±0.9 and classification of overweight and eutrophic respectively, where there was no difference in BMI values between them.

The body mass index (BMI) is a good indicator to determine the Nutritional Status (NS) of the population in general. It is a widely used instrument due to its ease of application, being of low cost, as it is not an invasive test and because there are several tables with values of reference standards allowing comparisons between populations (Anjos, 1992).

Several authors relate anthropometric characteristics such as height, weight, body mass, fat percentage, nutritional status and even anthropometric characteristics of the hand with handgrip forces (Sartório, et al., 2002).

In our results, men had higher HS rates when compared to those obtained by women (M = 4±2; W =29±2), corroborating the results presented in studies by Sasaki (2007) followed by Alexandre (2008) in which they consider that the mean HS in the elderly was higher in men when compared to women in all categories of BMI. This phenomenon can be explained by the physiological characteristics that differ between men and women. Men have higher levels of lean mass because they have higher concentrations of testosterone, growth hormones (GH), Dehydridropndrosterone (DHEA) and hormone insulin that helps increase growth hormone 1 (IGF-1) (Alexandre, 2008).

Kenjle et al (2005) evaluated the handgrip test with the nutritional status of 787 Indian children from six to ten years old. Grip strength was measured in the dominant hand and anthropometric factors, such as height, weight, arm circumference and skinfold triceps, were collected. The researchers observed that boys had greater handgrip strength than girls at all ages studied and that height, weight, arm circumference and skinfold, in addition to body fat mass, significantly interfered with handgrip strength.

In another study, there was no difference between genders in the handgrip of schoolchildren (12 to 15 years old). However, when children were separated by nutritional classification, underweight boys had higher strength values compared to girls who were also underweight. In addition, boys and girls who were overweight also had higher values of manual strength (Assis, et al., 2015), however, studies that did this correlation in swimmers have not been found.

Considering that HS can be associated with performance capacity in muscle strength (Kurakake et al., 1998; Vallejo et al., 2007), our HS values obtained in men's samples suggest that higher HS values are related to values lower BMI, while women have higher HS indexes related to higher BMI values, which leads us to believe that the lower the BMI value in men, the more muscular strength it will have, in women, the greater the BMI value, the more muscular strength it will have (Rolland, et al ,. 2004).

In a study that evaluated the HS and Flexibility of not trained women BMI classified as normal, as conclude that there was no correlation between this physical abilities in the group, considering that the sedentary group need to change the life style to improve force, so improving the quality of life (Hirota et al., 20015).

Studies show that men have higher HS than women, at all stages of human development. According to Alexandre et al. (2008) they describe that this fact is common, since the HS reflects the global muscular mass and strength, and men have greater amounts of lean mass and consequently have greater muscular strength. This is due to the fact that men have a higher concentration of hormones responsible for muscle protein synthesis, such as testosterone, growth hormone (GH), among other aspects.

A justification for our results may be due to the fact that the BMI assessment has some limitations, as it does not distinguish between adipose tissue and lean mass, or muscle hypertrophy. Thus, its applicability may be unreliable because it does not consider the loss and decrease of lean mass due to senescence and does not distribute body composition according to biological specificities in physically active adults (Mclaren, 1987).

Conclusion

The results of the present study show that the handgrip strength in swimmers is higher in males and has no correlation with BMI. However, it is possible to observe a different behavior between HS and BMI between genders. In men the relationship behavior is negative and in women the relationship behavior is positive.

References

1. Alexandre, T., de Oliveira Duarte, Y. A., dos Santos, J. L. F., & Lebrão, M. L. (2008). Relação entre força de preensão manual e dificuldade no desempenho de atividades básicas de vida diária em idosos do município de São Paulo. Saúde coletiva, 5(24), 178-182.
2. Anjos, L. A. (1992). Índice de massa corporal (massa corporal. estatura-2) como indicador do estado nutricional de adultos: revisão da literatura. Revista de Saúde Pública, 26(6), 431-436.
3. Assis, V. G., Araújo, M. F. F., & Hirota, V. B. (2015). Avaliação da capacidade física força e IMC de jovens escolares. *Cippus*, *4*(1), 55-66.
4. Bacurau, R. F. P.; Aoki, M. S. (2011). Nutrição no esporte. 1º edição, São Paulo: Casa da Palavra.
5. Balogun, J. A., Akomolafe, C. T., & Amusa, L. O. (1991). Grip strength: effects of testing posture and elbow position. Archives of physical medicine and rehabilitation, 72(5), 280-283.
6. Bertuzzi, R. C. D. M., Franchini, E. & Kiss, M. A. P. D. (2008). Análise da força e da resistência de preensão manual e as suas relações com variáveis antropométricas em escaladores esportivos. Revista Brasileira de Ciência e Movimento, 13(1), 87-94.
7. Blackwell, J. R., Kornatz, K. W., & Heath, E. M. (1999). Effect of grip span on maximal grip force and fatigue of flexor digitorum superficialis. Applied ergonomics, 30(5), 401-405.

8. Carvalho, J. & Soares, J. M. (2004). Envelhecimento e força muscular: breve revisão. Revista Portuguesa de Ciências do Desporto, 4(3), 79-93.

9. Clerke, A. M., Clerke, J. P., & Adams, R. D. (2005). Effects of hand shape on maximal isometric grip strength and its reliability in teenagers. Journal of hand therapy, 18(1), 19-29.

10. Cunha, S. M. B. D. & Barros, A. L. B. L. (2005). Análise da implementação da Sistematização da Assistência de Enfermagem, segundo o Modelo Conceitual de Horta. Revista Brasileira de Enfermagem, 58(5), 568-572.

11. Durward, B. R., Baer, G. D., & Rowe, P. J. (2001). Movimento funcional humano: mensuração e análise. Correr. Sao Paulo: Editora Manole, 123-33.

12. España-Romero, V., Artero, E. G., Santaliestra-Pasias, A. M., Gutierrez, A., Castillo, M. J., & Ruiz, J. R. (2008). Hand span influences optimal grip span in boys and girls aged 6 to 12 years. The Journal of hand surgery, 33(3), 378-384.

13. Fernandes, L. F. R. M., Bertoncello, D., Pinheiro, N. M., & Drumond, L. C. (2011). Correlações entre força de preensão manual e variáveis antropométricas da mão de jovens adultos. Fisioterapia e Pesquisa, 18(2), 151-156.

14. Godoy-Matos, A. F. D., Guedes, E. P., Souza, L. L. D., & Martins, M. F. (2009). Management of obesity in adolescents: state of art. Arquivos Brasileiros de Endocrinologia & Metabologia, 53(2), 252-261.

15. Hirota, V. B., De França, E., Romano, R. G., de Lima Paulo, L. F., & Caperuto, E. C. (2015). Evaluation of BMI Related to Flexibility and Strength of not Trained for Women. Arena: Journal of Physical Activities, (4).

16. Ikemoto, Y., Demura, S., Yamaji, S., Minami, M., Nakada, M., & Uchiyama, M. (2007). Force-time parameters during explosive isometric grip correlate with muscle power. Sport Sciences for Health, 2(2), 64.

17. Kenjle, K., Limaye, S., Ghugre, P. S., & Udipi, S. A. (2005). Grip strength as an index for assessment of nutritional status of children aged 6-10 years. Journal of nutritional science and vitaminology, 51(2), 87-92.

18. Kurakake, T., & Iwasaki, T. (1998). U.S. Patent No. 5,771,512. Washington, DC: U.S. Patent and Trademark Office.

19. LAZAR, H. (2013). A Message from the Editor. J Card Surg, 28: 1-2. doi:10.1111/jocs.12071.

20. Machado, A. B. (2000). Neuroanatomia funcional. 2a ed. São Paulo: Atheneu.

21. Massy-Westropp, N. M., Gill, T. K., Taylor, A. W., Bohannon, R. W., & Hill, C. L. (2011). Hand Grip Strength: age and gender stratified normative data in a population-based study. BMC research notes, 4(1), 127.

22. Mathiowetz, V. (2002). Comparison of Rolyan and Jamar dynamometers for measuring grip strength. Occupational therapy international, 9(3), 201-209.

23. Matsudo, S. M. (2004). Avaliação do idoso: física e funcional. 2° edição, Londrina, Editora Midiograf.

24. McLaren, D. S. (1987). Three limitations of the body mass index. The American Journal of Clinical Nutrition, 46(1), 121-121.

25. Neu, C. M., Rauch, F., Rittweger, J., Manz, F., & Schoenau, E. (2002). Influence of puberty on muscle development at the forearm. American Journal of Physiology-Endocrinology and Metabolism, 283(1), E103-E107.

26. Nicolay, C. W., & Walker, A. L. (2005). Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. International journal of industrial ergonomics, 35(7), 605-618.

27. Novo Junior, J. M. (1998). Teste de preensão isométrica da mão: metodologia e implicações fisiológicas.

28. WHOQOL, G. (1998). Organização Mundial da Saúde. Divisão de Saúde Mental. *Versão em português dos instrumentos de avaliação de qualidade de vida*.

29. Rantanen, T., Volpato, S., Luigi Ferrucci, M. D., Eino Heikkinen, M. D., Fried, L. P., & Guralnik, J. M. (2003). Handgrip strength and cause-specific and total mortality in older disabled women: exploring the mechanism. *Journal of the American Geriatrics Society*, *51*(5), 636-641.

30. Ribeiro, A. H., Fernandes Filho, J., & da Silva Novaes, J. (2002). A eficácia de três exercícios abdominais para teste de resistência muscular localizada.

31. Robergs, R. A., & Roberts, S. O. (2002). Princípios fundamentais de fisiologia do exercício para aptidão, desempenho e saúde.

32. Rolland, Y., Lauwers-Cances, V., Pahor, M., Fillaux, J., Grandjean, H., & Vellas, B. (2004). Muscle strength in obese elderly women: effect of recreational physical activity in a cross-sectional study. *The American journal of clinical nutrition*, *79*(4), 552-557.

33. Ruiz, J. R., España-Romero, V., Ortega, F. B., Sjöström, M., Castillo, M. J., & Gutierrez, A. (2006). Hand span influences optimal grip span in male and female teenagers. *The Journal of hand surgery*, *31*(8), 1367-1372.

34. Sartorio, A., Lafortuna, C. L., Pogliaghi, S., & Trecate, L. (2002). The impact of gender, body dimension and body composition on hand-grip strength in healthy children. *Journal of endocrinological investigation*, *25*(5), 431-435.

35. Sasaki, H., Kasagi, F., Yamada, M., & Fujita, S. (2007). Grip strength predicts cause-specific mortality in middle-aged and elderly persons. *The American journal of medicine*, *120*(4), 337-342.

36. Shechtman, O., Gestewitz, L., & Kimble, C. (2005). Reliability and validity of the DynEx dynamometer. *Journal of hand therapy*, *18*(3), 339-347.

37. Smith, L. K., Weiss, E. L., & Lehmkuhl, L. D. (1997). Cinesiologia clínica de Brunnstrom. Quinta Edição.

38. Su, C. Y., Lin, J. H., Chien, T. H., Cheng, K. F., & Sung, Y. T. (1994). Grip strength in different positions of elbow and shoulder. *Archives of physical medicine and rehabilitation*, *75*(7), 812-815.

39. Watanabe, T., Owashi, K., Kanauchi, Y., Mura, N., Takahara, M., & Ogino, T. (2005). The short-term reliability of grip strength measurement and the effects of posture and grip span. The Journal of hand surgery, 30(3), 603-609.

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Using Dance Therapy Among High School Students and its Effects on Motivational Persistence in Students 14-18 Aged

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Abstract:
Purpose: We live in a world where not only adults but also children and adolescents are subjected to stressful factors surrounding them such as demanding school responsibilities, a familiar environment that is difficult to bear, negative feelings or self-confidence, biological changes. **Methods:** the research took place over a period of 6 months, 2016 Sept.-2017 Feb., at "George Barițiu" High School, Cluj-Napoca. Scale of Motivational Persistence (SPM), this test evaluates motivational persistence, a person's ability to resist motivationally in the sense of achieving the assumed goal. **Results:** statistically significant differences between the two groups were not observed in the statistical analysis of the subjects' age values for non-paired samples in either of the two time periods studied. In contrast, statistically significant differences between the two time points were observed in the statistical analysis

for pairs, due to the proposed and applied intervention program. The statistically significant difference between the two lots ($p<0.05$) at time T1 and statistically significant differences between the two groups was observed in statistical analysis of unattained goals (RUP) $p <0.001$) at time T2. **Conclusion:** The data showed that the practice of dancing allows pupils to develop their potential and overcome their personal difficulties. In conclusion our hypothesis was confirmed, and dance – therapy can be used to increase effects of motivational perception.

Keywords: stress, dance-therapy, motivational persistence

Introduction

This paper aims to analyze stress levels in pupils aged 14-18. In daily life, stress and anxiety can come as a hindrance to the physical and mental health of man, seeking ways to reduce them through various methods and techniques. Applying artistic techniques improves student performance and optimizes their behavior by applying specific means systems, improves behavior and aims to modify dysfunctional emotions before and after dance therapy: stress, anxiety, sadness, blame. Increases positive emotions such as self-esteem.

Problem Situation: for this work to be feasible, research has been done on what dance-therapy and music therapy are represent and how it helps both the physically and mentally. It is well known that dance, among many others, is part of the social life of a people, or rather, dance is an important act of social life. Dance is a continuous rhythmic movement belonging to the body from a human soul's beginning. The movement of this rhythm is borne by the music. So, dance and music form a whole where one without the other would not be as spectacular for the viewer and just as beneficial to the practitioner. (Terry, W., 1956).

The term stress was introduced in science by Hans Selye (1974), who considered it to be related to the stress adaptation that an individual is making through the hardships of the environment. They are called to a high level both physically and mentally, which

leads to stress and fatigue, so a mental and emotional approach is also needed in their relaxation. It is not known exactly whether the origin of conscious sensation of fatigue is associated with localized brain structures or whether it is a result of electrophysiological synchronization of all brain activity. (Ursula Şchiopu, 1979)

Objectives: the main objective of this research is to reduce stress in young people aged 14-18. The secondary objective would be to establish the content and structure of a therapeutic training program over an annual cycle.

Hypothesis: using a dance-therapy program for 6 month we can obtain modified value of the indices of Motivational persistence.

Research Methods

Period and place was a period of 6 months, (2016 Sept.-2017 Feb.) at George Barițiu High School, Cluj-Napoca. *Subjects:* high school students from the 8th grade participated.

Applied tests: SPM Scale of Motivational Persistence. This test evaluates motivational persistence, a person's ability to resist motivationally in the sense of achieving the assumed goal. The test allows the evaluation of motivational persistence through 5-step response items (1 - to a very small extent, 5 - to a very large extent), items aiming at identifying three factors: long-term pursuit of goals (LTPP - Long Term Purposes Pursuing) identifies individuals who have long-term professional and personal goals, continuing work hard, finding resources always to achieve the proposed goal despite repeated obstacles; Current Purpose Pursuing (CPP), which is characteristic for those people who accept tasks with a high degree of difficulty, yet still manage to focus on day-to-day activities even if they become uninteresting. Recurrence of Unattained Purposes (RUP) defines those people who are often thinking about some of the deferred or even abandoned personal initiatives, detaching them from being difficult. They are thinking about past projects that they have had to give up and create new ideas about old projects. The

cumulative scores of the three factors of the SPM Questionnaire allow assessment of individual global persistence of persistence: a person's ability to persevere behaviorally and motivationally in the effort to achieve ambitious goals; the tendency to persist, to invest time and effort, not to abandon (high scores).

The intervention program was applied over a period of 6-months (sept.2016 - Feb. 2017), and consisted in the implementation of an intervention program built from gymnastic movements and dance steps. Classical music was used, musical compositions of the composer and musician Nikos Ignatiadis as well as Ernesto Cortazar.

The components of artistic execution, after Grosu & Padilla (2011), from different start positions:- In any trunk movement the head has a delayed action, it comes a little longer to give the impression of amplitude and prolongation of the movement.

- Holding the trunk, with the abdomen sucked, the basin slightly projected forward to reduce the lumbar curvature for the purpose of a supple line of the body.
- Shoulders pulled down to release throat line.
- Using the "sustained arms" position to release the headline.
- At the position of the arms supported sideways or forward they are slightly rounded (with elbow and fist joints), with slightly controlled but relaxed fingers.
- In any movement of the arms, the hand has a delayed action to give the impression of a smooth, flowing movement.
- The toes of the legs and knees are slightly twisted outward, and at any movement of the foot, the tip leaves the last of the soil, and when it comes back it sits first.
- The tip is stretched as many times as the foot rises from the ground, either totally or only the heel. We will show below structure patterns:

A. complex with balancing from sitting:

Sitting: 1-standing; 2.- galloping on the right foot with the boom in the right oblique upside down and the left arm obliquely down; 3. Passing the weight on both legs with the knees bent simultane-

ously with a large bending of the trunk forward, with rounded back and the head flexing. 4- side gesture on the left foot with the left oblique arm leading up and the arm obliquely downward through the arm port.

Sitting: Right side arms: 1-side lateral to the right followed by balancing the torso and arms in the horizontal arc from right to left, with slight knee bending, 2 completed with 90 ° turn left in standing on left leg, right back on top, through temps-lie; 3-4 returning to the initial position and moving to the right by temps-lie.

On the knee: the arms to the right: 1 - sitting on the heel, 2 - the torso balance in the form of a horizontal bow, from right to forward to the left and a return to the knee once the balance is completed.

Left to left: Support on left forearm: 1 - 2 - Balance of upper leg up to ear level, 3-4 - Raise the basin from the ground and support on the left arm and on the tip of the right foot, with the straight boom leading forward. Repeat the structure to the left.

B. Movement complexes:

Sitting: 1 - 2 - Chasse to the right (step added), 3 - 4 - turn 360 degree on the right foot and then on the left, 5 - cross with the left leg in front, 6 - grand-battement with the right leg), 7 - crossed with right leg in front, 8 - rebound.

Sitting: 1 - grapes - wine to the right with the arms extended forward to the left foot, 3 - grapes - wine left with the left arm oblique up and the right arm oblique down, 4 - returning to the initial position.

Sitting: 1 - 2 - chasse forward with his left foot, swinging his arms in the sagittal plane on the floor back up, stopping on the right foot with his left foot back, stretched, 3-4 - coming back, chasse back with his left foot and turning his arms before, down, back.

Results and findings

The Scale of Motivational Persistence (SPM) was applied to the two groups: Control group and experiment group in the two

tests: T1 - initial testing and T2 - final test. In the statistical analysis of Long-Term Purpose Pursuing (LTPP), statistically significant differences between the two lots ($p < 0.001$) were observed at non-paired samples at time T2. In the statistical analysis for pairs, statistically significant differences were observed between the two time points in both group I and group II ($p < 0.001$).

Tabel 1. Scale of Motivational Persistence in the groups studied and the statistical significance.

Indicators	Moment	Lot	Score	ES	Median	DS	Minimum	Maxim	*Statistical semnificance (p)*		
									I-II	**T1-T2**	
PM	**T1**	**I**	3,63	0,2935	3	1,6078	2	8	0,6237	**Lot I**	**< 0,0001**
		II	4,07	0,4095	3,5	2,2427	1	9			
	T2	**I**	4,50	0,3023	4	1,6557	2	8	**< 0,0001**	**Lot II**	**< 0,0001**
		II	7,13	0,2570	7	1,4077	5	10			
LTPP	**T1**	**I**	4,27	0,3320	4	1,8182	1	7	0,9786	**Lot I**	**< 0,0001**
		II	4,37	0,3968	4	2,1732	1	9			
	T2	**I**	5,00	0,2537	5	1,3896	3	7	**< 0,0001**	**Lot II**	**< 0,0001**
		II	7,33	0,2507	7	1,3730	4	10			
CPP	**T1**	**I**	4,53	0,3207	4	1,7564	2	8	0,8163	**Lot I**	**< 0,0001**
		II	4,60	0,3444	4	1,8864	1	8			
	T2	**I**	5,30	0,3000	5	1,6432	3	9	**< 0,0001**	**Lot II**	**< 0,0001**
		II	7,97	0,1825	8	0,9994	6	10			
RUP	**T1**	**I**	4,17	0,3036	4	1,6626	2	8	**0,0254**	**Lot I**	**0,0005**
		II	5,47	0,4617	5	2,5289	1	10			
	T2	**I**	4,70	0,3395	4,5	1,8597	2	8	**< 0,0001**	**Lot II**	**< 0,0001**
		II	8,33	0,2266	8	1,2411	6	10			

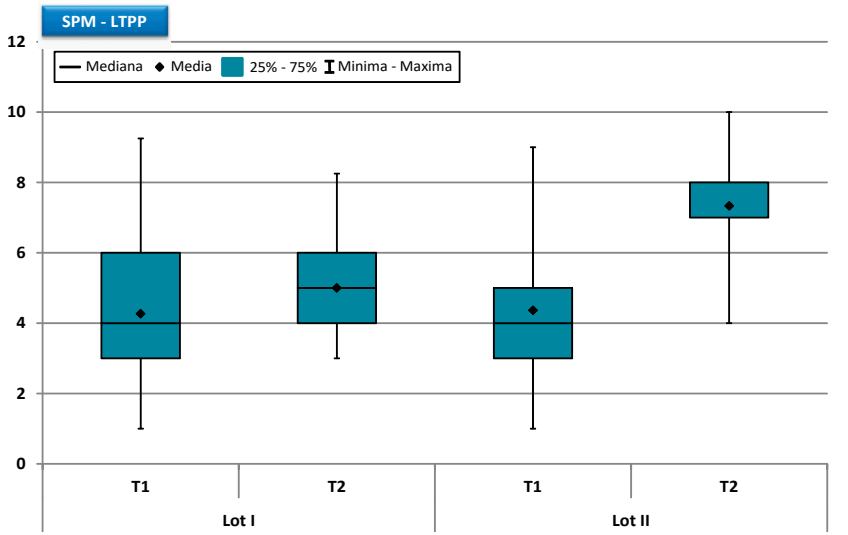

Fig.1 Correlations between SPM – LTPP.

In the statistical analysis of current Purpose Pursuing (CPP) values for non-paired samples, statistically significant differences were observed between the two groups ($p < 0.001$) at T2. In the statistical analysis for pairs, statistically significant differences were observed between the two time points in both group I and group II ($p < 0.001$).

The statistically significant difference between the two lots ($p < 0.05$) at time T1 and statistically significant differences between the two groups was observed in statistical analysis of unattained goals (RUP) $p < 0.001$) at time T2.

In the statistical analysis for pairs, statistically significant differences were observed between the two time points in both group I and group II ($p < 0.001$). In the statistical analysis of the Motivational Persistence Scoring (SPM) scores based on the three previous items, statistically significant differences between the two groups ($p < 0.001$) at T2 moment were observed.

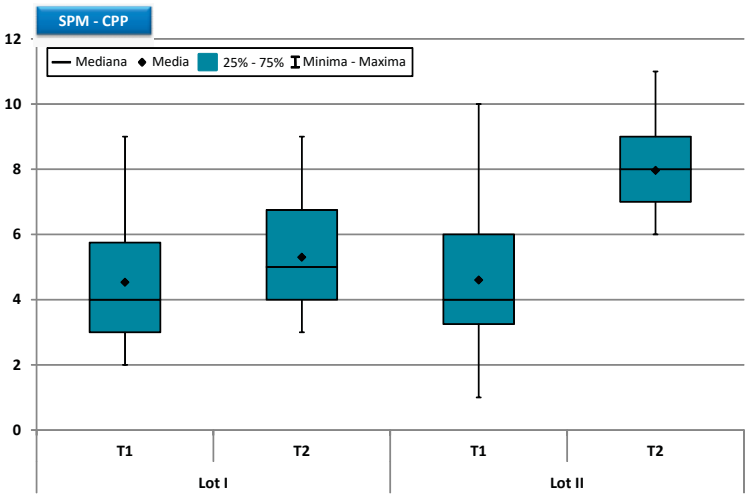

Fig.2. Correlations between SPM – CPP.

In the statistical analysis for pairs, statistically significant differences were observed between the two time points in both group I and group II ($p < 0.001$).

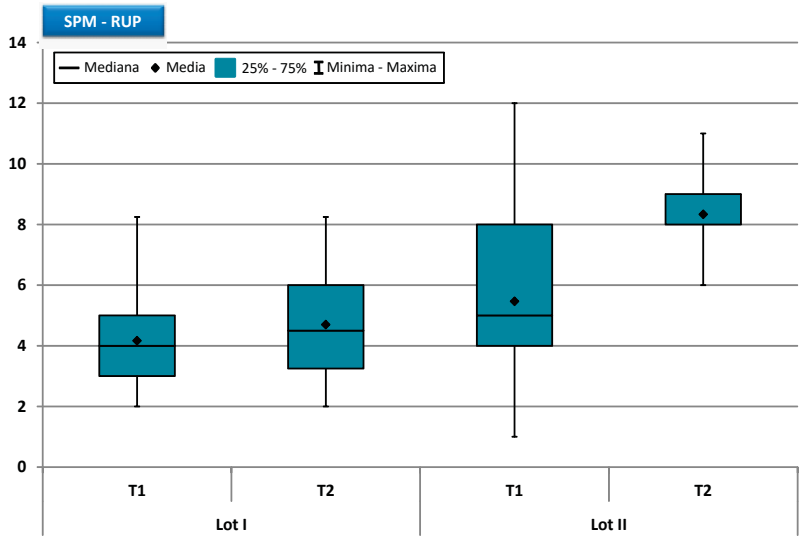

Fig. 3 Correlations between SPM – RUP.

The statistical analysis of the correlation between SPM item values showed: *at the I st group* **-** *at the time T1:* a good correlation between PM-LTTP, LTTP-RUP, CPP-RUP; an acceptable and same correlation between PM-CPP, PM-RUP, LTPP-RUP.

At the time T2: a good correlation between PM-LTTP, LTPP-CPP, LTTP-RUP, CPP-RUP, an acceptable correlation between PM-CPP and PM-RUP

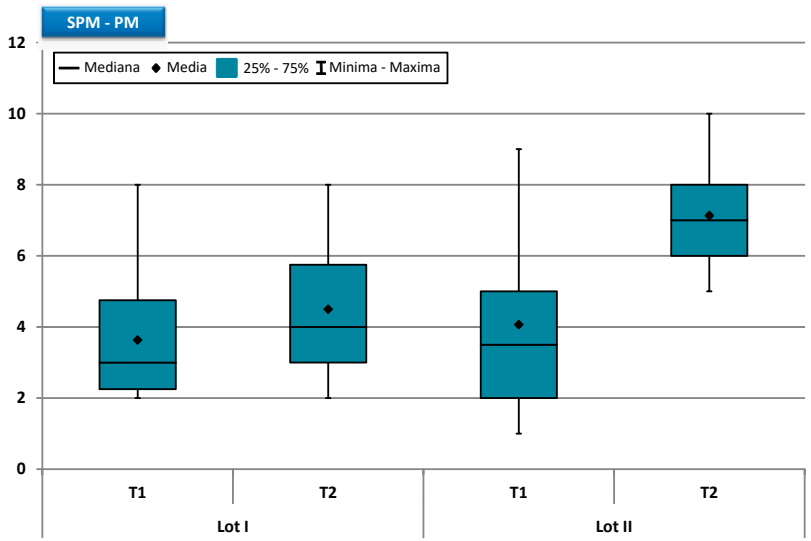

Fig.4 Correlation between SPM - PM Items at the studied groups

Tabel 2. Statistical analysis of correlation between item and SPM scores.

Lot	Indicators	Moment T1		Moment T2	
I	PM-LTPP	0,5806	***	0,5401	***
	PM-CPP	0,4371	**	0,3370	**
	PM-RUP	0,4549	**	0,3649	**
	LTPP-CPP	0,4961	**	0,5718	***
	LTPP-RUP	0,6066	***	0,6366	***
	CPP-RUP	0,5994	***	0,5396	***
II	PM-LTPP	0,7404	***	0,6608	***
	PM-CPP	0,7080	***	0,5744	***
	PM-RUP	0,7697	****	0,1385	*
	LTPP-CPP	0,5307	***	0,6236	***
	LTPP-RUP	0,6818	***	0,2802	**
	CPP-RUP	0,5464	***	0,2417	*

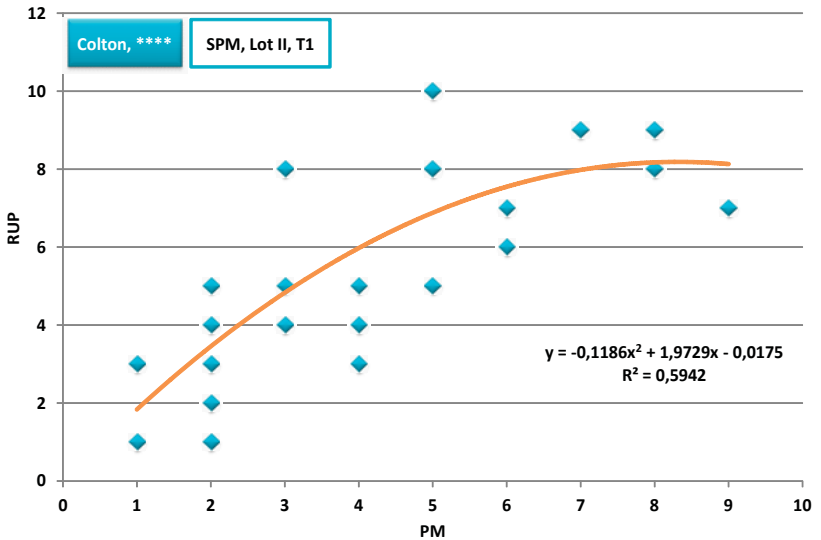

Fig. 5. Very good correlations between SPM indices, at Lot II, T1.

Discussions and conclusions

The conscious perception of fatigue (Alan St. Claire Gibson., 2012) is like a conscious feeling and less a physiological appearance. Feeling tired means awareness of the changes taking place in the subconscious homeostatic control system. In carrying out this research, we propose the development of an action strategy to reduce stress through different artistic techniques, and the evaluation of the effectiveness of applied research methods.

We would be tempted to think that a samurai was preparing his battle techniques by turning to dance and music. No, dance and music were just mystical forms, just like many of the techniques the practitioner used in prayers, prayers with which Kami (spirits) were called to participate in military training. Following these exhilarations, legends say that Yamagugi, the spirits of forests can participate and even reveal certain secret techniques. (Barboş, I.P, 2015).

*At the II nd group, at the time T1***:** a very good correlation and the same meaning between PM-RUP**;** a good correlation between PM-LTPP, PM-CPP, LTPP-CPP, LTPP-RUP, CPP-RUP

At the time T2: a good correlation between PM-LTPP, PM-CPP, LTPP-CPP*;* an acceptable and equal correlation between LTPP-RUP.

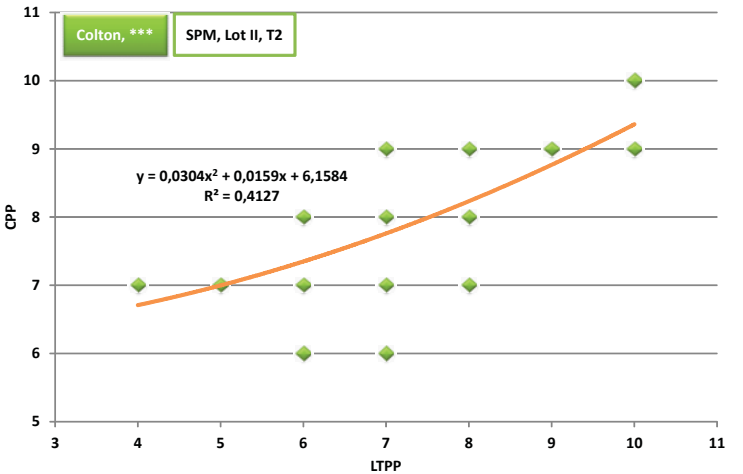

Fig. 6. Good corelations in T2 between SPM items at II group.

A study in the journal The Arts in Psychotherapy, found that dance therapy had a positive effect on participants suffering from depressive symptoms. Koch S.C., (2007). The article by Panagiotopoulou E. (2018) emphasizes the importance of dance therapy in the school environment. It is based on a research done in two schools in Greece. The purpose of the research was to determine whether dance therapy could contribute to the development of pupils' social and emotional abilities. The data showed that the practice of dancing allows pupils to develop their potential and overcome their personal difficulties.

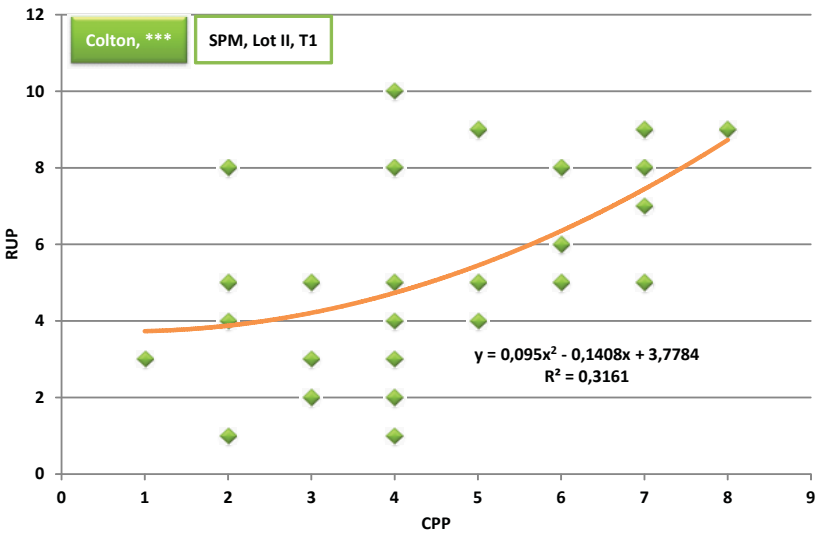

Fig. 7. Very good corelations and good corelations in T1, Lot II moment and between SPM items .

Dance is more than a therapy; it can offer more than therapeutic benefits. This is the conclusion researchers came to, analyzing Parkinson's disease and providing therapeutic dance for patients. Rocha P.A., Slade C. S., (2017).

A 16-week structured educational program combined with dance therapy seems to have a positive effect on the quality of life of obese people. Allet L., Muller-Pinget S., (2017). Dance therapy

has produced positive changes in body image: finding a pleasant sensation and feeling tolerance, finding pleasure and the significance of experiences. Pylvanainen P., Lappalainen R., (2018).

Moderate heterogeneity found in this analysis limits a pragmatic recommendation of dance therapy in people with hypertension. Meta-analysis showing a positive effect of dance therapy on exercise capacity. Conceicao S.R., Neto M.G., (2016). Dance therapy has allowed obese patients to establish their conscious and psychic consciousness over their body image. Muller-Pinget S., Carrard I, (2012). The findings in an article comparing dancers and athletes suggested that experienced dancers demonstrate safer landing strategies compared to athletes. Turner C., Crow S., (2018).

In an article by Hackett S., (2013), The Arts in Psychotherapy, it is proven that Music therapy provides conditions that can intentionally stimulate communication and increase opportunities for social interaction. Trend analysis using Statistical Process Control charts showed an improvement in hand frequency and return to MT.

In the article "Fifteen-minute music intervention reduces pre-radiotherapy anxiety in oncology patients" by Lee C., Le-Yung W., (2012), it has been investigated the effects of music therapy in reducing anxiety in patients to oncology. The results showed a statistically significant difference between the patients from the group of musicians and the control group. Music therapy has also lowered the level of anxiety.

In conclusions our hypothesis was confirmed, and dance – therapy can be used to increase effects of motivational perception.

Acknowledgments

This study is part of the research of the first author Vari Hanna, conducted within the doctoral studies of FEFS Cluj – Napoca with the theme: "Implementation of some elements of dance therapy in physical education classes, in order to reduce stress in schoolchildren"

References

1. Alan St. Clair Gibson, (2011*). The effect of exercise induced hyperthermia on muscle fibre conduction velocity during sustained isometric contraction,* Volume 21, Issue 5, October 2011, Pages 834-840
2. Allet L., Muller-Pinget S., (2017). *Dance therapy combined with patient education improves quality of life of persons with obesity: A pilot feasibility study for a randomised controlled trial,* Volume 11, Issue 1, January–February 2017, Pages 79-87
3. Barboş, I.P. (2015). *Artele Marţiale şi Societăţile Asiatice.* Teză de Doctorat, UBB, Cluj – napoca, Romania
4. Conceicao S. R., Neto M. G., (2016). *Effect of dance therapy on blood pressure and exercise capacity of individuals with hypertension: A systematic review and meta-analysis*, International Journal of Cardiology, Volume 220, 1 October 2016, Pages 553-557
5. Crawford I. (2014). *The Arts in Psychotherapy,* Volume 40, Issue 2, April 2013, Pages 224-229
6. Grosu, E., F. & Padilla, Moledo, C. (2011). Elementele tehnicii corporale în gimnastică artistică, ritmică şi dans, Vol. I din colecţia "Gimnastică", Editura GMI, Cluj – Napoca, ISBN 978-973-1776-32-3
7. Hackett S., (2013). *The Arts in Psychotherapy*, Volume 40, Issue 5, November 2013, Pages 473-477
8. Koch S. C. (2007). The joy dance: *Specific effects of a single dance intervention on psychiatric patients with depression,* The Arts in Psychotherapy, Volume 34, Issue 4, 2007, Pages 340-349
9. Hans Selye (1974). Stress without Distress, *Psychopathology of Human Adaptation,* pp 137-146.

10. Lee C., Le-Yung W., (2012). *European Journal of Oncology Nursing*, Volume 17, Issue 4, August 2013, Pages 436-441

11. Muller-Piaget S., Carrard, (2012). *Dance therapy improves self-body image among obese patients*, Patient Education and Counseling, Volume 89, Issue 3, December 2012, Pages 525-528

12. Panagiotopoulou E. (2018). Dance therapy and the public school: the development of social and emotional skills of hight school students in Greece. *The Arts in Psychotherapy, Pages 25-33*

13. Pylvänäinen P, R Lappalainen (2018). Change in body image among depressed adult outpatients after a dance movement therapy group treatment, *The Arts in Psychotherapy*, 2018, Elsevier

14. Rocha P. A., Slade S. C., (2017). *Dance is more than therapy: Qualitative analysis on therapeutic dancing classes for Parkinson's*, Complementary Therapies in Medicine, Volume 34, October 2017, Pages

15. Șchiopu, U., Verza, E., (1997). *Psihologia Vârstelor Ciclurile Vieții,* Editura Didactica și Pedagogica, 1997, București

16. Selye, H., Stress without Distress (1974). *Stress and Distress in Response to Psychosocial Stimuli***,** 1972, Pages v–vi

17. Worthington P., (2017). *Journal of Petroleum Science and Engineering,* Volume 156, July 2017, Pages 212-219

18. Panagiotopoulou E., (2018). Dance therapy and the public school: The development of social and emotional skills of high school students in Greece, Volume 59, July 2018, Pages 25-33

19. Terry, W. (1956). The dance in America. *USA: Harper Publisher*

20. Turner, C., Crow, S., & all (2018). Preventing non-contact ACL injuries in female athletes: What can we learn from dancers? *Physiology Therapy Sport*, 2018 May; 31:1-8. doi: 10.1016/j.ptsp.2017.12.002. Epub 2017 Dec 23. PMID: 29447910 DOI:

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Analysis of the Dynamics of the Basic Technical and Physical Training on Uneven Bars in Women's Artistic Gymnastics

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Abstract
Purpose. This paper makes an analysis of the basic technical and physical training on uneven bars in women's artistic gymnastics. **Methods.** A study was carried out in the Romanian national team of women's artistic gymnastics, with a group of 14 gymnasts aged 13-16. The study was conducted from 2017 (initial testing) to 2018 (final testing). The physical training (PT) was assessed by means of 10 physical tests and the basic technical training (TT) by 8 tests. Performance capacity (PC) on uneven bars was monitored in competitions too. Statistical analysis was made with KyPlot program, using descriptive indicators and the parametric method Paired Comparison for Means, at $p<0.05$. **Results.** The comparative analysis of PT indicators highlights an improvement of muscle strength development and significant differences at $p<0.05$ in holding a handstand (physical test - PT3), power handstand (PT4), alternating one-legged squats (PT5), long jump (PT8) and push-ups

(PT10). The comparative analysis results of basic TT indicators reveal an improved execution in final testing at $p<0.001$, $p<0.01$ and <0.05, except for elements with flight phase on the same bar (technical test - TT4) - $p>0.05$. The PC results highlight the elements difficulty increase ($p<0.05$), the execution decrease, the final score increase and $p>0.05$. **Conclusions.** The use of a physical training program (per muscle groups, both in the first and the second training) and preparatory exercises for each technical requirement on uneven bars showed the dynamics of muscle groups strength development according to the results obtained in competitions.

Keywords: artistic gymnastics, assessment, muscle strength, technical requirements, performance

Introduction

Contemporary artistic gymnastics develops in accordance with the laws and trends of world sport. The present-day stage is characterized by the development in depth and width, by higher difficulty of the competitive programs, increase of the technical mastery and widening of the geographical area (Arkaev & Suchilin, 2004).

The main goal of athletes' training in artistic gymnastics (high performance-oriented sport) is the successful participation in major competitions, with great achievements in terms of sports technical results, which are planned in advance (Atiković et al., 2017). One of the basic tasks in the training of elite female gymnasts from many teams in the world is to improve the accomplished technical execution of the competitive routines; the mastery criterion is the accurate and faultless performance required for obtaining the best results in competitions (Crețu, 2004).

The analysis of the method-scientific literature and the practical experience point out that the normative documents that ensure efficiency in the basic and special technical training, resting on the systemic materials, are not sufficient or lack totally. At the same time, the study of young gymnasts' training highlights that the coaches, in the conditions of "running" after sports results, teach the gymnastics elements in an accelerated manner, when the motor skills are not yet sufficiently developed; also, the individual style of

execution is created against the background of the mistakes omitted during the training process (Grigore, 2001; Potop, 2015).

The theory and methods of learning the women's artistic gymnastics exercises was studied for analyzing the process of improving the sports technical mastery; thus it was possible to set the bases of the macro-methods for teaching material assimilation in the basic specialization stage. As a dynamic system, this implies the unity of the long-term programs for learning the exercises of the movement school, basic level and specialization, the improvement of the routines on apparatus, respecting the requirements of didactic principles and learning rules (Boloban, 2013; Potop, 2015).

Based on the classic didactic principles, the concept of highly skilled gymnasts' preparation meets the requirements of complex training. This means that in the comparative learning of a simple element (layout salto, for example) it is necessary not only to learn an execution level without mistakes from judges' point of view, but also to pay attention to the parameters that allow the gymnast to learn faster and in due order the elements of higher difficulty (e.g. double or triple salto), in other words to use the horizontal and vertical transfer in learning (Potop et al., 2014).

Physical training is a process of education of the motor skills necessary for the correct acquisition of elements, connections and combinations, as well as of the entire routines in artistic gymnastics. Physical training is carried out in close connection with the technical, psychological, artistic, tactical and theoretical training. In practical activity, the physical training includes the following forms: *general* and *specific*. Throughout an annual training cycle, depending on the qualification level of the gymnasts and the training stage, there are two aspects of the physical training: *development of the motor skills* (preparatory period) and *maintaining the reached level,* even improving it (competitive period). Learning the routines and their execution, consistent with the requirements of the Code of Points (FIG, 2017), supposes the existence of a higher level of development of the coordinative capacity, strength, mobility-flexibility, speed, endurance and the combined qualities too (Grigore, 2001; Irwin et al., 2005; Readhead, 2011).

Uneven bars - women's artistic gymnastics event – has enriched its content lately with new technical procedures whose names are not yet to be found in the specialized literature. The main directions of development for this apparatus are: derivation, composition, concentration and loan (transfer) (Grosu, 2004).

The content and construction of the routines on uneven bars must present a variety of movements, namely: rotation and momentum, elements near the bar, flights from the high bar to the low bar and vice versa, flight on the same bar, elements with turn on the longitudinal axis and descents (FIG, 2017). From biomechanical point of view, the female gymnast must control her body in unusual conditions, to overcome her own weight – by segments and whole body – and also the effects of the gravity (external and internal forces) (Prassas, 2006).

Methods

The purpose of the study is to analyze the level of basic physical and technical training on uneven bars in women's artistic gymnastics.

Hypothesis of the study: we consider that the use of a physical training program, correlated per muscle groups, both in the first and the second training session and preparatory exercises for each technical requirement on uneven bars will highlight the dynamics of muscle groups strength development and their learning in conformity with the results achieved in competition.

This scientific approach led to the organization of an experimental study in the Romania national team of women's artistic gymnastics, with a group of 14 gymnasts of 13-16 years old. All investigations were conducted in conformity with the Code of Ethics of the World Medical Association (Declaration of Helsinki). The study was carried out during two annual training cycles: 2017 (initial testing) and 2018 (final testing). The physical training level was assessed in the beginning of each annual training cycle in the preparatory period.

The following fitness tests were used to assess the physical training: physical test 1 (PT1), rope climbing by means of the arms, from straddled position, 5m/sec; PT2, rib stall hanging leg raise in 60 sec, (max rep no); PT3, holding a handstand on the floor, (sec); PT4, power handstand – straddle press to handstand 60 sec, (max rep no); PT5, alternating one-legged squat with forward roll on the floor in 60 sec, (max rep no); PT6, torso extensions with arms up from prone position in 60 sec, (max rep no); PT7, pull-ups in 60 sec, (max rep no); PT8, standing long jump (cm); PT9, standing high jump (cm); PT10, push-ups from prone position in 60 sec., (max rep no).

Table no 1. Program of physical training used during the study

A1	**ABDOMEN + BACK + ABDOMEN - SIDE**	**Distribution**
1	Abdomen: from supine position / upside down on the rib stall, torso raises holding a 5 kg plate in the hands.	5 – 7 sets x 20 reps / 20-30 sec pause between sets
2	Back: torso extensions will be performed from prone position on the balance beam, arms forwards.	5 - 7 sets x 20 reps / 20-30 sec pause between sets
3	Abdomen - side: lying on the side, with one arm in the extension of the trunk and the other supported on the floor, lateral trunk extensions will be performed.	5 – 7 sets x 50 reps / alternating the sides
A2	**LEGS + ARMS**	
1	Legs: - squats	5 sets x 70 reps / pause 20 – 30sec
	- high jumps over 10 fences, knees to the chest	10 sets x 10 reps / pause 20 – 30 sec
	- high jumps will be performed on two inclined trampolines, with alternative change of the legs	3-4 sets x 100 reps / pause 20-30 sec

2	Arms: - handstand push-ups	5 sets x 13 reps / pause 20-30 sec
	- strength handstand (from rollover or on the beam)	5 sets x 7-10 reps / pause 20-30 sec
	- in standing position, the back supported on the rib stall - arms raises with a 5 kg plate in the hands.	5 sets x 20 reps / pause 20-30 sec

Note: A1 – training session 1 - a.m., A2 – training session 2 - p.m.

The preparatory exercises used to learn the content of the routine on uneven bars are the basic technical requirements presented in the given fitness tests. The following tests were used: technical test 1 (TT1), handstand on the floor (points); TT2, mount by strengthening, on the low bar or on the high bar (points); TT3, elements with flight and transition from the high bar to the low bar (Pak salto / transition with 180° twist), (points); TT4, elements with flight phase on the same bar (points); TT5, elements with different grip, except for mount and dismount (points); TT6, element with 360° twist on longitudinal axis (points); TT7, element next to the bar – clear hip circle to handstand (SPM) / toe circles in SPM / Stalder in SPM, (points); PT8, double salto tucked dismount (DST) / double salto piked (DSP) / double salto tucked with 360° twist (Tsukahara) / double salto stretched (DSS) / double salto forward (DSfwd), (points).

The results achieved on uneven bars by the gymnasts in 5 national and international competitions in 2017 and 5 competitions in 2018 (according to the competition calendar of the Romanian Gymnastics Federation) were used to assess the performance capacity (Difficulty (D), score; Execution (E), score; Final score (FS).

The statistical analysis was made by means of the computerized statistical calculation program ”KyPlot”, using the most common indicators: mean, standard errors mean (SEM), standard deviation (SD), coefficient of variability (CV%); parametric method, t -test, Paired Comparison for Means; all data were reported at the significance threshold $p < 0.05$.

Results

The level of basic physical and technical training on uneven bars was assessed in two stages at the end of the preparatory period of the annual cycle 2017 (initial testing) and 2018 (final testing). The performances of the gymnasts in the uneven bars events in both training cycles were also monitored. The results of the study were statistically analyzed and compared at $p<0.05$. The dynamics of the physical training is shown in table no 2.

Table no 2. Results of physical training, n =14.

Indicators	Testing	mean	SEM	SD	Cv (%)	t	p
PT 1 (sec)	final	9.60	0.20	0.76	7.94	-0.03	>0.05
	initial	9.61	0.19	0.74	7.72		
PT 2 (reps no)	final	35.36	0.29	1.08	3.06	1.10	>0.05
	initial	34.93	0.32	1.21	3.45		
PT 3 (sec)	final	46.84	3.52	13.18	28.14	2.81	<0.05
	initial	40.28	3.59	13.43	33.34		
PT 4 (reps no)	final	11.36	0.48	1.78	15.68	3.51	<0.01
	initial	9.43	0.71	2.65	28.13		
PT 5 (reps no)	final	24.71	0.69	2.61	10.58	2.99	<0.05
	initial	23.28	0.56	2.09	8.98		
PT 6 (reps no)	final	45.21	1.22	4.58	10.12	0.38	>0.05
	initial	45.00	1.34	5.02	11.16		
PT 7 (reps no)	final	15.57	0.62	2.31	14.84	-0.45	>0.05
	initial	15.78	0.74	2.78	17.60		
PT 8 (cm)	final	212.5	4.04	15.13	7.12	2.27	<0.05
	initial	208.21	4.05	15.17	7.28		
PT 9 (cm)	final	48.86	1.16	4.35	8.89	1.97	>0.05
	initial	47.28	1.14	4.25	8.98		
PT 10 (reps no)	final	36.21	2.00	7.49	20.69	2.50	<0.05
	initial	33.86	2.48	9.28	27.41		

The comparative analysis of the physical training indicators highlights differences in final testing at physical test 1 (PT1) - keeping the level of arms strength at both tests - and insignificant differences at $p>0.05$; in PT2 , the abdominal strength (legs raise) was improved by 0.43 reps, with insignificant differences at $p>0.05$; PT3 (holding a handstand) shows an improvement of the sense of balance by 6.56 sec with significant differences at $p<0.05$; in PT4 there was an increase of the number of power handstand mounts by 1.93 reps and significant differences at $p<0.01$; PT5 shows the improvement of legs strength by the increase of the number of alternating one-legged squats by 1.43 reps and significant differences at $p<0.05$; PT 6 highlights the maintaining of back muscles strength at 45.20 sec and insignificant differences at $p>0.05$; in PT 7 there is a decrease of arms strength by 0. 21 reps and insignificant differences at $p>0.05$; PT 8 reveals the increase of legs strength by the increase of long jump value by 4.29 cm and significant differences at $p<0.05$; in PT 9, the legs strength at high jump increases by 1.58 cm, with insignificant differences at $p>0.05$; PT10 (push-ups) shows the increase of arms strength by 2.35 reps and significant differences at $p<0.05$.

Table no 3 presents the results of the indicators of basic technical training on uneven bars, according to the technical requirements for this apparatus (FIG, 2017).

Table no 3. Results of the basic technical training on uneven bars, n=14

Indicators	Testing	mean	SEM	SD	Cv (%)	t	p
TT 1 (points)	final	7.00	0.10	0.39	5.60	10.94	<0.001
	initial	4.50	0.25	0.94	20.9		
TT 2 (points)	final	8.57	0.14	0.51	6.78	-3.12	<0.01
	initial	8.00	0.00	0.00	0.00		
TT 3 (points)	final	7.57	0.13	0.51	6.78	2.51	<0.05
	initial	7.00	0.28	1.04	14.83		
TT 4 (points)	final	7.28	0.16	0.61	8.39	1.71	>0.05
	initial	6.78	0.32	1.19	17.51		
TT 5 (points)	final	7.36	0.19	0.74	10.13	3.31	<0.01
	initial	6.78	0.26	0.97	14.37		
TT 6 (points)	final	7.57	0.14	0.51	6.78	2.48	<0.05
	initial	7.14	0.21	0.77	10.78		
TT 7 (points)	final	7.50	0.14	0.52	6.91	3.12	<0.01
	initial	7.07	0.19	0.73	10.32		
TT 8 (points)	final	7.43	0.14	0.51	6.91	4.77	<0.001
	initial	6.42	0.23	0.85	13.24		

The comparative analysis of the indicators of basic technical training reveals the following matters: the technical test 1 (TT1) shows differences in final testing, improvement of the handstand on the floor by 2.50 points and significant differences at $p<0.001$; TT2 highlights the improvement of the supported mount by 0.57 points and significant differences at $p<0.01$; in TT3 – the final test - there is an improvement by 0.57 points of the elements with flight phase and transition from high bar to low bar (Pak salto / transition with 180° twist) and significant differences at $p<0.05$; TT4 – initial testing has a low level of 6.78 points and a final improvement by 0.5 points of the elements with flight phase on the same bar (releases) and insignificant differences at $p> 0.05$; at TT5, there is an

improvement by 0.58 points in final testing as for the elements with different grip, excepting the mount and the dismount, and significant differences at p< 0.01; TT6 has a mean of 7.14 points in initial testing and an improvement by 0.43 points in final testing at the elements with 360° twist in longitudinal axis, with significant differences at p <0.05; TT7 highlights an improvement by 0.43 points in the final testing (7.50 points) at the elements close to the bar - clear hip circle to handstand (SPM) / toe circles in SPM / Stalder in SPM, with significant differences in p<0.01; TT8 has an improvement by 1.01 points in final testing (7.43 points) at double salto dismount (DST / DSP) / DST 360º (Tsukahara) / (DSS) / (DSfwd) and significant differences at p<0.001.

Fig. 1. Dynamics of the performance capacity on uneven bars, n =10

The results of the performance capacity are shown in figure 1, highlighting the mean of the scores obtained in 5 competitions of the training cycle 2017 and 5 competitions in 2018. The comparative analysis of the scores for Difficulty reveals an increase by 0.46 points (4.53 points) at the performances achieved in 2018; the scores for Execution have a decrease by 0.06 points and insignificant differences at p>0.05; the Final Score has an increase by 0.35

points in 2018 and insignificant differences at $p>0.05$. These differences are due to the introduction of some elements of great difficulty (such as transitions with flight phase, releases of the same bar and more difficult dismounts) in the content of the training plan.

Discussion

The basis of the contemporary artistic gymnastics is physical training. The high level of physical training is a prerequisite for achieving high results in artistic gymnastics. This condition is necessary but not sufficient. Finally, the main way to obtain sports technical result is the technical action, which can be found in the movements of athlete's body or its segments (Potop, 2011). If we consider the complete training of elite gymnasts from the systemic analysis angle and its description in terms of entry and exit, then the technical training could be seen as an exit and the physical training as an entry into the system (Arkaev & Suchilin, 2004).

The analysis of the specialized literature regarding the effort in training points out the correlation of training effort parameters with the average of the performances obtained in competitions (Cîmpeanu, 2014). An important approach within this study refers to the influence of physical training on the technical training on uneven bars (Potop & Cretu 2018). As for the basic technical training in accordance with the specific requirements on uneven bars, it was found out that improvements at the level of specific physical training and technical execution as well were still needed. This also implies the necessity of biomechanical study of the technical execution, for a deeper knowledge of the technique key elements. In this respect, we can mention some studies that focus on aspects like the optimization of the technique used in descents (Hiley & Yeadon, 2003, 2007; Forminte et al., 2020); the optimal kinematic model of the performance of the clear hip circle to handstand (Petkovic et al., 2018); biomechanical analysis of the double salto descent off the uneven bars (Potop, 2014); the mathematical modelling of the biomechanical characteristics of the dismounts off uneven bars

(Potop, Mihaila, & Urichianu, 2015). The study found out that the role and share of the special physical training increases in the training process. The volume of competitive training within an annual training cycle (5 competitions) also increases, at the same time as the number and level of the competitions. There are also studies that analyze the biomechanical characteristics and the performances obtained in the uneven bars events (Potop et al., 2014; Potop, Timnea, & Stanescu, 2017).

Conclusions

The comparative analysis of the physical training indicators following up the implementation of the training program between tests highlights the improvement of muscle strength development needed during the training, which was observed as a motor support in the learning of the specific requirements on uneven bars.

The results of the performance capacity reveal significant differences between the means of the scores obtained in the competitions of the training cycles 2017 and 2018, by increasing the elements difficulty, and insignificant differences at Execution by the decrease of the value and the increase of the Finale Score, as a result of their sum.

The use of a physical training program, correlated per muscle groups, both in the first and the second training session, and preparatory exercises for each technical requirement on uneven bars highlighted the dynamics of muscle groups strength development consistent with the results achieved in competitions; all this validates the hypothesis proposed in this study.

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Reference

1. Arkaev, L. Ja., & Suchilin, N. G. (2004). Kak gotovit' chempionov. Teorija i tehnologija podgotovki gimnastov vyshej kvalifikacii [Gymnastics: How to Create Champions] Moskva: Fizkul'tura i sport.
2. Atiković, A., Kalinski, S.D., Čuk, I. (2017). Change the gymnastics minimum age requirements and the changes that have occurred in major competitions in women's artistic gymnastics. *Acta Kinesiologica,* 11(Suppl 1): 80-88.
3. Boloban, V. N. (2013). Reguljacija pozy tela sportsmena [Regulation of Athlete Body Posture]. (Monograph). Kiev: Olympic Literature.
4. Cîmpeanu, M. (2014). Correlation of training effort parametrs with technical and physical training of junior female gymnasts. Știința culturii fizice, p.37-43.
5. Crețu, M. (2004). Perfecționarea tehnicii giganticii înapoi și a coborârii cu salt întins prin mijloace selecționate pe criterii biomecanice [Improvement of the technique of back giant and back somersault dismount by means selected on biomechanical criteria]. Pitesti: Universității din Pitești.
6. FIG. (2017). Federation Internationale de Gymnastique. About the FIG: history. Retrieved from http://www.gymnastics.sport/site/
7. Forminte, V.N., Potop, V., Micu, R., Grosu, EF (2020). Optimal kinematic characteristics of the uneven bars dismounts – a case study. *Discobolul – Physical Education, Sport and Kinetotherapy Journal*, 59(1):70-80. https://doi.org/10.35189/dpeskj.2020.59.1.7
8. Grosu, E. F. (2004). Paralele inegale din gimnastica artistică

feminină [Uneven bars of women's artistic gymnastics], Cluj-Napoca: GMI.

9. Hiley, M. J., & Yeadon, M. R. (2003). Optimum Technique for Generating Angular Momentum in Accelerated Backward Giant Circles Prior to a Dismount. *Journal of Applied Biomechanics,* 19(2), 119-130. DOI: https://doi.org/10.1123/jab.19.2.119
10. Hiley, M. J., & Yeadon, M. R. (2007). Optimization of Backward Giant Circle Technique on the Asymmetric Bars. Journal of Applied Biomechanics, 23(4), 300–308. https://doi.org/10.1123/jab.23.4.300
11. Irwin, G., Hanton, S. and Kerwin, D.G. (2005). 'The conceptual process of skill progression development in artistic gymnastics', *Journal of Sports Sciences,* 23(10), pp.1089-1099. http://dx.doi.org/10.1080/02640410500130763
12. Petkovic, E., Veličković, S., Kolar, E., Stanković, R., & Stanković, D. (2018). The optimal kinematic model of the performance of the clear hip circle to handstand on the uneven bars – a case study. *Facta universitatis. Series: Physical Education and Sport*, 16(2), 229-244. https://doi.org/10.22190/FUPES170314021P
13. Potop, V. (2011). Influence of physical training means on technical elements learning in women's artistic gymnastics. *Annals of the University Dunarea de Jos of Galati: Fascicle XV: Physical Education & Sport Management*, Issue 1, p.223-228.
14. Potop, V. (2014). Biomechanical Analysis of Sports Technique Key Elements in Back Double Somersault Dismount off Uneven Bars – Junior Gymnasts 12 to 14 Years Old. Procedia - Social and Behavioral Sciences, 117, 203-209. https://doi.org/10.1016/j.sbspro.2014.02.202
15. Potop, V. (2015). *Osnovy makrometodiki obuchenija sportivnym uprazhnenijam (na materiale zhenskoj sportivnoj gimnastiki)* [Bases of macro methods for sports exercises learning (Material from Women's Artistic Gymnastics)] (Monograph). Kiev:

Centre of Education Literature.

16. Potop, V., Cretu, M. (2018). Analysis of physical training influence on the technical execution of the dismounts off the uneven bars. *Pedagogics, psychology, medicalbiological problems of physical training and sports*, 22(1), 28-34. https://doi.org/10.15561/18189172.2018.0104
17. Potop, V., Grigore, V., Timnea, O. C., & Ulareanu, M. V. (2014). Biomechanical characteristics of transfer in the rotational movements on uneven bars. Applied Mechanics and Materials, 656, 650-660. https://doi.org/10.4028/www.scientific.net/AMM.656.650
18. Potop, V., Mihaila, J-M., & Urichianu, A. (2015). Mathematical modelling of the biomechanical characteristics of the dismounts off uneven bars in women's artistic gymnastics. *The European Proceedings of Social & Behavioral Sciences*, 11, 391-397. http://dx.doi.org/10.15405/epsbs.2016.06.54
19. Potop, V., Timnea, O. C., & Stanescu, M. (2017). Comparative analysis of the biomechanical characteristics of sports technique used in dismounts and the performances achieved by junior gymnasts in uneven bars events. *International Multidisciplinary Scientific GeoConference: SGEM*, 17, 191-198. DOI:10.5593/sgem2017/21
20. Potop, V., Timnea, O. C., Mihaiu, C., & Manole, C. (2014). Biomechanical characteristics of back double salto dismount off the uneven bars. *Journal of Physical Education and Sport,* 14(2), 248-253. DOI:10.7752/jpes.2014.02037
21. Prassas, S., Kwon, Y-N., & Sands, W. A. (2006). Biomechanical research in artistic gymnastics: a review. Sports Biomechanics, 5(2), 261-291. https://doi.org/10.1080/14763140608522878
22. Readhead, L. (2011). Gymnastics. Skills. Techniques. Training. Marlborough: Crowood Press.

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Teacher Physical Education Major Factor in Motivating Pupils

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Abstract
Introduction: Motivation is closely related to creating an active attitude and ensures more active involvement of pupils in the learning process, where it increases the security of the individual's vital involvement in general physical education activities. This requires the teacher to look for more innovative methods to ensure that students are actively involved in the learning organization process. **The purpose of this paper** review is to analyze literature in the field of teaching psychology as well as from the field of teaching, with a spectrum related to their motives, attitudes and connections with teacher strategies, to provide an analysis with conclusions on the most appropriate ways which would help improve the active involvement of pupils in physical education. **Methodology:** In order to fulfill this review are using methods of literature analysis, and is made combination and comparison of data from various works and projects of authors varied. To successfully realize this review paper we studied and analyzed the contemporary scientific literature provided by various Internet-based research sectors such as: "Jab Ref" "Pub Med" "Google Scholar" "Medline" "Sports Discuss" and "Research Gate". The methods used are: literature analysis, physical activity statistics, conclusions and recommendations. **Conclusions and recommendations:** all the literature used can be clearly seen the importance of understanding motivation, and the factors on which it depends on the teacher. The purpose of physical education, ie the concept of physical education class has changed radically in

all developed countries. Modern physical education should aim at strengthening personal traits, in preparing for an active lifestyle not only at school, but throughout life.

Keywords: physical activity, physical education, teacher motivational strategies, methodology teaching, pupils.

Introduction

Motivation can be conceived as energy and motivation to learn, work effectively and achieve the right potential in school. Increasing motivation increases the commitment that follows from this energy and push. Motivation and commitment play a big role in pupil interest in being satisfied with school. Motivation and commitment support pupil achievement. Pupils at all points of the academic spectrum benefit from motivation and commitment *(Ferrer-Caja E & Weiss M R., 2000)*.

Achieving a satisfactory level of motivation benefits both parties involved in the learning process. On the one hand, pupils reach their potential, taking advantage through the development of their strengths. Disruptive pupils benefit through greater engagement, both in school and in studies. Educators benefit through enhanced opportunities for learning and development. Motivation and commitment are important for all pupils and educators *(Currani V & Zhurda Y., 1996)*.

Motivation is closely related to the creation of an active attitude and ensures more active involvement of pupils in the learning process and at the same time increases the security of the vital involvement of the individual in general physical education activities. This requires the teacher to seek more innovative methods to ensure that pupils are actively involved in the learning organization process *(Standage et al., 2006)*.

In general, the term "motivation" should be understood as "a process of activating the body, completed the implementation of a decisive goal in regard to circumstantial conditions" (Chartrand T & Bargh, J A., 2002). The term motivation can be understood

as "a community of factors that promote the subject activity being oriented toward some objectives are not achieved immediately" *(Standage et al., 2007)*.

It is already known that physical education as a subject in school has a special importance. He realizes many formative aspects that are important and cannot be done by other subjects. But to achieve the stated objectives of physical education, an important role is to motivate pupils to be active in their participation in sports activities. The main role in this regard was the teacher of physical education, which should recognize these motivations and rely on them to build a more effective teaching. The physical education teacher should be clear that his role is not just in completing the lesson, but his work should focus and give importance to the way the pupil is as active and growing as possible their physical abilities as naturally as possible. In this context, it is clear that student motivation has a primary role. One of the most important successes of a teacher is his ability to motivate pupils to feel pleasure in practicing their physical activity. Students are always motivated by the pleasure of moving, of running, of dancing, of playing, especially when these are accompanied by a sense of freedom *(Ntoumanis N., 2005)*.

Looking at it from this perspective, the teacher should keep in mind this motivation, which means that every teacher in the classroom should create the opportunity (always within the teaching discipline) for the pupil to be free and feel the pleasure of practicing with sports activity. Another motivation is that of competition, it comes from an intrinsic human need to deal with others and himself. This motivation is related to competence motivation. Pupils need to face fellow friends and these motivations make them protagonist in a particular action *(Reeve J et al., 2004)*.

Competition between them makes pupils quite active and gives them a special pleasure, and also significantly affects the increase of their physical and psychological performance. But, this teacher should direct away from the competition to dominate the other and not affect the incitement of anxiety in pupils, which means that the competition should not be a promoter of selfishness, anger, etc., but a form that should give pleasure *(Tamo A et al., 2005)*.

The teacher should be very attentive to those pupils who for various reasons, for example are given behind the computer, mathematics, these motivations may be drowsy, where in these pupils he has the task that with the motivation of proper to "awaken" the feeling of exercising with sports activity. An important issue nowadays is also the tendency that adolescents have in their physical development, for the changes they want in relation to their body. But the knowledge they have does not help them to achieve this goal. Body preoccupation motivation is an action that the teacher should use to motivate adolescents, but at the same time this type of motivation makes adolescents more aware of the role that physical education has in shaping a beautiful and healthy body. Teenagers want to be equal with their peers, want not be avoided, they value and appreciate friends who have good physical qualities *(Taylor I & Ntoumanis, 2007)*.

Pupils are inclined to follow the example of some of their models, who can be great athletes, movie artists, etc. Their good physical shape makes pupils more motivated to be active in physical education, in exercising sports activities, to be as close as possible to their idols. The role of the teacher in this case should be primary, because he should give the pupil a precise orientation regarding what, the achievements for a beautiful and strong body, can not be achieved immediately. The teacher should make the best use of this motive to motivate pupils for physical activity *(Mouratidis M et al., 2008)*.

Psychologist *Ogilvie, B.C.* states: "I am convinced that sport gives a great benefit to children but this does not happen automatically, these benefits can be provided by a competent leadership teacher, who understands children and the structure of the right programs."

By using different techniques that increase motivation, the teacher will be able to improve and enhance pupil performance. Knowing how to focus at the right moment, being motivated to achieve the goal, having self-confidence and self-values, knowing how to keep one's emotions physiologically active, are among the most important psychological factors to influence the work of pupils. *(Musai B., 2003)*.

Physical education teachers by building their work on the basis of these motivations that are described in this material will be more productive and will be successful in their work.

Purpose of the paper

The purpose of this paper is to analyze literature in the fields of educational psychology as well as in the field of teaching, spectrum that has to do with the motives, attitudes, and their relationships with teaching strategies, provide an analysis of the results for routes appropriate which would help improve the active involvement of pupils in physical education.

Methodology

In order to fulfill the purpose of this review we are using methods of literature analysis, and is made combination and comparison of data from different works and authors of various projects. To successfully realize this review paper we studied and analyzed the contemporary scientific literature provided by various Internet-based research sectors such as: "Jab Ref" "Pub Med" "Google Scholar" "Medline" "Sports Discuss" and "Research Gate", physical activity statistics, conclusions and recommendations.

Statistics of physical activity in young people

Although young people are the most active population, specific factors make it less likely for adolescents to pursue an active lifestyle in adulthood. First: levels of physical activity in both boys and girls decline steadily during high school. Second: high school pupils do not engage in regular physical activity, which maintains or improves aerobic well-being, strength and flexibility *(Standage M & Gillison F., 2007).*

These trends have been shown in these results of physical activity *(Hagger et al., 2003)*

- 34.7% adapt to the recommended levels of physical activity.

- 53.6% attended physical education classes one or more days a week.
- 70% did not attend physical education classes every day.
- 35% watched television for an average of two or three hours on a school day.
- 25% played video games or computer games or used a computer for an average of 2 or 3 hours a school day, for something that was not school work.
- Research also shows changes in the behavior of strength exercises among high school pupils *(Chatzisarantis N & Hagger M S., 2009).*
- 53.4% of pupils have done strength exercises (eg pumps, abdominal exercises and weight lifting) on more than 3 of the 7 days of the week.
- Male pupils (62.8%) participated in strength training exercises significantly more than female pupils (44.5%).

Knowing that it is healthy to be physically active does not always affect the levels of physical activity in adults, while for children this knowledge is even less influential. The children put more importance to the value of an activity even if they do not feel competent and happy during the event *(Cavill N et al., 2001).*

In pupils who continue physical activity while growing up, it is clear that they should generally feel competent in physical activity. They also need to feel confident in their ability to achieve a specific goal. Efficiency itself suggests that children and adolescents believe they have a chance to succeed. Control over results is included based on self-efficacy efforts. To influence children's change, teachers need to know how to motivate pupils to actively participate in the classroom. Another component that teachers need to know is how to help pupils to achieve satisfaction or feel successful after their attempt *(Standage M et al., 2003).*

Recent research in the physical activity of children and the psychology of exercise provide sufficient evidence that fail to provide teachers of physical education who understand much better how they motivate children and where the difference lies between the motivation of children and adolescents. This understanding can help

teachers develop classroom work strategies that can help pupils understand the importance of being active and influence the change in physical inactivity in adolescence *(Goudas M et al., 1994).*

It is very important for children to feel competent during the efforts. To feel competent, young children need to be guided through acquisition skills and be provided with many skills to practice at their level of opportunity, without focusing on competition. Young children have a tendency to believe that, simply by trying too hard the result is controlled. The teacher should construct such strategies where all pupils are able to perform the assigned task but that the degree of difficulty must necessarily be adapted to the capabilities of each pupil. This does not mean that the tendency for pupils to reach the desired level should be abandoned, but it requires the teacher to construct in such a way where everyone builds their own strategies of trying to achieve the result *(Fraboni F & Minerva P M., 2003).*

Teachers can define the concept of effort in young children by rewarding the number of effort exercises or minutes spent working toward a goal. As children learn and develop, they realize that effort does not always lead to success and that the reward system must change to reward goals. This change in mental development is why older children need to be given more choices of activities so that they can find activities with which they can succeed. To develop self-efficacy, children need to be able to choose from a variety of activities. This approach will increase their chances of finding activities that compare to personal factors such as strength, height, endurance or other biological factors *(Morris G & Maisto A., 2008).*

Teachers should provide pupils with choices of activities, including team and individual activities, as well as different levels of competitive or non-competitive activities. Teachers can find a variety of relevant developmental activities in the "Best Physical Activity Guidelines". Using a variety of activities adapted to pupils age and development level will increase the interest and success of pupils, increasing self-efficacy of pupils.This approach can lead to greater pupil motivation in the classroom. Teachers who use appro-

priate developmental activities are taking the first steps in creating a psychologically safe classroom where children and adolescents can be successful, receive regular helpful reviews to improve the performance of their physical abilities and have choices of activities used to meet fitness goals. Pupils who feel confident and who have experienced success will insist on physical education activities in the classroom and during leisure time after school *(Ntoumanis N., 2001).*

Conclusions

From all the literature used it can be clearly seen the importance of understanding motivation, as well as the factors on which it depends. The purpose of physical education and the concept of physical education class has changed radically in all developed countries.

The latest trends in physical education with pupils in schools are moving in the direction where the main idea of change should lead to the development of basic motor skills, as well as to the development of attitudes enabling young people to continue developing those skills throughout life independently.

In other words, young people need to learn how to develop periodically and constantly, to be able to use those skills when they grow up. This is what school education should provide for young people today.

Boiché J et al., 2008, provide the following two proposals for the future of physical education:

- Physical education should develop physical fitness and motor skills to the level that enables young people to pursue an active lifestyle.
- Physical education should contribute to the overall social, cognitive and emotional development of young people in their preparation for life.

These findings show that in our schools a lot of work needs to be done in order for young people from an early school age to

build a right attitude towards being active all their lives, as well as to become aware of the values of a healthy lifestyle. To be active throughout life every individual must have the right worldview towards physical activity.

Many theories show that one of the key factors is the understanding of the emotional world of children, but also of theories of learning which explain the driving force, internal or external, which in psychology is known as motivation.

Recommendations

The research in this paper brings the following recommendations:

- Modern physical education should aim at strengthening personal traits (beliefs, moral values, motives, interests, motor skills or sports) in preparation for an active lifestyle not only at school but throughout life.
- Make changes in the teaching organization, where teaching is organized through pedagogical methods and the specific interactive nature of the relationship between teacher and pupils.
- To enable children to be educated through the variety of activities, forms and methods of their distribution, which are used to help young people towards their interests in physical education in the future.
- In social life, physical culture play an important role, that individuals of all ages to participate in physical activities.
- Provide the necessary conditions and infrastructure which would enable different categories to be involved more regularly in physical activity.
- To invest by society and institutions in promoting the value of physical activity and healthy living, by creating promotional activities and campaigns. Various mass initiatives which create right attitudes towards the value of being active.

References

1. Ferrer-Caja, E. & Weiss, M.R. (2000) *`Predictors of intrinsic motivation among adolescent students in physical education'*, Research Quarterly for Exercise and Sport 71, p. 267-279.
2. Currani, V., & Zhurda, Y. (1996) *Psikologjia sportive.* Tiranë. p. 39-42.
3. Standage, M., Duda, J.L., & Ntoumanis, N. (2006) *`Students' motivational processes and their relationship to teacher ratings in school physical education.* A self-determination theory approach', Research Quarterly for Exercise and Sport 77, p. 100-110.
4. Chartrand, T.L., & Bargh, J.A. (2002) *`Nonconscious motivations: Their activation, operation, and consequences'.* Washington, DC: American Psychological Association Press.
5. Standage, M., Gillison, F., & Treasure, D.C. (2007) *`Self-determination and motivation in physical education*, Champaign, IL: Human Kinetics. p. 71-85.
6. Ntoumanis, N. (2005) *A prospective study of participation in optional school physical education based on self-determination theory,* Journal of Educational Psychology 97, p. 444-453.
7. Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barsh, J. (2004) *Enhancing students' engagement by increasing teachers' autonomy support',* Motivation and Emotion 28, p. 147-69.
8. Tamo. A., Karaj, D., & Rapti, E. (2005) *Mësimdhënia dhe të nxënit*. p. 147-148.
9. Taylor, I., & Ntoumanis, N. (2007) *Teacher motivational strategies and student self-determination in physical education',* Journal of Educational Psychology 99, p. 747-60.
10. Mouratidis, M., Vansteenkiste, M., Lens, W., & Sideridis, G. (2008) *Motivating role of positive feedback in sport and physical education: Evidence for a motivational model',* Journal of Sport and Exercise Psychology 30, p. 240-248.

11. Ogilvie, B.C. (1968) *Psychological consistencies within the personality of high level competitors.* Journal of the American Medical Association. p. 205.

12. Musai, B. (2003) *Metodologji e mësimdhënies.* p. 244-245.

13. Standage, M., & Gillison, F. (2007) *Students' motivational responses toward school physical education and their relationship to general self-esteem and health-related quality life.* Psychology of Sport and Exercise 8, p. 714-721.

14. Hagger, M.S., Chatzisarantis, N., Culverhouse, T., & Biddle, S. (2003) *The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior:* A trans-contextual model', Journal of Educational Psychology 95, p. 784-795.

15. Chatzisarantis, N., & Hagger, M.S. (2009) *Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation',* Psychology and Health 24, p. 29-31.

16. Cavill, N., Biddle, S., & Sallis, J.F. (2001) *Health enhancing physical activity for young people.* Statement of the United Kingdom expert consensus conference', Pediatric Exercise Science 13, p. 24-25.

17. Standage, M., Duda, J.L., & Ntoumanis, N. (2003) *A model of contextual motivation in physical education: Using constructs from self-determination and achievement goal theories to predict physical activity intentions',* Journal of Educational Psychology 95, p. 109-110.

18. Goudas, M., Biddle, S., & Fox, K. (1994) *Perceived locus of causality, goal orientations, and perceived competence in school physical education classes',* British Journal of Educational Psychology 64, p. 59-63.

19. Fraboni, F., & Minerva, P. (2003) *Manuali i pedagogjisë së përgjithshme.* p. 73-76

20. Morris, G., & Maisto, A. (2008) *Psikologjia.* CDE. Tiranë. p. 158-159.

21. Ntoumanis, N. (2001) *A self-determination approach to the understanding of motivation in physical education'*, British Journal of Educational Psychology 71, p. 225-232.

22. Boiché, J., Sarrazin, P.G., Grouzet, E., Pelletier, L., & Chanal, J.P. (2008) *`Students' motivational profiles and achievement outcomes in physical education: A self-determination perspective',* Journal of Educational Psychology 100, p. 688-689.

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Strategies Used in the Stage of Learning to Swim

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Abstract:

Introduction: The reasons that determined me to approach the topic of this paper is the importance of the correct mastery of swimming from an early age, the formation of the mentality of practicing sports in general and swimming in particular and the maintenance of optimal fitness. **Purpose**: The present study aims at theoretical and experimental research on the very important role of swimming means used in the initiation stage in children aged 5-7 years. Thus, we tried to achieve a systematization of the most effective means of learning to swim, Increasing the efficiency of the preparation of the educational instructional process requires the establishment of precise finalities, of a well-objectified and optimized action system as well as the choice of the most efficient methods and means of action. **Methodology**: The establishment of training models as well as the judicious use of the most efficient methods and means specific and non-specific to swimming must lead to the following tasks: - appropriate mastery of the basic technical elements of swimming (floating, sliding, breathing) as well as the craul swimming process, - increasing the minimum motor qualities, - demonstration of the validity of the methods used and the applicability of some tests in order to follow the qualitative development of the motor qualities. **Results**. I consider that the focus on the technical component of sports training, especially at this age, when the psycho-physiological peculiarities of the subjects allow motor acquisitions, high receptivity, plasticity of the nervous system. the basic technical elements of swimming and the craul swimming process over a distance of 25m. Following the evolution of the arithmetic mean, we can interpret it as follows: the arithmetic mean of the sample included in the research has 3.93

points in the initial test, increasing it to 5.07 points in the intermediate test. There is a progress of 1.14 points. At the final test the average of the sample is 6.91 points, so we can see an improvement in performance by 2.88 points from the initial test. Following the evolution of amplitude (W), the simplest statistical indicator, we can see that if at the beginning of the experiment, the difference between the subjects' scores was 2.70 points, it is reduced to 2.30 points in the intermediate test, that in the end it reaches 2.11 points. **Conclusion**. These results show that the value differences between the subjects fade, the subjects mastering the basic elements in swimming and the craul swimming process. Following the evolution of the standard deviation, we observe the same homogenization of the results in the investigated sample. Analyzing the evolution of the variability coefficient, we observe in this case the tendency to homogenize the value of the subjects from the point of view of recorded performances.

Keywords: learning, technical elements, systematization, models, swimming

Introduction

Swimming as a sport has become a major concern, improving as a technique and gaining more and more popularity. At the same time, the hygienic and recreational character, the need for movement of the contemporary man, educational valences, explain the interest they enjoy all over the world, being spread equally among children and mature citizens (Silviu Salgau, 2005).

I approached this topic because I consider it very important to learn to swim correctly from an early age, to form the mentality of playing sports in general and swimming in particular, and to maintain optimal fitness throughout life. I thought it would be useful to make a systematization of the most effective means of learning on the influence of technique on the acquisition of the basic elements and swimming in the craul process, (Silviu Salgau, Gheorghe Marinescu, 2005).

Increasing the efficiency of the preparation of the educational instructional process requires the establishment of precise finalities, of a well objectified and optimized action system as well as the choice of the most efficient methods and means of action (Dick Hannula, Nort Thornton, 2001).

We started to develop this system from the observation that some coaches neglect in the training of athletes the technical com-

ponent of small swimmers, paying attention only to specific physical training in the water, (David Thomas 1996).

By systematically applying over three months a system of specialized algorithms for learning and consolidating the basic technical elements of swimming and the technique of the swimming process, I believe that the correct mastery of the basic technical elements can be obtained (floating, sliding, breathing), as well as the movements of the legs and arms, as well as a very good coordination of them, (Tudor, Bompa, 2003).

The importance of the paper lies in the special value of a methodical material that has the quality of synthesizing a vast problem that if it were to be observed directly in the practical process would require a long time spent on the edge of the swimming pool.

Through this paper, I provide a material that includes a series of theoretical, practical and methodical knowledge, regarding the efficiency of the means of swimming used in the initiation stage.

Methods

The experiment on the efficiency of the means of swimming used in the initiation stage of the children took place over three months, between September and November 2019, in this way I consider that the results obtained can bring conclusive conclusions.

The experiment consisted in the application of some methods, means in order to learn and consolidate the basic technical elements of learning to swim in the craul process.

For the good development of the experiment we applied three tests: initial testing, intermediate testing, final testing.

The initial testing took place on September 1, 2019. We chose this date, being one week after the start of the experiment, because we considered that the accommodation with water took place, and the children are ready to learn the basics.

The intermediate test was on October 1, 2019, considering it necessary to test in the middle of the experiment.

The final testing took place on December 1, 2019.

On the occasion of these tests we followed and noted with grades from 1-10 the evolution of the children in mastering the tech-

nique of the basic elements and the technique of the craul procedure and the completion towards the end of 25m in the craul swimming process.

The experiment was conducted with 16 children over a period of 3 months. The courses took place 3 times a week, from Monday to Friday. The age of the subjects is between 5-7 years. Based on lesson plans, their swimming skills were assessed. Throughout the experiment, children were individually corrected using exercises that were applied in the training plans.

To carry out the experiment, selected children were selected from children born between 2013-2014, in the preschool cycle and in grades 0-1 at kindergartens and schools in Arad.

The choice of subjects was made according to the following criteria:

- to be a disciplined group, to have a rhythmic presence in class
- to work according to a common plan, so that all subjects use the same means, training methods, exercises dosed differently depending on the morpho-physiological features.
- to measure progress, the statistical indicators recommended by specialized manuals were used in the initial and final tests.

Usual statistical indicators were used:

1. Arithmetic mean: $X = \frac{\sum x}{n}$

2. Amplitude: $W = X_{max} - X_{min}$

3. Standard deviation: $S = \pm \sqrt{\frac{\sum d^2}{n-1}}$

4. Coefficient of variability: $Cv = \frac{S}{X} * 100$

Although the indicators used represent the minimum of the parameters used in the statistics, they can give us conclusive data on the experiment carried out.

Experimental conclusions:

The expression of the conclusions was made after quantifying the differences between the tests performed. The experiment was performed on a single group that at the initial test was considered a control sample, and at the final one was considered an experimental sample. (Horghidan Valentina 1997).

During the experiment the children were subjected to the following tests:

- horizontal buoyancy test in apnea on water
- chest slip test
- aquatic respiration test
- test on the movement of the legs in the craul swimming procedure
- test on the movement of the arms in the craul swimming procedure
- test on the coordination of arm movements with breathing
- test on coordinating the movement of the legs with the movement of the arms
- test on the coordination of the movements of the arms, legs, breathing
- test regarding the start in the craul procedure

Results

The subjects included in the research are born between 2013-2014. The distribution by sex is as follows: 12 boys and 4 girls. Considering that at this age the differences between boys and girls, from a sexual point of view are insignificant and also due to the level of training (beginners) we can consider that the investigated subjects are part of the same statistical sample.

The experimental results were ordered in tables, taken statistically and interpreted according to the methodology of physical activity science research. In order to validate the research hypothesis, the data are analyzed from a statistical point of view and of the specialized literature in the field. The evolution in learning and consolidating the basic elements of swimming and learning to swim in the craul procedure, obtained by the subjects included in the study are those in the following tables:

Table no. 1 - Scoring the technical execution

Sub-jects	The year birth	Sex (f/m)	Initial testing									
			Floa-ting	Glide	Aquatic respiration	Leg movement	The movement of the arms	Coordinating leg movement with hands	Coordination of arm movement with breathing	Coordinating legs, arms and breathing	Jum-ping	Final grade 1
1	2013	m	4	3	3	3	3	3	3	1	3	2,89
2	2013	m	5	5	4	4	5	5	3	2	5	4,22
3	2014	m	6	6	6	5	4	5	4	3	6	5,00
4	2013	m	6	5	6	5	4	4	5	3	6	4,89
5	2014	m	7	5	6	5	5	5	5	2	7	5,22
6	2014	f	4	3	4	3	4	4	3	2	5	3,56
7	2013	m	5	4	4	4	4	4	3	2	5	3,89
8	2014	f	6	5	5	4	5	4	3	3	6	4,56
9	2013	m	6	6	6	5	4	4	4	3	6	4,89
10	2014	m	3	3	3	4	3	3	3	1	5	3,11
11	2014	f	5	4	4	4	4	4	3	2	5	3,89
12	2013	f	5	5	5	4	4	4	3	2	5	4,11
13	2014	m	7	7	6	5	5	5	4	3	7	5,44
14	2014	m	4	4	4	4	3	4	4	2	6	3,89
15	2013	m	4	3	3	4	4	4	3	1	4	3,33
16	2013	m	4	3	3	3	4	4	3	1	3	3,11
Arithmetic mean												**3.93**
Amplitude												**2,70**
Standard deviation												**0,78**
Coefficient of variability												**19,08**

Table no. 2 - Scoring the technical execution.

Sub-jects	The year birth	Sex (f/m)	Intermediate testing									
			Floa-ting	Glide	Aquatic respi-ration	Leg move-ment	The move-ment of the arms	Coordi-nating leg movement with hands	Coordi-nation of arm movement with breathing	Coordi-nating legs, arms and breathing	Jum-ping	Final grade 2
1	2013	m	6	6	5	5	6	6	5	4	6	5,44
2	2013	m	7	7	7	6	5	6	6	5	7	6,22
3	2014	m	7	6	6	6	5	5	6	5	7	5,89
4	2013	m	8	6	7	6	6	6	6	4	7	6,22
5	2014	m	5	4	5	4	5	5	4	4	6	4,67
6	2014	f	6	4	6	6	6	6	5	4	6	5,44
7	2013	m	7	6	6	6	5	5	4	4	6	5,44
8	2014	f	7	6	7	6	5	5	5	4	7	5,78
9	2013	m	5	4	5	4	5	5	4	4	6	4,67
10	2014	m	6	5	5	5	6	5	4	4	6	5,11
11	2014	f	6	6	6	5	5	5	4	4	6	5,22
12	2013	f	8	7	7	6	6	6	5	5	7	6,33
13	2014	m	6	5	5	6	5	5	5	4	6	5,22
14	2014	m	5	4	4	5	5	5	4	4	5	4,56
15	2013	m	5	4	4	4	4	4	5	4	4	4,33
16	2013	m	6	4	4	6	6	5	5	5	5	5,11
Arithmetic mean												**5,078**
Amplitude												**2,30**
Standard deviation												**0,62**
Coefficient of variability												**11,90**

Table no. 3 - Scoring the technical execution

Subjects	The year birth	Sex (f/ m)	Final testing									
			Floating	Glide	Aquatic respi-ration	Leg move-ment	The move-ment of the arms	Coordi-nating leg movement with hands	Coordi-nation of arm movement with breathing	Coordi-nating legs, arms and breathing	Jum-ping	Final grade 3
1	2013	m	8	7	7	7	7	7	6	6	8	7,00
2	2013	m	9	8	8	7	7	7	7	7	8	7,56
3	2014	m	8	7	7	7	6	6	7	7	8	7,00
4	2013	m	9	8	8	8	8	7	7	7	9	7,89
5	2014	f	7	6	6	5	6	6	6	6	7	6,11
6	2014	m	8	7	8	8	8	8	7	7	8	7,67
7	2013	f	9	8	8	8	7	7	7	7	8	7,67
8	2014	m	9	8	9	8	8	8	8	7	9	8,22
9	2013	m	7	7	7	6	6	6	6	6	8	6,56
10	2014	f	8	7	8	8	7	7	7	7	8	7,44
11	2014	f	7	7	7	6	6	6	5	5	7	6,22
12	2013	m	9	8	9	8	8	8	9	7	8	8,22
13	2014	m	8	8	8	7	7	7	7	7	8	7,44
14	2014	m	8	7	7	7	6	6	6	6	7	6,67
15	2013	m	7	5	5	6	5	5	5	5	6	5,44
16	2013	m	9	8	7	8	7	7	7	7	7	7,44
Arithmetic mean												**6,81**
Amplitude												**2,11**
Standard deviation												**0,59**
Coefficient of variability												**8,89**

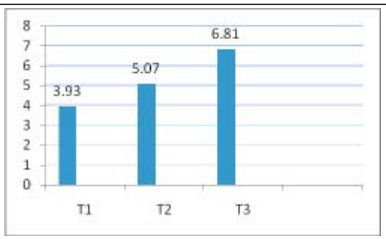	**Initial testing** **T 1**	**Intermediate Testing** **T 2**	**Final testing** **T 3**
Arithmetic mean	3,93	5,07	6,81

Figure no. 1 - Representing the arithmetic mean of the researched sample.

Following the evolution of the arithmetic mean from table 4 and figure no. 1, we can interpret it as follows: the arithmetic mean of the sample included in the research has 3.93 points in the initial test, increasing it to 5.07 points in the intermediate test. There is a progress of 1.14 points. At the final test the average of the sample is 6.91 points, so we can see an improvement in performance by 2.88 points from the initial test.

Overall, analyzing the entire period covered by the research, it is revealed that the biggest jump in results is between the second and third testing.

This fact can be interpreted as follows:

- after mastering the basic elements, the subjects improve their technique in learning and consolidating swimming in the crawl stroke
- the means used for the technical training were chosen and used judiciously

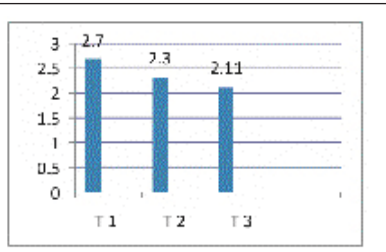	**Initial testing** **T 1**	**Intermediate Testing** **T 2**	**Final testing** **T 3**
Amplitude W	2,70	2,30	2,11

Figure no. 2 - Representing the amplitude W of the researched extension.

Following the evolution of the amplitude (W) from table 4 and figure no. 2, the simplest statistical indicator, we can see the following:

If at the beginning of the experiment, the difference between the subjects' marks was 2.70 points, it is reduced to 2.30 points in the intermediate test, that in the end it reaches 2.11 points. These results show that the value differences between the subjects fade, the subjects mastering the basic elements in swimming and the crawl swimming process.

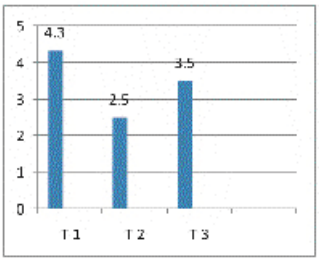	**Initial testing** **T 1**	**Intermediate Testing** **T 2**	**Final testing** **T 3**
Standard deviation	0,78	0,62	0,59

Figure no. 3 - Representing the standard deviation of the researched extension.

Following the table no. 4 and figure no.3, we observe the same homogenization of the results in the investigated sample and in the case of the standard deviation, as in the case of the amplitude. At the final measurement, this statistical indicator changes by 0.19 points.

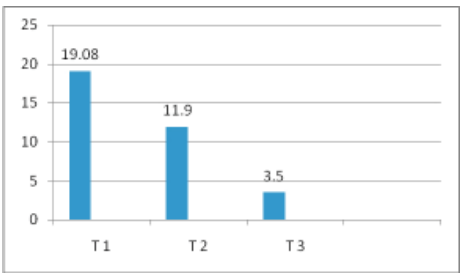	**Initial testing** **T 1**	**Intermediate Testing** **T 2**	**Final testing** **T 3**
Coefficient of variability	19,08	11,90	8,89

Figure no. 4 - Representing the coefficient of variability of the researched sample.

Analyzing the evolution of the variability coefficient (table 4 and figure no. 4), it is also observed in this case the tendency to homogenize the value of the subjects from the point of view of the registered performances. Thus, although the statistics state that between 0 and 10%, the sample is very homogeneous, except for the first and second tests, the results obtained fall within these limits. Between the first and the last test there is a decrease of the distribution by approx. 10 percent.

The homogenization of the experimental sample, detached from the analysis of the other statistical indicators used in the paper, is specific to the teams trained in a correctly directed instructive-educational process.

The analysis of the distribution indicators shows the homogenization of the experimental sample, through the prism of the quality of the swimming motor act. Progress can be seen in terms of mastering the technique of swimming.

Due to the means used in training considered as effects, both their sports evolution and the qualitative level of manifestation of the motor act of swimming are improved. This is perfectly explicable, if we take into account that technical training has a great importance in mastering the basic elements of swimming.

Finally, we can state as a result of the analysis of the collected data, that the research hypothesis is confirmed, the differences between the control sample (considered as such in the initial testing) and the experimental one (considered as such in the final testing), being significant. This is reinforced by the fact that the research period is quite short, during which there are not too many changes in the children's body.

Conclusion

Following the data recorded and statistically processed we can summarize the following:

- the results obtained from the tests performed were continuously improved, in the end the progress being obvious. The other statistical indicators considered had values specific to well-established and prepared teams.
- the appreciation of the technique, although more difficult to achieve but in our case based on a rigorous algorithm, demonstrat-

ed an improvement of the basic technical skills, which can be put on the judicious choice of independent variables.

I consider that the focus on the technical component of sports training, especially at this age, when the psycho-physiological peculiarities of the subjects allow motor acquisitions, high receptivity, plasticity of the nervous system. basic technical elements of swimming and the process of swimming in a distance of 25m (Luciela Cirla, 1999).

Of course, the rigorous quantification of the influence of technique and obtaining sports performance is difficult to achieve, but referring to the literature we consider that at this age the efficiency of the means used in the initiation stage, in learning the basics and swimming technique in the craul process must take precedence over physical, tactical and psychological training. The obtained results, both on the motor level and on the one with technical accuracy, confirm the experimental hypothesis statistically.

Finally, the means used in the initiation stage and in the technical preparation for learning to swim in the craul process consider that they have reached their goal.

References

1. David Thomas, (1996), Swimming steps to success, David Thomas, Humam Kinetics;
2. Dick Hannula, Nort Thornton, (2001), The swim coaching bible, Humam Kinetics;
3. Horghidan, Valentina, (1997), The issue of psychomotor skills, Globus Publishing House;
4. Luciela Cirla, (1999), Swimming Psychomotor skills and technical training, Printech Publishing House;
5. Silviu Salgau, (2005), Swimming - technical-methodical guide, Tehnopress Publishing House Iasi;
6. Silviu Salgau, Gheorghe Marinescu, (2005), Adaptation of effort and programming for swimmers, Tehnopress Publishing House Iasi;
7. Tudor, Bompa, (2003), Everything about training young champions, Ex Ponto Publishing House Bucharest.

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Comparative Study on Multi-Joint and Single-Joint Exercises in Bodybuilding Economics

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Abstract
Introduction. A relevant aspect of bodybuilding is that each person wants to improve muscle mass, or remove adipose tissue and build muscle, but this can only be done through a specific training program. **The purpose** of this current research is to make a comparative study between MJ and SJ exercises, and to see if through specific training routines, the subjects can achieve the proposed objectives, muscular hypertrophy or weight loss. **Methods.** The study was carried out on a number of 30 subjects divided in two groups with specific trainings methods. To obtain specific results, we will develop 2 training routines, one routine for hypertrophy based on multi-joint exercises, and one for weight loss based on single-joint exercises. These training structures will be consistent with the specific objectives, in terms of load used, number of repetitions and rest break. **Results.** Following the experiment, we recorded a series of significant results, regarding the HMM group, respectively the DM group. The most representative increases were recorded in the chest muscle from HMM group, with an increase of 5.86%. The smallest increase was on the chest on DM group, -2.57%, and in the thighs the highest of -4.15%. **Conclusions.** The hypothesis works to confirm, this allows us to affirm that it is possible as through a predetermined program with multi-joint exercises, and a program with single-joint exercises combined with cardio routines, subjects accumulate muscle mass, or lose weight by reducing the perimeters of body segments, to reach the desired physical shape.

Keywords : bodybuilding, multi-joint exercises, single-joints exercises

Introduction

In general, it is common to classify bodybuilding exercises as multi-joint (MJ) or single-joint (SJ), depending on how many joints are involved in the movement. Some authors suggest that SJ exercises promote greater muscle hypertrophy because they are easier to be learned and therefore have less reliance on neural factors than MJ exercises (Rutherford, O. M., and colab. 1986, Chilibeck, P. D and colab. 1998).

On the other hand, some authors recommend an emphasis on MJ exercises for maximizing muscle strength, assuming that MJ exercises are more effective than SJ exercises because they enable a greater magnitude of weight to be lifted (Kraemer, W. J and colab. 2008, American College of Sports Medicine, 2009). Exist many opinions for these claims because are limited from the lack of studies comparing muscle hypertrophy and strength gains between SJ and MJ exercises.

Joint exercises are the best way to get your entire body fully functional and physicaly fit for the activities of daily life and not only (National Institute on Aging, 2020). Compound exercises, also known as multi-joint, are one form of these exercises, and if we list a few multi-joint exercises that we can perform, they would be : step-ups, lunges, leg presses, dead lifts, push-ups and squats (Fitday.com). Each of these exercises applies stress to different muscles: step-ups exercise, engage the lower body muscles, leg presses increased muscle growth to the quadriceps, hamstrings, calves and glutes due to the heavier resistance involved, dead lifts increase muscular mass in both the lower and upper body, push-ups increase muscular mass in the chest, shoulders, back and triceps and squat exercises can vary but generally focus on the quadriceps, hamstring, calves and glutes (Healthline.com). As a generalization, exercises that by their nature involve pulling, pushing, or kneeling using gravitational force itself, are called compound exercises (Nuffieldhealth.com). Practically, each of these exercises applies stress to different muscles (Fitday.com).

An important aspect of multi-joint exercise and good food indgestion, is that it triggers muscle hypertrophy. Schoenfeld B. J. (2010) consider that three major factors are emphasized in the conventional hypertrophy model: mechanical tension, metabolic stress, and muscle damage . Also, muscle hypertrophy occurs when muscle protein synthesis exceeds muscle protein breakdown and results in positive net protein balance in cumulative periods (Damas, F., and colab. 2018).

Single-joint exercises (SJ), help us to build and maintain a strong and healthy body. These exercises are also known as isolation exercises. Isolation exercises are also called exercises for definition or for a low fat physique, they are those exercises of monoarticular type, which involve in the actual movement a single muscle group, because the participation of other muscle groups is limited. Gentil. P., and colab, (2015), consider that the weights used in these exercises are less than to the multi-joint(MJ) exercises. As we said about multi-joint exercises and muscle group involved, isolation exercises include : the leg curl, biceps curl, quadriceps extension, wrist curl and front raise and many other examples. On the other hand, weight machines are often used to undertake these exercises.

As basic principles specific to weight loss training to achieve muscle quality, are the following : a correct and strict diet, meals should not be high in calories but rich in protein, combined aerobic and anaerobic workouts, additional appropriate to the goal (those that support the weight loss).

We recommended to perform some form of aerobic exercises at least maybe two or three times a week, for a minimum of 25 minutes per session. However, on days when a cardio workout of more than 25-30 minutes will take place, combined with a workout with isolation exercises, and strict diet, in time, will generate a decrease in weight, but also an increase in muscle quality.

Methods

Thirty-teen young men (N=30), without prior bodybuilding training experience, were divided into two groups (HMM group; N=15, and DM group; N=15). Both groups trained four days a week, for a period of twenty-four weeks.

The HMM group performed only MJ exercises(e.g. bench press, bent-over row, squat, deadlift), and the DM group, performed SJ exercise(e.g. biceps curl, lateral raise, leg extension) program combined with cardio for at least 20 minutes(e.g treadmill, cycle ergometer), twice a week for weight loss. The training period took the form of 2on / 1off, for example, two days of training, one day of rest, and a free weekend. In these twenty-four weeks, the subjects had 3 phases of evaluations (initial, intermediary and final). The subjects were measured from an anthropometric point of view in all three phases to see if the routines were successful..

To be accepted in this research, participants should be at least 18 years of age, have not been participating in any bodybuilding training program over the past six months and be free of health problems that could be aggravated by the experimental procedures (Gentil, P, and colab., 2015).

To be included in the analysis, the participants had to attend at least 80% of the training sessions (Gentil, P., & Bottaro, M. 2013).

The anthropometric measurements of perimeters from the three test stages, were performed with a mechanical thalliometer for the circumference.

Statistical analysis

The usual statistical indicators were used : the average (M), and standard deviation (SD). We used the SPSS program. The experiment was performed on two samples with two different objectives. Both groups were considered a control samples at the initial testing, and the final one was considered an experimental samples.

Results

The obtained data from both groups, with the best results on specific muscle area after the 3 stages of testing are presented in Table no.1, and Table no. 2. It is noticeable that, all two research groups are not unitary regarding the anthropometric measurements, and represent the averages obtained after twenty-four weeks of training according to the requirements established in the current study. This is a result of the fact that in the same group different somatic types are found. From each group, there were subjects who responded very well to training and had a very good evolution, especially in the first two tesing stages, but also subjects who registered a slower progress due to various causes.

We chose to present the most exponential results from the somatic point of view of 3 muscle groups (chest, back and thighs), obtained during the 3 tests performed in different periods. These data represent the results obtained from training based on compound exercises for muscle hypertrophy and on the other hand, results obtained from training with isolation exercises for the oxidation of adipose tissue and the increase of muscle quality.

Discussions

From an analytical point of view, the results obtained summarize the fact that the training routines gave results in both groups involved in the research. The proof that the experiment goes on an ascending path, are the anthropometric measurements periods called initial, intermediate and final testing, shown in Fig.1 and Fig. 2, where we can follow the dynamics of the results.

Table 1. The data with the evolution of measurements from 3 tests at the level of the targeted muscle groups (HMM).

		Initial Test - Perimeter of chest muscles (cm)	Intermediar Test - Perimeter of chest muscles (cm)	Final Test - Perimeter of chest muscles (cm)	Initial Test - Perimeter of back muscles (cm)	Intermediar Test - Perimeter of back muscles (cm)	Final Test - Perimeter of back muscles (cm)	Initial Test - Perimeter of thigh muscles (cm)	Intermediar Test - Perimeter of thigh muscles (cm)	Final Test - Perimeter of thigh muscles (cm)
Subject	**B.I**	113.0	115.0	119.2	118.0	119.2	122.0	59.0	60.0	61.0
	C.C	104.0	107.3	113.0	120.0	124.2	127.0	58.0	60.0	61.0
	C.L	97.5	99.7	105.0	103.0	105.0	110.6	57.0	58.0	59.5
	D.A	105.0	107.6	110.2	110.0	116.0	120.5	58.0	59.7	61.0
	D.S	104.5	106.2	109.0	111.5	115.5	119.0	58.0	59.2	60.3
	G.A	104.0	105.0	109.0	120.0	122.5	124.0	58.0	59.6	62.0
	G.D	99.5	102.3	108.4	102.0	104.1	107.6	50.0	52.0	54.0
	J.R	104.0	105.0	106.7	115.0	117.0	118.5	55.0	56.2	57.0
	M.I	102.0	105.6	107.2	115.0	119.0	121.0	52.0	53.5	55.0
	M.M	103.0	106.0	107.2	112.0	114.3	117.0	53.0	54.2	56.0
	P.G	116.0	118.0	119.5	106.5	109.0	111.2	61.0	61.9	62.4
	P.O	96.0	99.2	103.0	101.0	104.2	108.2	48.0	50.0	51.5
	S.O	101.5	104.8	108.8	110.0	114.7	117.3	56.0	57.6	59.0
	T.C	103.5	106.5	108.8	120.0	122.3	124.5	58.0	59.2	60.6
	V.F	98.0	102.3	104.0	100.0	110.7	112.0	50.0	51.5	52.0
	Mean	103.4	106.0	109.3	110.9	114.5	117.4	55.4	56.8	58.2
	SD	5.314624925	4.974458573	4.779968121	7.138593966	6.654951612	6.142916943	3.887709572	3.700347474	3.640617425

Table 2. The data with the evolution of measurements from 3 tests at the level of the targeted muscle groups (DM).

		Initial Test - Perimeter of chest muscles (cm)	Intermediar Test - Perimeter of chest muscles (cm)	Final Test - Perimeter of chest muscles (cm)	Initial Test - Perimeter of back muscles (cm)	Intermediar Test - Perimeter of back muscles (cm)	Final Test - Perimeter of back muscles (cm)	Initial Test - Perimeter of thigh muscles (cm)	Intermediar Test - Perimeter of thigh muscles (cm)	Final Test - Perimeter of thigh muscles (cm)
Subject	**B.B**	103.0	102.3	101.0	134.0	132.5	131.0	56.5	55.8	55.0
	C.A	107.0	105.0	104.0	128.0	127.2	125.0	59.5	58.0	57.5
	C.M	101.5	100.0	99.7	110.0	105.4	103.0	57.6	55.0	54.0
	C.R	105.0	104.0	102.0	112.0	109.0	107.0	61.7	60.0	59.4
	D.D	107.5	103.5	101.6	125.0	123.0	119.0	56.3	55.0	54.0
	H.L	103.5	102.0	100.3	120.0	117.0	115.0	58.0	56.0	55.2
	I.C	104.5	102.0	101.0	120.0	116.0	112.0	55.8	54.1	53.8
	M.V	116.0	115.0	114.0	137.5	136.0	132.0	61.5	61.0	60.0
	O.A	110.0	109.2	108.0	135.0	134.1	132.0	52.0	51.6	51.0
	P.D	104.0	103.0	102.3	120.0	118.0	114.0	57.8	56.9	55.0
	R.C	103.0	102.0	100.0	112.0	110.0	109.6	59.6	58.8	56.2
	R.N	104.5	103.0	101.0	111.5	110.0	109.4	67.8	66.0	63.1
	S.D	104.0	102.5	100.0	110.0	109.0	108.0	51.5	50.0	49.7
	T.I	104.0	103.8	102.1	115.0	114.5	112.0	55.9	54.3	53.8
	V.B	105.0	103.0	102.0	120.0	118.0	115.0	55.9	54.7	53.9
	Mean	105.5	104.0	102.6	120.7	118.6	116.3	57.8	56.5	55.4
	SD	3.570714214	3.639701715	3.761078873	9.391612266	9.866383522	9.496064348	3.996331651	3.925957572	3.432783127

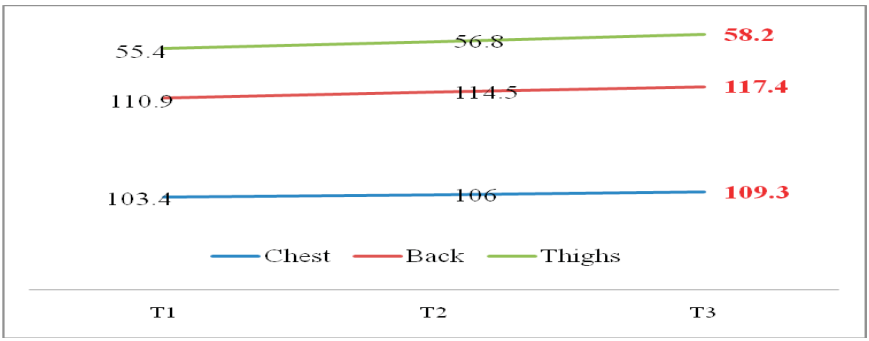

Fig. 1. Graph of the evolutions of the perimeters averages, to the HMM group during the 24 weeks of specific training.

The data obtainet in Fig.1, show that after 24 weeks of compound exercises, correlated with a proper diet and an adequate rest period, the subjects registered a muscular hypertrophy. We exposed the most representative increases during the 3 stages of tests, as in the Table no. 1, and which are expressed in centimeters and represent the increase in muscle perimeters.

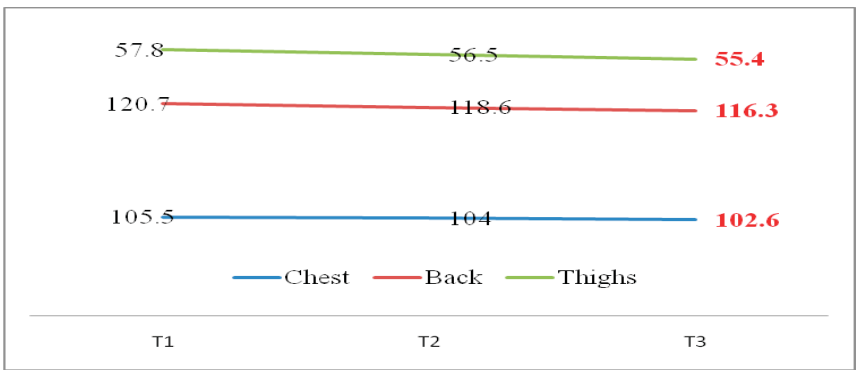

Fig. 2. Graph of the evolutions of the perimeters averages, to the DM group during the 24 weeks of specific training.

The data obtained in Fig. 2 show that after 24 weeks of single-joint exercises and cardio training, correlated with a proper diet and an adequate rest period, the subjects registered a decrease in somatic perimeters, through the oxidation of adipose tissue and acquired a superior muscle quality.

Although, group homogeneity was not our target in research from the beginning, because it is very difficult to find volunteer subjects with the same body proportions, we wanted to find out if through compound or isolation exercises, the average perimeter of muscle groups can change on the novice subjects.

With the passage of time, subjects will evolve as a level of training, and for this, they will need new training plans and an update of the food plan, reported per envidid, somatic type, and objective.

Subjects should strive to have a balanced sports life, without too many deviations, because the results will be minimal, compared to those who strive to have a much better extrasport lifestyle.

Finally, we can state, as a result of the analyzes performed on the collected data, that the trainings based on multi-joint and single-joint exercises can bring changes on the body perimeters.

Conclusions

Following the experimental research using compound and isolation exercises, we recorded a series of data on the progress of the subjects from an anthropometric point of view. These results were noted at the perimeters of the muscle groups, selected for research from the initial testing.

Our opinion is that the use of multi-joint exercises, but also single-joint exercises used systematically and consciously, depending on the objectives of the subjects, brought a number of positive results.

Regarding the dynamics of the results recorded by the subjects, regarding the anthropometric dimensions, at the level of different muscle groups, we consider that their purpose has been achieved, in a large share, because the measurements made at the somatic

level certainly help us to we highlight this fact. In the HMM group, the subjects recorded increases from a somatic point of view and in the DM group, the subjects obtained a diminution in the perimeters of the segments, which was due to decreased adipose tissue. The results of the 3 tests of the HMM and DM group were due to the fact that the subjects were novices, and due to the strict training program, nutrition and rest, the increase in muscle mass was much more accessible.

Through the usual use of exercise and proper nutrition, we noticed in subjects an increase in mental state through good mood, but also a good physical fitness through increases in muscle mass and muscle definition, which results in the fact that sports regardless of how is practiced, brings benefits, increases health, well-being, develops us harmoniously and beautifully.

We consider the fact that through this paper, we managed to demonstrate the role of compound and isolation exercises in bodybuilding, related to ordinary people who want a change in their life in sports by increasing muscle mass and muscle definition.

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References

1. American College of Sports Medicine (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Medicine and science in sports and exercise*, *41*(3), 687–708. https://doi.org/10.1249/MSS.0b013e3181915670

2. Chilibeck, P. D., Calder, A. W., Sale, D. G., & Webber, C. E.

(1998). A comparison of strength and muscle mass increases during resistance training in young women. *European journal of applied physiology and occupational physiology*, *77*(1-2), 170–175. https://doi.org/10.1007/s004210050316

3. Damas, F., Libardi, C. A., & Ugrinowitsch, C. (2018). The development of skeletal muscle hypertrophy through resistance training: the role of muscle damage and muscle protein synthesis. *European journal of applied physiology*, *118*(3), 485–500. https://doi.org/10.1007/s00421-017-3792-9

4. Gentil, P., & Bottaro, M. (2013). Effects of training attendance on muscle strength of young men after 11 weeks of resistance training. *Asian journal of sports medicine*, *4*(2), 101–106. https://doi.org/10.5812/asjsm.34489

5. Gentil, P., Soares, S., & Bottaro, M. (2015). Single vs. Multi-Joint Resistance Exercises: Effects on Muscle Strength and Hypertrophy. *Asian journal of sports medicine*, *6*(2), e24057. https://doi.org/10.5812/asjsm.24057

6. Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Medicine and science in sports and exercise*, *36*(4), 674–688. https://doi.org/10.1249/01.mss.0000121945.36635.61

7. Rutherford, O. M., & Jones, D. A. (1986). The role of learning and coordination in strength training. *European journal of applied physiology and occupational physiology*, *55*(1), 100–105. https://doi.org/10.1007/BF00422902

8. Schoenfeld B. J. (2010). The mechanisms of muscle hypertrophy and their application to resistance training. *Journal of strength and conditioning research*, *24*(10), 2857–2872. https://doi.org/10.1519/JSC.0b013e3181e840f3

9. https://www.fitday.com/fitness-articles/fitness/exercises/what-are-multi-joint-exercises.html What are Multi-Joint Exercise ?, (accessesd: 2020, December 7);

10. https://www.fitday.com/fitness-articles/fitness/exercises/what-

are-single-joint-exercises.html (retrived 8 Dec, 2020);

11. https://www.healthline.com/health/deadlift-vs-squat (acc 2020, December 18);
12. https://www.nuffieldhealth.com/article/isolation-versus-compound-exercises#about (acc 2020 December 18);
13. https://www.nia.nih.gov/health/four-types-exercise-can-improve-your-health-and-physical-ability (acc 2020, December 18).

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Exercise Interventions on Balance in Older People: a Systematic Review

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Abstract
Introduction: Age-related changes in the sensorimotor and neuromuscular system negatively affect performance in static and dynamic postural control even in healthy older adults, leading to deficits in balance and gait performance with negatively impact on the functional ability of the older person. Regular exercise can elicit many favourable responses that contribute to balance improvement. **Objectives**: The objective of this systematic review is to present evidence for effectiveness of exercise interventions designed to improve balance in healthy older people. **Methods**: The studies were identified from four databases (PubMed, Web of Science, Cochrane Library and Sportdiscus) from January 2011 to January 2020. A total of 17 articles meet the inclusion criteria. **Results**: Statistically significant effects were reported for static and dynamic balance, translated into several balance abilities improve-

ments. The most used type of exercise was the gait, balance and functional training, followed by the strength/resistance training. There is a lack of consensus regarding to balance programs methodology. **Conclusion**: Exercise appears to have beneficial effects on balance ability. We considered fundamental that the studies should include the specifications of the intervention program regarding to intensity control, exercises performed, guidelines used in the balance exercises and the exercise progression and variation during training. This information will help instructors to provided validated routine exercises.

Keywords: exercise program; physical activity; balance; elderly

Introduction

Age-related changes in the sensorimotor and neuromuscular system negatively affect performance in static and dynamic postural control even in healthy older adults (Lesinski, Hortobagyi, Muehlbauer, Gollhofer & Granacher, 2015), leading to deficits in balance and gait performance (Boisgontier et al., 2017; Gschwind et al., 2013). These factors potentially negatively affect balance control and impact on the functional ability of the older person (Howe, Jackson, Banks, Blair, 2007). Preventing falls by improving balance in older people has been a public health issue in several studies (Thiamwong & Suwanno, 2014).

Balance is important for maintaining postural equilibrium and thus for the avoidance of falls (Gschwind et al., 2013). Balance is defined as the ability to maintain the projection of the body's center of mass within manageable limits of the base of support, as in standing or sitting, or in transit to a new base of support, as in walking (Winter, 1995). It is also important to distinguish static balance from dynamic balance, since some studies use this differentiation. Therefore, static balance can be defined like the ability to maintain postural stability and orientation with center of mass over the base of support and body at rest (O'Sullivan, Schmitz & Fulk, 2014). On the other hand, dynamic balance can be defined as the ability to maintain postural stability and orientation with

center of mass over the base of support while the body parts are in motion (O'Sullivan et al., 2014).

Balance plays an essential role in tasks such as moving from sitting to standing, standing, walking, performing many activities of daily living, maintaining independence, as well as reacting to external disturbances (Treacy, Schurr, Lloyd & Sherrington, 2015). However, balance control is very complex and multifactorial, involving not only balance but other factors such as strength, proprioception, integrity of the neuromuscular system, pain, vision and in some instances, fear of falling.

Balance may be measured when the body has a constant, or static, base of support, or during movement from one base of support to another. It can be analyzed directly by quantifying the position of the center of mass in relation to the base of support. Alternatively, balance can be measured indirectly through observation, self-reporting or other reporting methods such as objective tests of functional activities (Howe et al., 2007).

Balance can decline with older age and pathology but can be improved with proper exercise (Treacy et al., 2015). Balance training primarily aims at improving postural control by challenging the alignment of the body's center of gravity with regard to the base of support and proved to be effective in improving measures of postural control and ultimately fall risk and rate in older adults (Lesinski et al., 2015).

Some exercise interventions with balance and muscle strengthening components have been shown to reduce fall rates, fall risk and fear of falling (Gillespie et al., 2009; Maughan, Lowry, Franke, Smiley-Oyen et al., 2012; Schoene, Valenzuela, Lord, & De Bruin et al., 2014; Sherrington, Tiedemann, Fairhall, Close & Lord, 2011; Taylor, 2014), although it is not clear which element or combination of elements is necessary to achieve this result (Howe et al., 2007).

This systematic review aims to present an updated evidence for effectiveness of exercise interventions designed to improve balance in healthy older people.

Methods

This systematic review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (Moher, Liberati, Tetzlaff & Altman, 2009) and other systematic reviews. An exhaustive search was conducted on four databases of literature (PubMed, Web of Science, Cochrane and SportDiscus), published between January 2011 and January 2020. The search strategy was conducted by using a keyword search of the following terms: (exercise OR physical exercise OR exercise program OR physical activity) AND (balance OR balance training OR balance exercise OR standing balance OR dynamic balance) AND (older adults OR older people OR elderly). Additional filters were added to the search: publication dates (9 years), age (65+ years), article type (clinical trial) and text availability (free full text).

Relevant publications containing at least one term from each of the three categories were identified. The documents selected for inclusion were analysed with a predetermined set criterion: *(i)* the study was a full text report published in a peer-reviewed journal, *(ii)* the study included a healthy and independent population, *(iii)* the study included papers published in English, Portuguese and Spanish, *(iv)* the study used a longitudinal or interventional design and *(v)* there were no exclusion criteria regarding ethnic origin. The flow of search results through the systematic review process is shown in Figure 1. Through database searching 2896 articles were identified. After removal of duplicates, a total of 962 papers were retrieved. The screened process was carried out by two independent reviewers (CP and VL).

The reviewers read every title and all the abstracts and doubtful decisions for inclusion/exclusion were resolved by a third reviewer (ECV). After the screening process, 928 articles were excluded due

to *(i)* subject irrelevance, *(ii)* being meta-analysis/review papers, *(iii)* irrelevant endpoint outcomes, *(iv)* the inclusion of one or more health pathology, and *(v)* being a study conducted with dependent population. After screening the remained 34 full papers, a total of 17 articles were excluded for the following reasons: irrelevant age-range, a cross-sectional study design or no exercise intervention and absence of balance assessments or endpoint conclusions.

The 17 remaining articles were included in the review (Irez, Ozdemir, Evin, Irez & Korkusuz, 2011; Clemson et al., 2012; Gusi et al., 2012; Maughan et al., 2012; Zheng et al., 2013; Nicholson, McKean & Burkett, 2014; Oliveira, Silva, Dascal & Teixeira, 2014; Thiamwong & Suwanno, 2014; Mesquita, Carvalho, Freire, Neto & Zangaro, 2015; Ansai, Aurichio, Gonçalves & Rebelatto, 2016; Eckardt, 2016; Raj, Vadivelan & SivaKumar, 2016; Fraser et al., 2017; Ordnung, Hoff, Kaminski, Villringer & Ragert, 2017; Bernard et al., 2018; Hamed, Bohm, Mersmann & Arampatzis, 2018; Leem, Kim & Lee, 2019).

Information from the aforementioned articles were summarized with respect to: *(i)* demographic characteristics of participants (sample size, mean age, number of group participants and country), *(ii)* characteristics of the intervention (protocol, duration/frequency and exercise modalities) and *(iii)* the effects of the intervention on balance (Table 2).

The quality assessment was conducted on the basis of other standardized assessment lists (Castro-Piñero et al., 2010) and on our selection criteria. The list included six items (A-F) on peer reviewed journal, population, measurement, design and report of the results. Each item was rated as ‘‘2’’ (fully reported), ‘‘1’’ (moderately reported) or ‘‘0’’ (not reported or unclear). For all studies, a total quality score was calculated by counting the number of positive items (a total score between 0 and 12). Three levels of evidence were created: high quality, medium quality and low quality (Table 1).

Table 1. List of included studies with quality scores.

Authors and variables	A	B	C	D	E	F	Total Score	Quality Level
Irez et al. (2011). Pilates and dynamic balance, flexibility, strength, reaction time, number of falls	2	2	2	2	2	2	12	**HQ**
Clemson et al. (2012). Balance and strength training and rate of falls	2	2	2	2	2	2	12	**HQ**
Gusi et al. (2012). Biodex Balance System and dynamic balance, fear of falling	2	2	2	2	2	2	12	**HQ**
Maughan et al. (2012). Dose-response of balance training and static, dynamic balance	2	2	2	2	2	2	12	**HQ**
Zheng et al. (2013). Proprioception and cognitive exercise and falls	2	2	2	2	2	2	12	**HQ**
Nicholson et al. (2014). BodyBalance® and balance, functional tasks performance, fear of falling	2	2	2	2	2	2	12	**HQ**
Oliveira et al. (2014). Exercise modalities and postural balance	2	2	1	2	2	2	11	**HQ**
Thiamwong et al. (2014). Balance training and balance and fear of falling	2	2	2	2	2	2	12	**HQ**
Mesquita et al. (2015). PNF and Pilates exercise and balance	2	2	2	2	2	2	12	**HQ**
Ansai et al. (2016). Multicomponent and strength exercises and balance	2	2	2	2	2	2	12	**HQ**
Eckardt (2016). Resistance training on unstable surfaces and balance	2	2	2	2	2	2	12	**HQ**
Raj et al. (2016). Multisensory and strength exercises and balance	2	2	1	1	1	1	8	**MQ**
Fraser et al. (2017). Physical and Cognitive training and balance	2	2	2	2	2	1	11	**HQ**
Ordnung et al. (2017). Exergame training and balance	2	2	2	2	2	2	12	**HQ**
Bernard et al. (2018). Posture-Balance-Motricity program and balance	2	2	2	2	2	2	12	**HQ**
Hamed et al. (2018). Perturbation-based exercise and balance	2	2	2	2	2	2	12	**HQ**
Leem et al. (2019). Otago Exercise Program and balance	2	2	2	2	2	2	12	**HQ**

Note: Rating for total score: high quality (HQ)=9-12; medium quality (MQ)= 5-8; low quality (LQ)=0-4. A: The study was a full text report published in a peer reviewed journal. B: The study population was healthy and independent. C: The selected physical exercise and balance outcomes were clearly described. D: The population was 65 years of age or over. E: The study had a longitudinal or interventional design. F: The results were clearly reported.

Results

General findings

All studies were longitudinal and intervention studies. This review includes data from 1552 individuals and the sample size of the studies varied from 28 (Nicholson et al., 2014) to 338 (Bernard et al., 2018) participants. The samples were from 10 different countries: 3 studies were conducted in Brazil (Ansai et al., 2016; Mesquita et al., 2015; Oliveira et al., 2014), 3 in Germany (Eckardt, 2016; Ordnung et al., 2017, Hamed et al., 2018), 2 in Australia (Clemson et al., 2012; Nicholson et al., 2014), 1 in Canada (Fraser et al., 2016), 1 in China (Zheng et al., 2013), 1 in Corea (Leem et al., 2018), 1 in France (Bernard et al., 2018), 1 in India (Raj et al., 2016), 1 in Spain (Gusi et al., 2012), 1 in Thailand (Thiamwong et al., 2014), 1 in Turkey (Irez et al., 2011) and 1 in the United States of America (Maughan et al., 2012). Information about all the studies is presented in Table 2.

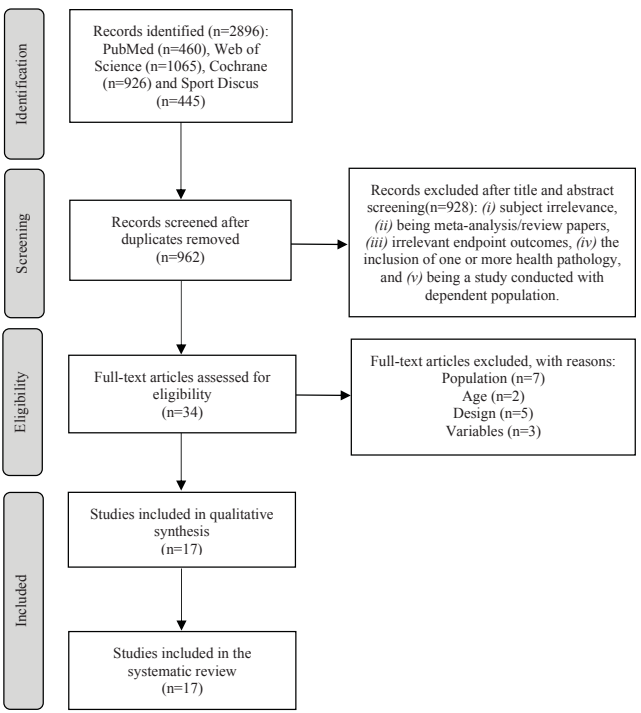

Figure 1. Flow chart of the articles through the selection process.

Table 2. Characteristics of analysed studies (N=17).

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Irez et al. (2011). Pilates and dynamic balance, flexibility, strength, reaction time, number of falls	Interventional and longitudinal / 12 weeks - 3 sessions week	60 (IG=30; CG=30) / 75.4 / Turkey	Flexibility ("Sit-and-reach" test, Muscle strength (Muscle Manual Tester - Lafayette Company, Model 01160); Reaction time (New Test 2000, Co and Finland device).	Dynamic balance (MED-SP 300 platform in 30-second trials); Number of falls (self-report).	Significant main effect of time (p<0.05) and main effect of group (p<0.05) for dynamic balance, flexibility, muscle strength, reaction time and number of falls.
Gusi et al. (2012). Biodex Balance System and dynamic balance, fear of falling	Interventional and longitudinal / 12 weeks - 2 sessions week	40 (IG=20; CG=20) / 76 / Spain	Isometric strength of the knee extensor: Biodex System 3 dynamometer.	Dynamic balance (Biodex Balance System); Fear of falling (FES-I Questionnaire).	Dynamic balance: improved by 2.1% in the IG; Fear of falling: improved 7 points in the IG; Isometric strength of the knee extensor: increase of 7% in the IG.
Clemson et al. (2012). Balance and strength training and rate of falls	Interventional and longitudinal / 12 months	317 (LPG=107; IG=105; CG=105) / 83.4 / Australia	Isometric strength of the lower limb: Chatillon DMG250 dynamometer.	Static balance (2 developed balance hierarchy scales); Dynamic balance (3 meters tandem walk time); Rate of falls (self-report).	Static and Dynamic balance: significantly improved in the LPG compared with IG and CG with moderate to large effect sizes for the 2 balance scales; Rate of falls: LPG=1.66 person/year; IG=1.90 person/year; CG=2.28 person/year; Isometric strength: significantly improved in the LPG compared with IG and CG.

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Maughan et al. (2012). Dose-response of balance training and static, dynamic balance	Interventional and longitudinal / 6 weeks	60 (1-day=21; 3-day=20; CG=19) / 78.8 / United States of America	-	Static balance (Single-leg-stance; Tandem balance); Dynamic balance (Alternate stepping (Berg *et al*., 1992);	SLS-R: main effect of session (p=0.002) with a 40%, 10% and 8% improvement, for 3-day, 1-day and CG respectively; SLS-L: main effect of session (p<0.001) with a 67%, 21% and 6% improvement, for 3-day, 1-day and CG respectively; Tandem balance: no main effects of group or session; Alternate stepping: main effect of session (p<0.001) with a 15%, 5% and 8% improvement, for 3-day, 1-day and CG respectively;
Zheng et al. (2013). Proprioception and cognitive exercise and falls	Interventional and longitudinal / 8 weeks - 3 sessions week	100 (IG=50; CG=50) / 68.1 / China	-	Static Balance (Biodex Balance System); Static/Dynamic Balance (Berg Balance Scale);	Static Balance Test: significant improvement in the IG, in the mediolateral sway distance with eyes open or closed (p<0.05) and in the anteroposterior sway distance with eyes open (p<0.05); BBS: significantly greater improvement (p<0.05) in BBS scores in the IG.
Thiamwong et al. (2014). Balance training and balance and fear of falling	Interventional and longitudinal / 12 weeks	104 (IG=52; CG=52) / 71.4 / Thailand	-	Dynamic Balance (TUG test; FRT). Fear of falling (FES-I Questionnaire).	FRT: distance of additional reach in the IG increased significantly (p<0.001); TUG: decreased significantly (p<0.001) in the IG; FES-I scores decreased significantly (p<0.001) in the IG.

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Nicholson et al. (2014). BodyBalance® and balance, functional tasks performance, fear of falling	Interventional and longitudinal / 12 weeks - 2 sessions week	28 (IG=15; CG=13) / 66.5 / Australia	-	Dynamic Balance (30-second chair-stand; TUG; FRT); Static Balance (Single-leg balance); Fear of falling (10-item Iconographical FES-I);	Significant group-by-time interactions in favour of the IG, for the 30-second chair-stand (p=0.037), TUG (p=0.038), partial and mediolateral COP range in narrow stance eyes closed (p=0.017) and Single-leg stance left time (p=0.024). Significant time effect in favour of the IG, for lateral reach left (p=0.037), 30-second chair-stand (p=0.001) and mediolateral COP range with comfortable stance eyes closed (p=0.022). There were no significant group-by-time interactions for fear of falling.
Oliveira et al. (2014). Exercise modalities and postural balance	Interventional and longitudinal / 12 weeks - 2 sessions week	74 (MT=23; AG=28; GG=23) / 69.4 / 74 (MT=23; AG=28; GG=23) / 69.4 / Brasil	-	Static balance (Biomec 400 - EMG system from Brazil: two-legged stand with eyes open, two-legged stand with eyes closed, semi-tandem with eyes open, semi-tandem with eyes closed and one-legged stand in one leg).	Static balance significantly (p<0.05) improved after intervention with the 3 modalities. There was no significant interaction (p>0.05) between groups. No difference was found in favour of any modality over another in the post-intervention effect.

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Mesquita et al. (2015). PNF and Pilates exercise and balance	Interventional and longitudinal / 4 weeks - 3 sessions week	63 (PNFG=21; PG=21; CG=21) / 69.1 / Brasil	-	Dynamic Balance (TUG; FRT); Static/ Dynamic Balance (Berg Balance Test);	PNFG had greater reductions in 4 of the 7 sway measures than the CG. No significant differences were found between the PG and the CG in any of the sway measures. Functional tests: women in the PNFG and PG exhibited improved performance in the TUG test and FRT compared with women in the CG. The BBS scores improved in the PNFG when compared to the CG (p=0.005).
Ansai et al. (2016). Multicomponent and Strength exercises and balance	Interventional and longitudinal / 16 weeks - 3 sessions week	69 (MTG=23; RT=23; CG=23) / 82.4 / Brasil	Muscle strength of the lower limbs: 5 repetition Sit-to-stand test.	Static Balance (one-leg standing and tandem tests); Dynamic Balance (TUG motor test (Hofheinz & Schusterschitz, 2010)); Number of falls (self-report).	Significant interaction between groups and assessments in the sit-to-stand (p=0.001) and the one-leg standing (right support) (p<0.001) tests. The MTG had a significant improvement in the sit-to-stand and one-leg standing (right support) tests. There was a significant main effect between times regarding the one-leg standing (left support) test (p=0.035).

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Eckardt (2016). Resistance training on unstable surfaces and balance	Interventional and longitudinal / 10 weeks - 2 sessions week	75 (M-SRT=27; M-URT=26; F-URT=22) / 70.4 / Germany	Isometric strength of the lower limb (Takei A5002, cable pull device); Handgrip strength (Takei A5401, hand dynamometer); Chair raise test.	Dynamic Balance (10-m walkway test, TUG, FRT and Push and Release Test).	All groups showed improvements over time in the lower extremity muscle strength (*range Cohen's d*:.30-.55), with meaningfully better improvements for M-URT. Lower-extremity muscle power (chair rise test) showed improvements for all groups over time (*d*:.32-.95), though significantly best improvements were provided by F-URT. All groups improved the functional reach distance (*d*:.60-1.03), however F-URT revealed the highest effects. For the TUG, no interaction effect was found, indicating similar improvements across groups.
Raj et al. (2016). Multisensory and strength exercises and balance	Interventional and longitudinal / 6 weeks - 5 sessions week	45 (MSE=15; SE=15; W=15) / between 60-70 years / India	-	Dynamic Balance (TUG test); Static/ Dynamic (Short Physical Performance Battery test (SPPB)).	All groups showed improvements, with meaningfully better improvements for MSE group for both TUG (p<0.001) and SPPB battery test (p=0.05).
Fraser et al. (2017). Physical and Cognitive training and balance	Interventional and longitudinal / 12 weeks - 3 sessions week	72 (ACT=21; ACL=17; SCT=18; SCL=16) / 71.4 / Canada	6-minutes walking test; Short Physical Performance Battery; Dual-task walking;	Dynamic Balance (Dual-task walking). Static/Dynamic Balance (SPPB).	All groups improved on their 6-minutes walking test and there were no significant differences between the groups (p=0.21). Dual-task cost changes scores revealed significant differences between the groups (p=0.005); All groups improved (p<0.05) in several (but not all) mediolateral postural sway variables and in their cognitive accuracy during balance.

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Ordnung et al. (2017). Exergame training and balance	Interventional and longitudinal / 6 weeks - 2 sessions week	30 (IG=15; CG=15) / 69.2 / Germany	3-minute step test; Rowing (upper body muscular endurance); Grip strength (SEAHAN® hydraulic dynamometer); Ruler Drop Test (motor reaction time) (Del Rossi *et al.*, 2014); JTT (Jebson *et al.*, 1969); Back Scratch Test (Konopack *et al.*, 2008).	Static balance (Wii balance board (Nintendo® Co., Ltd.)).	Significantly greater improvements for the IG in the JTT performance of the left hand (p=0.001), in the assessment of static balance with eyes closed (COP AP, p=0.044; COP ML, p= 0.046). Within-group comparison, the CG only showed significant performance improvements in one assessment of static balance (COP AP, p=0.005).
Bernard et al. (2018). Posture-Balance-Motricity program and balance	Interventional and longitudinal / 12 weeks – 2 sessions week	338 (IG=338; CG=0) / 74.4 / France	Individual Motor Profile (Posture-balance-motricity) (Bernard *et al.*, 2008);	Static balance (Unipedal Stance; Stabilometric evaluation (Medicapteurs SFP 40Hz/16b force platform): two-legged stand with eyes open and eyes closed); Dynamic balance (TUG).	Significant positive evolution of all parameters measured; The three dimensions of "Posture-Balance-Mobility" increased significantly (p<0.001); The time taken in the TUG test decreased significantly (p<0.001); Unipedal stance time analysis showed significant evolution in eyes-open (p<0.004) and eyes closed (p<0.001) conditions; For the stabilometric evaluation was observed a significant decrease of the surface (p<0.02) and the length (p<0.001) of the COP.

Study (Authors/Year/ Reference)	Intervention design / Duration	Sample / Mean age / Country	Physical fitness measures	Balance measures	Results
Hamed et al. (2018). Perturbation-based exercise and balance	Interventional and longitudinal / 14 weeks – 2 sessions week	47 (MSG=15; Perturbation-based Group=16; CG=16) / 71.2 / Germany	Maximum strength of the knee extensor and ankle plantar flexor muscles (Biodex dynamometer).	Static balance (COP AP two test trials: AMTI BP 400600-2000 force platform);	Only the Perturbation-based group showed significant improvement of standing balance ability (38%, *d*=1.61); Plantar flexor strength increased 20% (*d*=0.72) in the MSG and 23% (*d*=1.03) in the Perturbation-based group; Muscle strength of the knee extensors increased only in the MSG (8%, *d*=1.61).
Leem et al. (2019). Otago Exercise Program and balance	Interventional and longitudinal / 12 weeks - 3 times week	30 (AO+Otago =10; Otago=10; CG=10) / 79 / Korea	Muscle strength of hip flexion, ankle dorsiflexion and plantar flexion (Lafayette, model 01163 Dynamometer)	Dynamic balance (TUG).	Both the AO+Otago and the Otago groups showed significant increases in right side plantar flexion muscle strength ($p<0.05$); In the TUG test, both intervention groups showed significant improvements ($p<0.05$), reducing the time by 4.08 seconds (AO+Otago) and 3.76 seconds (Otago).

1-day = 1 day intervention group; 3-day = 3 day intervention group; ACL = aerobic and computer lessons; ACT = aerobic and cognitive training; AG = Aquatic gymnastic; AO = Action observation; BBS = Berg Balance Scale; CG = control group; COP = Centre of Pressure; COP AP = Centre of Pressure Anterior-Posterior; COP ML = Centre of Pressure Medio-Lateral; FES-I = Falls Efficacy Scale International; FRT = functional reach test; F-URT = free-weight unstable resistance training; GG = General gymnastic; IG = intervention group; JTT = Jebson-Taylor Hand Function Test; LPG = LiFE programme group; MT = Mini-trampoline; MSE = multisensory; MSG = Muscle strength group; MTG = Multicomponent training group; M-SRT = machine-based stable resistance training; M-URT = machine-based unstable resistance training; PG = Pilates group; PNFG = proprioceptive neuromuscular facilitation group; RT = Resistance training; SCL = stretch and computer lessons; SCT = stretch and cognitive training; SE = strengthening; SLS-R = single-leg-stance on right leg; SLS-L = single-leg-stance on left leg; SPPB = Short Physical Performance Battery; TUG = timed up-and-go; W = walking.

Physical Fitness, balance and exercise assessment

Physical fitness measures used in each study are shown in Table 2: 10 studies used objective measures to assess physical fitness (Ansai et al., 2016; Bernard et al., 2018; Clemson et al., 2012; Eckardt, 2016; Fraser et al., 2017; Gusi et al., 2012; Hamed et al., 2018; Irez et al., 2011; Leem et al., 2019; Ordnung et al., 2017).

From the 10 studies, that assess physical fitness, 8 assessed muscular strength (Bernard et al., 2018; Clemson et al., 2012; Eckardt, 2016; Gusi et al., 2012; Hamed et al., 2018; Irez et al., 2011; Leem et al., 2019; Ordnung et al., 2017); 2 flexibility (Irez et al., 2011; Ordnung et al., 2017); 2 cardiorespiratory fitness (Fraser et al., 2017; Ordnung et al., 2017); 2 Reaction Time (Irez et al., 2011; Ordnung et al., 2017); 1 assessed the fine motor skills (Ordnung et al., 2017); and 1 assessed posture and motricity (Bernard et al., 2018). From the 8 studies that assessed the muscular strength, 7 assessed lower limbs muscular strength (Ansai et al., 2016; Clemson et al., 2012; Eckardt, 2016; Gusi et al., 2012; Hamed et al., 2018; Irez et al., 2011; Leem et al., 2019); 2 hand grip muscular strength (Eckardt, 2016; Ordnung et al., 2017) and 1 upper body muscular endurance (Ordnung et al., 2017). To evaluate the lower limbs muscular strength, 6 studies used dynamometer (Clemson et al., 2012; Eckardt, 2016; Gusi et al., 2012; Hamed et al., 2018;

Irez et al., 2011; Leem et al., 2019) and 2 studies use the five-repetition sit-to-stand test (Ansai et al., 2016; Eckardt, 2016). To evaluate the hand grip strength the 2 studies used dynamometer (Eckardt, 2016; Ordnung et al., 2017). The upper body muscular endurance was evaluated in 1 study with rowing with dumbbell's (Ordnung et al., 2017). To assess flexibility, 1 used the sit-and-reach test (Irez et al., 2011) and other used the back-scratch test (Ordnung et al., 2017). The cardiorespiratory fitness was evaluated with the six minutes walking test (Fraser et al., 2017) and the 3-minute step test (Ordnung et al., 2017). With regard to reaction time, 1 study used a test with light and sound stimuli (Irez et al., 2011) and other use the ruler drop test (Ordnung et al., 2017). The fine motor skills were assessed with Jebson-Taylor Hand Function Test (Ordnung et al., 2017). Finally, posture and and motricity were assessed by 10

specific motor exercises. Each dimension was tested on 30 points and the addition of the dimensions constituted the "Individual Motor Profile" (Bernard et al., 2018).

Exercise interventions

Regarding the exercise interventions and to group the several studies, we use the fall prevention classification system that has been developed by the Prevention of Falls Network Europe (ProFaNE) and already used by other studies (Gillespie et al., 2009; Kumar et al., 2016). Therefore, exercise modalities are grouped into six categories using the ProFaNE taxonomy: gait, balance and functional training; strength/resistance training; flexibility training; 3D training; general physical activity; and endurance training.

Analysing the different interventions, 9 studies included the gait, balance and functional training (Ansai et al., 2016; Bernard et al., 2018; Clemson et al., 2012; Hamed et al., 2018; Leem et al., 2019; Maughan et al., 2012; Raj et al., 2016; Thiamwong et al., 2014; Zheng et al., 2013), 6 included the strength/resistance training (Ansai et al., 2016; Clemson et al., 2012; Eckardt, 2016; Hamed et al., 2018; Leem et al., 2019; Raj et al., 2016), 5 included the 3D training (Gusi et al., 2012, Irez et al., 2011; Mesquita et al., 2015; Nicholson et al., 2014; Ordnung et al., 2017), 1 included general physical activities (Oliveira et al., 2014) and 1 included endurance and flexibility training (Fraser et al., 2016). In 12 trials, the exercise intervention fell in only one category (Bernard et al., 2018; Eckardt, 2016; Fraser et al., 2016; Gusi et al., 2012; Irez et al., 2011; Maughan et al., 2012; Mesquita et al., 2015; Nicholson et al., 2014; Oliveira et al., 2014; Ordnung et al., 2017; Thiamwong et al., 2014; Zheng et al., 2013). The remain 5 trials (Ansai et al., 2016; Clemson et al., 2012; Hamed et al., 2018; Leem et al., 2019; Raj et al., 2016) included more than one category of exercise.

Frequency and duration of the exercise interventions

Eight of the studies had the duration of 12 weeks (Bernard et al., 2018; Fraser et al., 2016; Gusi et al., 2012; Irez et al., 2011; Leem et al., 2019; Nicholson et al., 2014; Oliveira et al., 2014;

Thiamwong et al., 2014) and 3 studies had an intervention period of 6 weeks (Maughan et al., 2012; Ordnung et al., 2017; Raj et al., 2016). One study had a duration of 16 weeks (Ansai et al., 2016), 1 study had a duration of 14 weeks (Hamed et al., 2018), 1 study had a duration of 10 weeks (Eckardt, 2016), 1 study had a duration of 8 weeks (Zheng et al., 2013) and 1 study had a duration of 4 weeks (Mesquita et al., 2015). Only 1 study had a longer intervention period with 12 months (Clemson et al., 2012).

Regarding the frequency of the interventions, 7 studies performed their exercise program 2 times/week (Bernard et al., 2018; Eckardt, 2016; Gusi et al., 2012; Hamed et al., 2018; Nicholson et al., 2014; Oliveira et al., 2014; Ordnung et al., 2017), 6 studies performed 3 times/week (Ansai et al., 2016; Fraser et al., 2016; Irez et al., 2011; Leem et al., 2019; Mesquita et al., 2015; Zheng et al., 2013), and 1 study performed 5 times/week (Raj et al., 2016). The rest of the trials (n=3) were left out of this information (Clemson et al., 2012; Maughan et al., 2012; Thiamwong et al., 2014).

Balance assessment

All studies used objective measures to assess balance and other associated variables, like number of falls and fear of falling. Thus, 14 studies assessed dynamic balance (Ansai et al., 2016; Bernard et al., 2018; Clemson et al., 2012; Eckardt, 2016; Fraser et al., 2016; Gusi et al., 2012; Irez et al., 2011; Leem et al., 2019; Maughan et al., 2012; Mesquita et al., 2015; Nicholson et al., 2014; Raj et al., 2016; Thiamwong et al., 2014; Zheng et al., 2013) and 12 studies assessed static balance (Ansai et al., 2016; Bernard et al., 2018; Clemson et al., 2012; Fraser et al., 2016; Hamed et al., 2018; Maughan et al., 2012; Mesquita et al., 2015; Nicholson et al., 2014; Oliveira et al., 2014; Ordnung et al., 2017; Raj et al., 2016; Zheng et al., 2013), being that 9 studies assessed both types of balance in the same investigation (Ansai et al., 2016; Bernard et al., 2018; Clemson et al., 2012; Fraser et al., 2016; Maughan et al., 2012; Mesquita et al., 2015; Nicholson et al., 2014; Raj et al., 2016; Zheng et al., 2013). The number of falls was assessed in 3 studies (Ansai et al., 2016; Clemson et al., 2012; Irez et al., 2011), by self-report of the indi-

viduals. Fear of falling was assessed also in 4 studies (Gusi et al., 2012; Leem et al., 2019; Nicholson et al., 2014; Thiamwong et al., 2014), with the particularity of the study of Nicholson et al. (2014), to have used the version 10-item Iconographical of the FES-I.

From the 14 studies that evaluated the dynamic balance, 8 used the TUG test (Bernard et al., 2018; Eckardt, 2016; Fraser et al., 2016; Leem et al., 2019; Mesquita et al., 2015; Nicholson et al., 2014; Raj et al., 2016; Thiamwong et al., 2014), being the most used test in the studies. In 1 study (Ansai et al., 2016), was used the TUG-motor, which is a variation of the TUG, but in which participants must carry a full cup with water. Then, 4 studies used the Functional Reach Test (FRT) (Eckardt, 2016; Mesquita et al., 2015; Nicholson et al., 2014; Thiamwong et al., 2014), 2 used the Berg Balance test (Mesquita et al., 2015; Zheng et al., 2013), 2 used the SPPB test (Fraser et al., 2016; Raj et al., 2016), 1 used the 3-meters tandem walk time (Clemson et al., 2012), 1 used the alternate stepping (Maughan et al., 2012), 1 used the 30-second chair stand (Nicholson et al., 2014), 1 used the 10-meter walkway test (Eckardt, 2016), 1 used the push-and-release test (Eckardt, 2016), 1 used the dual-task walking (Fraser et al., 2016), 1 used a force platform (Irez et al., 2011) and 1 used a balance system platform (Gusi et al., 2012).

Regarding the static balance, 5 studies used a single-leg stance test (Ansai et al., 2016; Bernard et al., 2018; Maughan et al., 2012; Nicholson et al., 2014; Oliveira et al., 2014), 2 used the Short Physical Performance Battery test (SPPB) (Fraser et al., 2016; Raj et al., 2016), 2 used the Berg Balance Test (Mesquita et al., 2015; Zheng et al., 2013), 1 used 2 developed balance hierarchy scales (Clemson et al., 2012), 1 used the tandem stance (Maughan et al., 2012), 1 used the Biodex Balance System device (Zheng et al., 2013), 1 used the Wii balance board (Nintendo® Co., Ltd.) (Ordnung et al., 2017) and 2 used a force platform (Hamed et al., 2018; Oliveira et al., 2014), with the following tests: semi-tandem with eyes open (Oliveira et al., 2014), semi-tandem with eyes closed (Oliveira et al., 2014), two-legged stand with eyes open (Hamed et al., 2018; Oliveira et al., 2014) and two-legged stand with eyes closed (Oliveira et al., 2014).

Exercise and Dynamic Balance

Four studies (Bernard et al., 2018; Maughan et al., 2012; Thiamwong et al., 2014; Zheng et al., 2013) from the category gait, balance and functional training, investigated the effects of their interventions on dynamic balance. The TUG motor test, the 3 meters tandem walk time, the alternate stepping, the FRT, the SPPB and BBS tests, were used to assess these interventions. Bernard et al. (2018) found a significantly (p<0.001) decreased time taken in the TUG test. Maughan et al. (2012) reported a main effect of session (p<0.001) with a 15%, 5% and 8% improvement, for the group that completed 3 sessions/week, 1 session/week and CG respectively. Thiamwong et al. (2014), mentioned that in the FRT, the distance of additional reach in the IG increased significantly (p<0.001) and the time in the TUG test decreased significantly (p<0.001) in the IG. Finally, Zheng et al. (2013), registered significantly greater improvement (p<0.05) in BBS scores in the IG.

One study included the strength/resistance training (Eckardt, 2016). Outcome measures used to evaluate this intervention were 10-m walkway test, TUG, FRT and push and release test. All groups improved the functional reach distance (d:.60-1.03), however F-URT revealed the highest effects. For the TUG, no interaction effect was found, indicating similar improvements across groups. Gait analysis revealed meaningful main effects of "time" (d: .54–1.40) for stride velocity, stride length, stride width and double support and a main effect "group" for stride length (d = .70). Non-parametric analysis of the push and release test revealed meaningful improvements over time (d = 1.46) but little effects between groups and interaction effects.

Four studies (Ansai et al., 2016; Clemson et al., 2012; Leem et al., 2019; Raj et al., 2012) investigated the effect of multicomponent exercise programs involving gait, balance, functional training and strength/resistance training, on dynamic balance. Ansai et al. (2016) mentioned significant interaction between groups and assessments in the sit-to-stand (p=0.001) and Clemson et al. (2012) found moderate to large effect sizes for the 2 balance scales used

in his trial. Leem et al. (2019) registered significant improvements (p<0.05) through the time to complete the TUG test. Raj et al. (2016) referred that all groups showed improvements, with meaningfully better improvements for MSE group for both TUG (p<0.001) and SPPB battery test (p=0.05).

Four studies investigated the effect of 3D training (Gusi et al., 2012; Irez et al., 2011; Mesquita et al., 2015; Nicholson et al., 2014) on dynamic balance. Outcome measures used to evaluate these interventions where the Biodex Balance System, a force platform, the 30-second chair-stand, the TUG test and the FRT. Gusi et al. (2012) found improved dynamic balance by 2.1% in the IG. Irez et al. (2011) reported a significant main effect of time (p<0.05) and main effect of group (p<0.05) for dynamic balance. Mesquita et al. (2015) mentioned improved performance in the TUG test and FRT and improved BBS scores in the PNFG when compared to the CG (p=0.005). In a within-group comparison, women in both the PNFG and PG showed significant improvements in the FRT, timed up-and-go test and BBS scores. Nicholson et al. (2014) found significant group-by-time interactions in favour of the IG, for the 30-second chair-stand (p=0.037), TUG (p=0.038) and significant time effects in favour of the IG, for lateral reach left (p=0.037), 30-second chair-stand (p=0.001).

Finally, 1 study (Fraser et al., 2016) investigated the effects of exercise programmes involving endurance and flexibility training on dynamic balance. To assess those effects, the author used the TUG test and the dual-task walking test. All groups improved on their 6-minutes walking test and there were no significant differences between the groups (p=0.21). Dual-task walking scores revealed significant differences between the groups (p=0.005) in favour of the IG.

Exercise and Static Balance

Three studies from the category gait, balance and functional training, investigated the effects of their interventions on static balance (Hamed et al., 2018; Maughan et al., 2012; Zheng et al., 2013). Different outcome measures were used to evaluate these interven-

tions like, limits of stability, single-leg-stance, tandem stance, the Berg Balance Scale and the Biodex Balance System. Statistically significant differences were observed in these measures. Hamed et al. (2018) found a significant improvement (38%, d=1.61) of the standing balance ability. Maughan et al. (2012) denoted a main effect of session (p=0.002) in the single-leg-stance test, but no main effects of group or session in the tandem stance. Zheng et al. (2013) reported a significantly greater improvement (p<0.05) in the BBS scores and significant improvement in the mediolateral sway distance with eyes open or closed (p<0.05) and in the anteroposterior sway distance with eyes open (p<0.05).

Three studies (Ansai et al., 2016; Clemson et al., 2012; Raj et al. 2016) investigated the effect of multicomponent exercise programs involving gait, balance, co-ordination and functional task activities and strengthening exercises on static balance. Outcome measures were used to evaluate these interventions like, single-leg-stance, tandem stance and the SPPB battery test. Ansai et al. (2016) reported significant interaction between groups and assessments in the one-leg standing (right and left support) tests (p<0.001) and a significant main effect between time regarding the one-leg standing (left support) test (p=0.035). Clemson et al. (2012) referred moderate to large effect sizes for the 2 balance scales used in his trial. Raj et al. (2016) declared meaningfully better improvements through the SPPB battery test results (p=0.05). Zheng et al. (2013) mentioned significant improvement in the intervention group, in the mediolateral sway distance with eyes open or closed (p<0.05) and in the anteroposterior sway distance with eyes open (p<0.05).

Three studies investigated the effect of 3D training (Mesquita et al. 2015; Nicholson et al., 2014; Ordnung et al., 2017) on static balance. BBS, Wii balance board (Nintendo® Co., Ltd). tandem stance, single-leg stance were the outcome measures used. Mesquita et al. (2015) found that PNFG had greater reductions in 4 of the 7 sway measures than the CG. No significant differences were found between the PG and the CG in any of the sway measures. The BBS scores improved in the PNFG when compared to the CG (p=0.005). In a within-group comparison, women in both the PNFG and PG

showed significant improvements in the BBS scores. Women in the CG did not show significant differences in the evaluated parameters. Nicholson et al. (2014) denoted a significant group-by-time interaction in favour of the IG, for the partial and mediolateral COP range in narrow stance eyes closed (p=0.017) and single-leg stance left time (p=0.024). Ordnung et al. (2017) reported significantly greater improvements for the IG in the assessment of static balance with eyes closed (COP AP, p=0.044; COP ML, p= 0.046). Within-group comparison, the CG only showed significant performance improvements in one assessment of static balance (COP AP, p=0.005).

One study (Oliveira et al., 2014) investigated the effects of exercise programmes involving mini-trampoline, aquatic gymnastics and general floor gymnastics as general physical activity on static balance. Two-legged stand with eyes open, two-legged stand with eyes closed, semi-tandem with eyes open, semi-tandem with eyes closed and one-legged stand in one leg were the outcome measures used, assessed in a force platform. Static balance significantly (p<0.05) improved after intervention with the 3 modalities. There was no significant interaction (p>0.05) between groups. No difference was found in favour of any modality over another in the post-intervention effect.

One study (Fraser et al., 2016) investigated the effects of endurance and flexibility training on static balance. The Short Physical Performance Battery test (SPPB) was used. All groups improved (p<0.05) in several (but not all) mediolateral postural sway variables and in their cognitive accuracy during balance.

Discussion

This systematic review has researched recent evidence for effectiveness of exercise interventions designed to improve balance in healthy older people and found that physical exercise has positive effects on static and dynamic balance. All the trials reported statistically significant effects for static and dynamic balance. These

results are in accordance with another reviews that show that participation in regular physical activity programs plays a key role in maintaining balance and preventing falls in older adults (De Labra, Guimarães-Pinheiro, Maseda, Lorenzo & Millan-Calenti, 2015; Ishigaki, Ramos, Carvalho & Lunardi, 2014; Tiedemann, Sherrington & Lord, 2013; Lesinski et al., 2015; Schoene et al., 2014; Sherrington et al., 2011; Howe et al., 2007; Gillespie et al., 2009).

Improvements were seen in several abilities like, stand on one leg and in two legs with eyes open or closed, sit-to-stand, leaning forward, backward and sideway, regain balance after a sudden perturbation, gait speed and walk and balance in tandem.

Analysing the different studies, we found that the most used type of exercise was the gait, balance and functional training, followed by strength/resistance training. According to the ProFaNE exercise classification, the gait, balance and functional training involves specific correction of walking technique and changes of pace, level and direction, efficient transfer of bodyweight from one part of the body to another or challenges specific aspects of the balance systems and functional activities as the training stimulus based on the theoretical concept of task specificity. Some examples are: heel raises, toe raises, walking on the toes/ heels, heel to toe walking, walking backward, forwards, sideways, turning, bending, stepping and side stepping; vestibular and proprioceptive retraining exercises in different head and eye positions; reaction games; obstacle courses; standing on unstable surfaces; standing in one leg or tandem standing. On the other hand, strength/resistance training involves all types of weight training i.e., contracting the muscles against a resistance and bring about a training effect in the muscular system. Illustrative examples are weight training (free weights, resistance bands or body weight), functional training with added weight, exercise on machines and cable pulleys.

The majority (70.6%) of the studies used only one type of exercise and only 29.4% included more than one category of exercise, associating gait, balance and functional training and strength training. Those types of exercise provide a moderate to high challenge to balance, reducing the base of support, movement of the centre of

gravity and reduced need for upper limb support, which are according with the methodology accessed by other reviews (Sherrington et al., 2011; Tiedemann et al. 2013). The inclusion of strength training can produce many benefits, as reduced muscle strength is an important risk factor for falls there may also be longer-term falls prevention benefits (Fisher, Steele, Gentil, Giessing, & Westcott, 2017).

Regarding to the duration and frequency of the interventions, there is no consensus among the analyzed studies and none of them reported detailed information on training volume, like the number of exercises per training session, or the number of sets or repetitions per exercise. The literature does not provide a clear guideline but there is an indication from Sherrington et al. (2011), that there are greater benefits from higher doses of exercise, suggesting that exercise should be undertaken for at least 2 hours per week and ongoing exercise would be necessary for a lasting falls prevention effect because the benefits of exercise are rapidly lost when exercise is ceased. Lesinski et al. (2015) refers that a training period of 11–12 weeks, a frequency of 3 sessions per week, a total number of 36–40 training sessions, a duration of a single training session of 31–45 min, and a total duration of 91–120 min of balance training/week is most effective to improve balance. In our review, most of the interventions (42.86%), had a duration of 12 weeks and performed their exercise program with a frequency of 3 times/week (35.71%), which are in accordance with the guidelines presented by Lesinski et al. (2015). Concerning to exercise intensity, also none of the analysed studies reported any detailed information. Exercise intensity should be progressed in a tailored manner that considers individual tolerances and preferences. Perhaps this is why the studies analysed do not provide any detailed information about this parameter. Methods to increase the intensity and effectiveness of balance challenging exercises include (Gschwind et al., 2013): using progressively difficult postures with a gradual reduction in the base of support (two legged stand, semi-tandem stand, tandem stand, one-legged stand); using movements that perturb the centre of gravity (tandem walk, circle turns, leaning and reaching activities, stepping over obstacles); specific resistance training for postural

muscle groups (heel stands, toe stands, hip abduction with added weights to increase intensity, unsupported sit to stand practice); and reducing sensory input standing with eyes closed, standing/walking on an unstable surface such as foam mats). Further challenge can be provided using dual tasks, such as combining a memory task with a gait training exercise or a hand-eye co-ordination activity with a balance task (Tiedemann et al., 2013).

From the studies included in this review, 52.9% evaluated both types of balance in the same investigation. The dynamic balance was evaluated by 82.4% of the studies and the static balance by 70.6%. The most used test to assess the dynamic balance was the TUG test, used by 57.1% of the studies, followed by the FRT (33%).

According to Eckardt (2016), both tests showed excellent test-retest reliability (TUG: ICC=.99; FRT: ICC=.92). Regarding to the static balance, the most used test in the evaluations was the single-leg stance test, used in 41.7% of the studies.

This review found that exercise has statistically significant positive effects on balance. The identified studies are heterogeneous about the protocols implemented on the interventions and assessments. Nevertheless, program delineation should be tailored to the needs and abilities of the target population to ensure challenging and safe exercise. We considered essential that the studies should include the specifications of the intervention program regarding to duration of the study protocol, frequency, volume, intensity, exercises performed, guidelines used in the balance exercises, information about the exercise progression and variation during the training period. Other aspects are the need to clearly mentioned the training status of the participants in the beginning of the interventions. In addition, the sample of the analysed studies are very different; the smallest group consisted of 28 participants and the biggest of 338. Moreover, the sample size of the examined studies varies greatly. This makes it hard to represent a general community, as a sample size of 9 is rather small. Furthermore, the manuscript aimed to understand the effects of exercise on static balance in healthy elderly, and due to such specific inclusion criteria a very limited number of studies have been included in this article.

Conclusion

The present review analysed the association of exercise interventions and balance in healthy older people. The investigated studies exhibited that exercise appears to have positive effects on balance. Multicomponent exercise interventions based on gait, balance and functional training combined with strength/resistance training appears to be more effective. Significant improvements were observed in balance assessed across a variety of outcome measures for exercise interventions. The regular practice of supervised physical exercise should be promoted with the intention of promoting balance and reducing the future risk of falling.

References

1. Ansai J., Aurichio T., Gonçalves R. & Rebelatto J. (2016). Effects of two physical exercise protocols on physical performance related to falls in the oldest old: A randomized controlled trial. *Geriatr Gerontol Int*, 16 (4): 492-499. DOI:10.1111/ggi.12497.

2. Bernard, P., Blain, H., Gerazime A., Maurelli O., Bousquet J. & Ninot G. (2018). Relationship between a three-month physical conditioning "posture-balance- motricity and health education" (PBM-HE) program on postural and balance capacities of sedentary older adults: influence of initial motor profile. *European Review of Aging and Physical Activity,* 15 (14). DOI: 10.1186/s11556-018-0203-0.

3. Boisgontier, M., Cheval, B., Chalavi, S., Ruitenbeek, P., Leunissen, I., Levin, O., . . . Swinnen, S. (2017). Individual differences in brainstem and basal ganglia structure predict postural control and balance loss in young and older adults. *Neurobiology of Aging*, 50, 47-59. DOI:10.1016/j.neurobiolaging.2016.10.024.

4. Clemson, L., Fiatarone Singh, M. Bundy, A., Cumming, R. Manollaras, K., O'Loughlin, P. & Black, D. (2012). Integration of balance and strength training into daily life activity to reduce rate of falls in older people (the LiFE study): randomised parallel trial. *BMJ,* 345, e4547. DOI:10.1136/bmj.e4547.

5. De Labra, C., Guimarães-Pinheiro C., Maseda A., Lorenzo T. & Millán-Calenti J. (2015). Effects of physical exercise interventions in frail older adults: a systematic review of randomized controlled trials. *BMC Geriatrics*, 15:154. DOI:10.1186/s12877-015-0155-4.

6. Eckardt, N. (2016). Lower-extremity resistance training on unstable surfaces improves proxies of muscle strength, power and balance in healthy older adults: a randomised control trial. *BMC Geriatr*, 16 (1): 191. DOI:10.1186/s12877-016-0366-3.

7. Fisher J., Steele J., Gentil P., Giessing J., & Westcott W. (2017). A minimal dose approach to resistance training for the older adult; the prophylactic for aging. *Experimental Gerontology* 99: 80–86. DOI:10.1016/j.exger.2017.09.012.

8. Fraser, S. A., Li, K. Z., Berryman, N., Desjardins-Crepeau, L., Lussier, M., Vadaga, K., ... Bherer, L. (2017). Does Combined Physical and Cognitive Training Improve Dual-Task Balance and Gait Outcomes in Sedentary Older Adults? *Front Hum Neurosci, 10*, 688. DOI:10.3389/fnhum.2016.00688.

9. Gillespie L., Robertson M., Gillespie W., Lamb S., Gates S., Cumming R., Rowe B. (2009). Interventions for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews*, Issue 2. Art. No.: CD007146. DOI: 10.1002/14651858.CD007146.pub2.

10. Gschwind, Y., Kressig, R., Lacroix, A., Muehlbauer, T., Pfenninger, B., & Granacher, U. (2013). A best practice fall prevention exercise program to improve balance, strength/power, and psychosocial health in older adults: study protocol for a randomized controlled trial. *BMC Geriatrics*, 13 (105). DOI: 10.1186/1471-2318-13-105.

11. Gusi, N., Carmelo, J., Corzo, H., del Pozo-Cruz, B., Olivares, P., & Parraça, J. (2012). Balance training reduces fear of falling and improves dynamic balance and isometric strength in institutionalised older people: a randomised trial. *Journal of Physiotherapy,* 58 (2), 97-104. DOI:10.1016/s1836-9553(12)70089-9.

12. Hamed, A., Bohm, S., Mersmann, F., & Arampatzis, A. (2018). Exercises of dynamic stability under unstable conditions increase muscle strenght and balance ability in the elderly. *Scand J Med Sci Sports* (28), 961–971. DOI:10.1111/sms.13019.

13. Howe T., Rochester L., Jackson A., Banks P. & Blair V. (2007). Exercise for improving balance in older people. *Cochrane Database of Systematic Reviews* (4). DOI:10.1002/14651858.

14. Irez, G., Ozdemir, R., Evin, R., Irez, S., & Korkusuz, F. (2011). Integrating pilates exercise into an exercise program for 65+ year-old women to reduce falls. *Journal of Sports Science and Medicine*, 10 (1), 105–111.

15. Ishigaki E., Ramos L., Carvalho E., Lunardi A. (2014). Effectiveness of muscle strengthening and description of protocols for preventing falls in the elderly: a systematic review. *Braz J Phys Ther,* 18 (2):111-118. DOI:10.1590/ S1413-35552012005000148.

16. Kumar, A., Delbaere, K., Zijlstra, G., Carpenter, H., Iliffe, S., Masud, T., . . . & Kendrick, D. (2016). Exercise for reducing fear of falling in older people living in the community: Cochrane systematic review and meta-analysis. *Age and Ageing, 45*(3), 345-352. DOI:10.1093/ageing/afw036.

17. Leem, S., Kim, J., & Lee, B. (2019). Effects of Otago exercise combined with action observation training on balance and gait in the old people. *Journal of Exercise Rehabilitation*, *15*(6), 848–854. DOI:10.12965/jer.1938720.360.

18. Lesinski M., Hortobágyi T., Muehlbauer T., Gollhofer A. & Granacher U. (2015). Effects of Balance Training on Balance

Performance in Healthy Older Adults: A Systematic Review and Meta-analysis. *Sports Med*. DOI:10.1007/s40279-015-0375-y.

19. Maughan, K., Lowry, K., Franke, W., & Smiley-Oyen, A. (2012). The Dose-Response Relationship of Balance Training in Physically Active Older Adults. *J Aging Phys Act,* 20 (4), 442–455. DOI:10.1123/japa.20.4.442.

20. Mesquita, L., Carvalho, F., Freire, L., Neto, O., & Zangaro, R. (2015). Effects of two exercise protocols on postural balance of elderly women: a randomized controlled trial. *BMC Geriatr,* 15 (61). DOI:10.1186/s12877-015-0059-3.

21. Moher D., Liberati A., Tetzlaff J. & Altman D. (2009). Preferred Reporting Items for systematic reviews and meta-analysis: The PRISMA Statement. *BMJ*, 339 (b2535). DOI:10.1136/bmj.b2535.

22. Nicholson, V., McKean, M., & Burkett, B. (2014). Twelve weeks of BodyBalance(R) training improved balance and functional task performance in middle-aged and older adults. *Clin Interv Aging,* 9, 1895-1904. DOI:10.2147/CIA.S71769.

23. Oliveira M., Silva R., Dascal, J. & Teixeira, D. (2014). Effect of different types of exercise on postural balance in elderly women: a randomized controlled trial. *Arch Gerontol Geriatr,* 59 (3), 506-514. DOI:10.1016/j.archger.2014.08.009.

24. Ordnung, M., Hoff, M., Kaminski, E., Villringer, A., & Ragert, P. (2017). No Overt Effects of a 6-Week Exergame Training on Sensorimotor and Cognitive Function in Older Adults. A Preliminary Investigation. *Front Hum Neurosci, 11*, 160. DOI:10.3389/fnhum.2017.00160.

25. O'Sullivan, S., Schmitz, T., & Fulk, G. (2014). *Physical Rehabilitation (Sixth Edition)*. Philadelphia: F.A. Davis.

26. Raj, Y., Vadivelan, K., & SivaKumar, V. (2016). Comparison of Multisensory vs. Strenghthening Exercises on Functional Mobility and Balance in Elders. *Int J Physiother, 3* (5), 557-561. DOI:10.15621/ijphy/2016/v3i5/117439.

27. Sherrington C., Tiedemann A., Fairhall N., Close J., & Lord, S. (2011). Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *NSW Public Health Bulletin.,* 22, 3-4. DOI: 10.1071/NB10056.

28. Schoene D., Valenzuela T., Lord S., & De Bruin, E. (2014). The effect of interactive cognitive-motor training in reducing fall risk in older people: a systematic review. *BMC Geriatrics*, 14 (107). DOI: 10.1186/1471-2318-14-107.

29. Taylor D. (2014). Physical activity is medicine for older adults. *Postgrad Med J*, 0: 1–7. DOI:10.1136/postgradmedj-2012-131366.

30. Thiamwong L. & Suwanno J. (2014). Effects of Simple Balance Training on Balance Performance and Fear of Falling in Rural Older Adults. *International Journal of Gerontology*, 8 (3), 143-146. DOI:10.1016/j.ijge.2013.08.011.

31. Tiedemann, Sherrington, & Lord. (2013). The role of exercise for fall prevention in older age. *Motriz,* 19 (3), 541-547. DOI: 10.1590/S1980-65742013000300002.

32. Treacy D., Schurr K., Lloyd B., & Sherrington, C. (2015). Additional standing balance circuit classes during inpatient rehabilitation improved balance outcomes: an assessor-blinded randomised controlled trial. *Age and Ageing*, 44, 580-586. DOI:10.1093/ageing/afv019.

33. Winter, D. (1995). *A.B.C. Anatomy, biomechanics and control of balance during standing and walking.* Waterloo, Ont.: Waterloo Biomechanics.

34. Zheng, J., Pan, Y., Hua, Y., Shen, H., Wang, X., Zhang, Y., . . . & Yu, Z. (2013). Strategic targeted exercise for preventing falls in elderly people. *J Int Med Res, 41*(2), 418-426. DOI:10.1177/0300060513477297.

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Development of Motor Qualities Through the Specific Means of Gymnastics

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Abstract
Introduction: The study entitled "Development of motor skills through specific means of gymnastics" refers mainly to the specific means of artistic gymnastics used by the physical education teacher for physical training and development of motor skills of high school students considering that gymnastics discipline is one of the most important parts of the physical education class in school. **The aim** of this paper is to demonstrate the progress made in increasing the level of motor skills by using the means of artistic gymnastics and to present the effectiveness of these means in physical education. The experiment was performed at *the Vasile Goldiş National College Arad* for an interval of 6 months between January 15, 2019 and July 15, 2019. The classes subjected to the experiment were from the 5th A and 5th C classes from the above mentioned unit, 48 female students and boys between the ages of 11 and 12. The 5th A class comprises 23 students, of which 13 girls and 10 boys, and the 5th C class comprises 25 students, of which 14 girls and 11 boys. Both classes were subjected to the same group of tests at both the initial determination at the beginning of the experiment and the final one. The experiment consisted in applying a set of exercises to the experimental group, ie to class V A, different from the one applied to the control group, class V C. **The research methods** used were: bibliographic study, observation method, survey, experiment method, test method and statistical-mathematical method. Tests applied in the expermient: 1.Shuttle; 2. Lumbar mobility; 3. The bridge; 4. Antero-posterior cord; 5. Long jump from the spot; 6. Trunk lifts from supine to sitting and back**. Results** The average values obtained by the experimental

class in the tests were are following: - Shuttle I.T =11,96 ± 0,64 and to F.T = 11,69 ± 0,64; - Lumbar Mobility I.T = 49,3 ± 8 and to F.T = 55,43 ± 5,6; - Bridge I.T = 46 ± 10,4 and to F.T = 43 ± 11,2; - Split A-P I.T = 17,6 ± 9,4 and to F.T=14,8 ± 9,5; - Jump in length from sport I.T= 163 ± 8,7 and to F.T = 169 ± 5,5; -Abdomen I.T = 21 ± 4,2 and to F.T = 22 ± 4,4. Compared to those of the control class : - Shuttle I.T = 13,03 ± 0,85 and to F.T = 12,88 ± 0,78: - Lumbar Mobility I.T = 53,28 ± 6,32 and to F.T = 54,32 ± 6,04; -Bridge I.T = 50,8 ± 8,9 and to F.T = 50,1 ± 9,3; - Split A-P I.T = 23,6 ± 8,2 and to F.T = 23 ± 9,2; -Jump in the length I.T = 158 ± 7,8 and to F.T = 159 ± 7,3; - Abdomen I.T = 23 ± 4,6 and to F.T = 23 ± 4,8. The research conducted, through which we aimed to demonstrate the effectiveness of gymnastics in the physical education lesson in middle school classes, was confirmed, as can be deduced from the comparative table of results obtained, set out in the research annexes. **Conclusions*:*** Following the study, we can conclude that the means of gymnastics, used intensively in physical education classes, along with traditional means, increase students' attendance, increase their attractiveness, create a motivational framework for conscious and active participation of students, contributing largely to increase the level of development of motor skills in physical education lessons. Given the results obtained, we recommend physical education teachers in primary and secondary school to introduce in their lessons as many exercises and games specific to gymnastics both for the harmonious physical development of students and for maintaining their health and mental relaxation they need during school. In this way the physical education lessons do not seem to be boring, they become pleasant, attractive.

Keywords*: driving qualities, flexibility, mobility, speed, strength.*

Introduction

This material refers to the specific means of gymnastics that the physical education teacher uses in physical education classes for the physical training of students in secondary school.

The motor qualities represent "qualities of the organism, materialized in the capacity to perform movement actions with certain indices of strength, speed, skill, endurance" (I. Şiclovan, 1972).

Gymnastics is one of the most important means of physical education. Having an extremely rich content and a great variety of means, it fulfills an essential role in the harmonious physical devel-

opment, in the improvement of the motor qualities, in the formation of the basic and specific motor skills.

Gymnastics is mandatory for all school, the volume of activities being established according to the material endowment of the school. With the help of gymnastics we can train students in a correct posture, mobility, suppleness, strength, speed of execution and repetition, skill and endurance.

The topicality of the problem consists in the fact that by the intensive use of the gymnastics means that are numerous they will contribute to a very good psycho - motor training. We thought that through this work we can bring an improved methodical training in the gymnasium cycle, so that the students acquire new knowledge in this field.

Current gymnastics is developed in terms of technical training in all its branches, providing the most varied means of action to solve many tasks in the lesson including the development of coordination abilities (skill), speed, strength, endurance and mobility-flexibility.

After (A. Dragnea and A. Bota, 1979) the term skill, used by many authors in specialized works, seems restrictive in relation to the richness (complexity) of the manifestation of these abilities. The same authors define the coordinative capacities "a complex of predominantly psycho-motor qualities, which implies the ability to quickly learn new movements, fast and efficient adaptation to various conditions, specific to different types of activities, by restructuring the existing motor resources."

With the help of the means of artistic gymnastics, the speed that represents "the capacity of the human organism to perform motor acts or actions, with the whole body or only with certain segments (parts) of it in a short time, with maximum rapidity (speed, quickness), depending on the existing conditions". (I. Şiclovan, 1972).

We can say that no other branch of sport develops flexibility as gymnastics does, being defined as "the ability of an athlete to perform movements with great amplitude, in one or more joints by itself or under the action of extreme forces" (J. Weineck, 1992). Some authors also use the term mobility.

It can be stated that without the exercises and exercise structures offered by gymnastics, a project of didactic technology cannot be conceived. From those 10-12 minutes that the preparatory part of the lesson lasts, 70-80% is gymnastics. If this part of the lesson is well structured, harmonized and dosed with gymnastic elements, the body will be brought into an optimal state of excitement, ready to approach the fundamental part of the lesson.

Gymnastics benefits from a large number of hours, 1/3 of the total volume of hours. It is practiced in all schools, regardless of the material base or geographical area in which it is located and is accessible to all students regardless of age or gender. It is practiced in the form of acrobatic, rhythmic, artistic gymnastics (jumping) and aerobics.

Through its great variety, gymnastics enables all students to find the means of expression that will bring them satisfaction. The elements of acrobatic gymnastics provided in the curriculum are accessible to all students. Once understood and learned correctly, they are repeated with great interest by the vast majority of students. In general, at this age gymnastics "likes" and enjoys a lot of interest and a wide popularity among students (V. Grigore, G. Niculescu, 2009).

The permanent modernization of the physical education and sports activity in school requires the finding of new methods, procedures and means to act in practice as well as the continuous improvement of the existing ones, of the so-called classic, traditional ones, based on the new objectives. in front of this educational object. In accordance with this task of great importance for physical education and school sports, we have developed this paper that aims at physical training in high school through specific means of gymnastics.

We chose this topic to show how effective the means of gymnastics are in psycho - motor training for the development of speed, strength and mobility. In the first part of the paper we presented the main characteristics of motor skills (speed, strength and mobility) and driving exercises for their development through gymnastics. In the second part of the paper we tested experimentally the devel-

opment of speed, strength and mobility before and after training through acrobatic gymnastics.

The aim of this paper is to obtain a progress of the level of motor qualities involved in order to show the efficiency of the gymnastic means in the physical education class.

If exercises and means specific to gymnastics are used in physical education lessons, a better physical training will be obtained, improving the motor qualities: speed, strength, dexterity, endurance, mobility - suppleness.

In accordance with the general docimology, applicable to all educational objects, so also to the subject "physical education", the efficiency of teachers' activity is appreciated mainly by the progress made by students in acquiring knowledge, training skills and abilities, development motor skills.

The objectification of the training process refers to the establishment of concrete ways of quantitative assessment of the progress on the basis of which the value of the methods, procedures and means used can be evaluated.

The development of motor skills is a field that offers us broad and concrete possibilities for objective assessment of the progress made by students, the quality of work performed by students and teachers.

The objectification of the process of development of motor qualities requires the teacher:

- to know the level of preparation of the students, from which study starts
- to establish tests and norms specific to each motor quality and to apply them periodically in the students' activity (at the beginning of the school year, at the end of the semester and at the end of the school year)
- to elaborate the final model regarding the development of the motor qualities and the exercise structures used.
- to keep a precise record of all the data obtained and to use it accordingly, for the critical appreciation of the activity carried out, retaining the necessary lessons.

Research methods used

To prepare a paper, it is natural to use as many methods, techniques and procedures as possible, but it is not enough for the results to be real. Some general conditions of scientific research must be observed

The main ways of action for the development of motor qualities

a) the use of basic motor skills and technical procedures specific to different branches of sport with the change of their dominance ;

b) the use of methods, procedures and means specific to the development of motor qualities .

Means used in the experiment:

We used during the whole experiment a number of *15exercises* general physical developmentand the combination of these exercises contributes to the development of motor qualities such as: speed, explosive force, skill, endurance, mobility.

We used in the experimental class combined exercises in the form of applicationas follows:

Movement 1

Materials : four gym benches Exercise

Description of the exercise: the benches are zigzagged, the middle ones being parallel, at a distance of one meter from each other. On the first bench there are jumps from squatting in the distance, grabbing the edges of the bench with your hands; on the next two benches that are parallel, lateral movement in a supine position with the hands on one bench and the legs on the other. At the fourth bench, jumps are performed over the bench, on either side of it.

Indications: when jumping on the first bench, the weight of the body will alternately pass from the legs to the arms.

Movement 2

Materials : two benches, a vaulting horse, a mattress

Description of the exercise**:** running with the back forward four meters, stepping over the first bench sitting transversely, stepping over the second bench sitting parallel to the first, at a distance of one meter from it, running four meters, passing under the vaulting horse, standing up, turning 180 °, rolling back from squatting to squatting on the mattress, rolling forward, climbing the vaulting horse, running, jumping over the benches, running and returning to training.

Indications: when running with your back forward, your gaze will be directed forward toward the device..

Movement 3

Materials: a gym bench, trampoline, crate, a mattress placed at the end of the box.

Description of the exercise: crawling on the bench sitting longitudinally, running, beating on the trampoline, jumping in a squat on the crate, stepping on it, landing by jumping with a 180° turn, running in formation.

Indication: when jumping the box, help will be given where appropriate.

Movement 4

Materials: fixed ladder, a gym bench, a mattress .

Description of the exercise: the gym bench is supported with one end of a slat of the fixed ladder, at a height of 50-70 centimeters, thus achieving an inclined plane. In front of the bench, in length, a mattress is placed. At the running signal, rolling forward on the mattress with standing up, running on the sloping bench, free climbing on the fixed ladder to the last slat, descending from slat to slat with arm and leg opposite to the ground, turning 180 ° and running in formation.

Indications: the course can be done in the form of a race: which string ends first. Those who lose their balance on the bench are allowed to continue the race.

Games used during the experiment :

1. *Cockfighting*: In pairs: jumping on one leg with imbalance by pushing with the hands. The one who puts his first free foot on the ground loses.

2. *Wheelbarrow*: Two teams divided into two adjacent rows. A partner grabs the performer's ankles who are lying face down and moves on his arms for a distance of 5-10 meters. Places are exchanged on return. The team that finishes the route faster wins.

3. *Rabbits*: The team is divided into two teams lined up: at the signal, the first players in each team, with the medicine ball between their ankles, move by jumping on both legs to a line 10 meters away, return and teach the ball of the next. The team that finishes the course faster without losing the ball wins.

4. *The flight of the bench*: 4 performers at a gym bench, sitting sideways to it. At the signal, the executors grab the edge of the bench, lift it above their heads and place it on the other side, returning to their feet. Performers step over the bench and repeat the exercise 5 times.

The team that finishes faster wins.

In addition to these means, in the experimental class I insisted on the acrobatic elements provided in the curriculum for the fifth grade. I mainly used exercises to develop mobility and strength in the joints and muscles involved in performing these acrobatic elements.

Ground exercise for 5th grade

Initial position: Sitting

Raising the arms up, step added forward with the arms lowered, pirouette, squatting, rolling forward from squatting to squatting, turning 180 °, rolling forward from distance to distance, rope forward with the support of the palms on the ground, crossing the leg back, forward, lying on the back, lower bridge, returning to lying on the back, sitting on the shoulder blades, crossing the scales on one knee, jumping in a squat and lifting in the standing body wave forward.

Methods used :

a) *observation method;* **b)** *experimental method;* **c)** *survey*; **d)** *test method;* **e)** *statistical – mathematical*.

Results obtained

The experiment was performed at *the Vasile Goldiş National College Arad* for an interval of 6 months between January 15, 2019 and July 15, 2019. The classes subjected to the experiment were from the 5th A and 5th C classes from the above mentioned unit, 48 female students and boys between the ages of 11 and 12.

The 5th A class comprises 23 students, of which 13 girls and 10 boys, and the 5th C class comprises 25 students, of which 14 girls and 11 boys. Both classes were subjected to the same group of tests at both the initial determination at the beginning of the experiment and the final one. The experiment consisted in applying a set of exercises to the experimental group, ie to class V A, different from the one applied to the control group, class V C.

In the experimental class, exercises and means specific to gymnastics were used. The tests were performed during physical education classes, in which students participated with appropriate equipment. The material base of the school consists of a gym with a rich and varied range of tools and working sports equipment; In the school yard there is a basketball court, a volleyball court, a sand pit, a running track.

Tests applied in the expermient

1. *Shuttle*; *2. Lumbar mobility; 3. The bridge; 4. Antero-posterior cord; 5. Long jump from the spot; 6. Trunk lifts from supine to sitting and back.*

We also applied three complexes of exercises for the physical development of the body that we used in different periods of the experiment, their difficulty gradually increasing.

Table 1. Table representing the individual values recorded ,at the initial and final tests Experimental Class.

Nr. crt.	Initial name and sur-name	W	B	Shuttle		Lumbar Mobility		Bridge		Split A - P		Jump in length from the spot		Abdomen force	
				T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.
1	**A.T.**		X	12,0	11,8	54,2	49,1	48,2	46,1	30	28	150	150	28	30
2	**B.I.**		X	12,1	11,7	56,1	54,1	50,3	38,2	30	32	158	160	30	30
3	**C.A.**		X	11,5	11,7	54,4	49,5	50,1	48,3	30	30	175	175	26	25
4	**C.D.**	X		11,7	11,6	53,6	48,9	48,4	42,2	22	22	160	160	16	14
5	**C.T.**	X		11,2	11,4	56,1	52,4	48,3	42,1	23	20	154	152	16	16
6	**D.A.**	X		12,2	12,1	60,2	58,5	54,5	42,4	32	33	154	156	20	18
7	**I.T.**	X		12,5	12,5	42,7	41,8	54,6	43,3	30	30	152	150	20	20
8	**K.D.**		X	11,5	11,3	49,9	42,7	48,4	40,5	30	34	170	167	24	26
9	**N.E.**		X	11,4	11,3	58,6	46,9	50,3	42,2	42	40	168	170	28	28
10	**N.L.**	X		12,1	12,3	50,5	49,6	42,2	40,1	24	24	158	160	25	25
11	**O.B.**		X	11,5	11,4	55,4	54,1	45,1	35,3	38	36	172	170	30	30
12	**O.L.**	X		11,3	11,2	62,1	60,1	50,2	48,2	20	20	158	158	28	20
13	**P.F.**	X		12,2	12,0	66,7	55,3	32,3	32,1	14	14	163	160	26	28
14	**P.S.**		X	11,6	11,6	50,6	48,1	45,4	44,4	18	20	154	150	30	26
15	**R.A.**	X		11,8	11,7	53,5	52,2	48,5	40,5	12	8	155	153	20	18
16	**R.T.**		X	11,6	11,3	54,3	44,6	48,1	38,2	20	28	170	168	24	26
17	**S.I.**	X		11,6	11,4	54,6	52,1	38,2	40,3	8	4	156	160	14	16
18	**S.T.**		X	12	12,5	48,6	48,2	50,2	42,1	20	24	170	170	22	24
19	**T.D.**	X		11,4	12,2	56,1	52,2	48,4	38,4	14	12	150	162	18	20
20	**T.G.**	X		12,3	12,5	52,2	48,5	50,3	46,3	16	10	155	156	20	18
21	**U.D.**	X		11,4	11,2	54,4	51,6	52,2	42,2	25	24	165	160	22	20
22	**V.O.**	X		12,8	12,2	55,6	50,7	38,1	40,1	26	20	148	150	20	20
23	**V.D.**		X	12,3	12,0	58,3	50,1	48,5	46,2	30	30	158	160	28	28
	X			**11,96**	**11,69**	**49,3**	**55,43**	**46**	**43**	**17,6**	**14,8**	**163**	**169**	**21**	**22**
	Am			**0,009**	**0,001**	**0,004**	**0,004**	**0,08**	**0,04**	**0,008**	**0,06**	**0,08**	**0,34**	**0,03**	**0,03**
	S			**0,64**	**0,64**	**8**	**5,6**	**10,4**	**11,2**	**9,4**	**9,5**	**8,7**	**5,5**	**4,2**	**4,4**
	CV			**5,35**	**4,27**	**16,22**	**10,1**	**22,6**	**26**	**53,4**	**64,1**	**5,3**	**3,2**	**19,9**	**19,6**

Table. 2. Table representing the individual values recoreded at the initial and final tests at the control class.

Nr. crt.	Initial name and surname	W	B	Shuttle		Lumbar Mobility		Bridge		Split A – P		Jump in length from the spot		Abdomen force	
				T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.	T.I.	T.F.
1	**A.R.**		X	12,2	11,5	50,1	50,2	50,1	50,2	20	18	160	170	18	20
2	**A.V.**		X	12,1	11,8	50,3	54,3	60,2	58,3	20	22	178	180	20	24
3	**C.F.**		X	12,5	12,2	54,4	54,3	60,3	58,4	23	10	175	185	26	27
4	**C.L.**	X		12,8	14,8	50,1	58,1	48,2	42,2	16	12	160	170	17	18
5	**C.Ş.**	X		12,2	14,4	52,6	52,6	48,4	48,1	13	10	164	167	16	16
6	**I.A.**	X		12,2	14,2	60,2	58,5	64,3	62,2	22	13	164	167	20	21
7	**I.D.**	X		14,5	13,5	42,1	46,4	64,5	60,3	20	10	152	157	21	22
8	**L.D.**		X	12,5	12,3	40,6	42,3	58,5	60,1	20	14	170	173	22	23
9	**M.D.**		X	12,4	12,3	48,3	46,2	60,4	62,4	12	10	168	170	23	24
10	**M.L.**	X		13,0	13,3	50,2	52,3	62,4	60,3	14	14	155	162	22	25
11	**O.P.**		X	13,5	12,4	50,6	54,4	65,3	65,2	18	16	174	171	24	25
12	**O.R.**	X		11,4	13,2	62,2	60,5	50,4	48,5	10	10	155	158	18	20
13	**P.E.**	X		14,2	12,8	66,4	70,4	32,6	36,3	14	14	167	167	23	24
14	**P.J.**		X	12,6	12,6	50,5	48,3	45,7	44,2	18	20	158	159	20	26
15	**R.E.**	X		12,8	12,7	50,2	52,1	48,4	50,0	12	8	156	158	20	22
16	**R.F.**		X	12,6	12,8	54,5	54,8	48,3	48,12	20	28	170	178	22	23
17	**S.D.**	X		12,6	12,4	54,7	56,5	38,5	40,4	8	4	159	160	14	16
18	**S.H.**		X	12,1	13,5	48,4	48,6	50,6	52,6	20	14	170	173	22	23
19	**Ş.D.**	X		13,4	13,2	56,2	56,3	48,2	48,7	14	12	160	162	18	19
20	**Ş.G.**	X		14,2	14,5	52,1	58,5	50,1	46,2	16	10	165	167	20	21
21	**T.D.**		X	13,4	13,2	54,4	52,2	52,5	52,1	25	14	165	165	21	24
22	**T.O.**	X		13,8	13,2	58,3	58,1	38,4	40,3	16	20	158	159	20	23
23	**Ţ.D.**		X	12,5	12,5	58,2	56,7	48,6	46,2	10	20	168	169	21	23
24	**U.G.**	X		13,2	13,3	66,1	64,4	44,3	38,5	16	12	150	1502	20	24
25	**V.C.**	X		13,8	14,4	58,7	60,9	40,2	40,3	20	14	160	154	21	26
	X			**13,03**	**12,88**	**53,28**	**54,32**	**50,8**	**50,1**	**23,6**	**23**	**158**	**159**	**23**	**23**
	Am			**0,015**	**0,016**	**0,1**	**0**	**0**	**0,4**	**0,008**	**0**	**0,92**	**0,24**	**0**	**0,02**
	S			**0,85**	**0,78**	**6,32**	**6,04**	**8,9**	**9,3**	**8,2**	**9,2**	**7,8**	**7,3**	**4,6**	**4,8**
	CV			**6,52**	**6,05**	**11,86**	**11,1**	**17,5**	**18,5**	**34,7**	**40**	**4,9**	**4,5**	**19,6**	**20,7**

Conclusions

After the presentation and interpretation of the research results it can be stated that the type of lesson in which specific means of gymnastics are used, in this case the experimental class a V-a A within *the Vasile Goldiş National College Arad* has achieved its goal, achieving a development of motor qualities, a much better physical training than in the control class.

The means of gymnastics, used intensively in physical education classes, along with traditional means, increase students' attendance, increase their attractiveness, create a motivational framework conducive to the conscious and active participation of students, greatly contributing to increasing the effectiveness of lessons.

Throughout the work program we aimed to use the specific means of gymnastics with special emphasis on the development of motor skills. The statistical indicators obtained, especially the arithmetic means, indicate an ascending evolution confirming the initial hypothesis, according to which the gymnastics means used in the lessons contribute to the development of morpho-functional indices and to an achievement with an obvious progress in the development of motor qualities. Following the experiment, I noticed, in the experimental class, that the physical education lessons became more attractive, engaging and enjoyable for the students.

Given the results obtained, we recommend physical education teachers in primary and secondary school to introduce in their lessons as many exercises and games specific to gymnastics both for the harmonious physical development of students and for maintaining their health and mental relaxation they need during school. In this way the physical education lessons do not seem to be boring, they become pleasant, attractive.

These data showed us clearly that, after using the exercises and games specific to gymnastics, we obtained good results and an obvious progress in terms of motor skills in students and it is also a sure way to achieve the goals of normal growth and harmonious physical development. the students.

References

1. Bompa, T, O, (2001). *Development of biomotor qualities*, Ex-Ponto Publishing House, Constanța;
2. Bota,C,.Prodescu,B, (1997).*Physiology physical education and sports - ErgophysiologyRm.*, Antim Ivireanul Publishing House,-Valcea;
3. Demeter,A, (1981). *Physiological and biochemical bases of motor qualities*, Sport - Tourism Publishing House, Bucharest;
4. Dragnea,A.,Bota,A, (1999). *Theory of motor activities*, Didactic and Pedagogical Publishing House, Bucharest;
5. Dragnea, A., Teodorescu,S, (2002). *Theory of sport*, Fest Publishing House, Bucharest;
6. Drăgan,I,(1989).*Medical–sportsselectionandorienation,Sport-Tourism Publishing House, Bucharest;*
7. Epuran, M, (2001) et al. *psychology performance sports theory and practice* Fest Publishing House, Bucharest;
8. Galea, I.,D., Ardelean, V. P., Iștvan, G, (2010). *Metodologia cercetarii stiintifice in educatie fizica si sport: sinteze si aplicatii,* Editura Universitatii Aurel Vlaicu, Arad;
9. Grigore,V, (2001). Artistic gymnastics . Theoretical bases of sports training , Semne Publishing House , Bucharest;
10. Grigore, V, (1998). *Performence gymnastics – Introductory notions , Inedit Publishing House*;
11. Grigore, V, Niculescu, G, (2004). Acrobatic gymnastics – elements and models. Bren, Publishing House , Bucharest;
12. Grigore, V, (2003). *Gymnastics-textbook for the basic course*, Bren Publishing House, Bucharest;

13. Hidi, I, (1991). *Course notes*, ANEFS, Bucharest;

14. Huțanu, C, (1970). *Criteria and methods used in selection for sports gymnastics*, In: EFS, XXIII, no.7, pp. 4-9;

15. Ifrim, M, (1986). *Motor Anthropology , Bucharest Scientific and Encyclopedic Publishing House;*

16. Mitra, Gh., Mogoș, A, (1977). Development of motor qualities ; Sport Publishing House – Tourism Bucharest ;

17. Podlaha, R., HIDI I., (1979). Course notes Sports gymnastics , optional course Year III IEFS, Bucharest;

18. Popa, L, (2008). *Acrobatic gymnastics and school jumping, „A Vlaicu " Univeristy Publishing House , Arad;*

19. Rusu, I,C, (1998) . Gymnastics, G.M.I., Publishing House Cluj-Napoca;

20. Șiclovan, I, (1979). *Theory of pshysical education and sports , Stadion Publishing House 3rd edition;*

21. Uțiu, I, (1998). *Methodology of school physical education , Argonaut Publishing House , Cluj -Napoca;*

22. Vieru, N, (1997). *Handbook of sports gymnastics*, Driada Publishing , Bucharest;

23. Weineck, J, (1994). *Biology of Sports*, S.C.J. nr. 1-2, M.T.S., C.C.P.S., Bucharest.

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Contributions to the Technical Training of Handball Players Specialized in the Wing Post

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Abstract
Aim: The level of performance achieved at the current stage, both internationally and internally, is very high and can only be achieved by players whose performance capability is particularly high and steadily increasing. The field of game technology has expanded a lot. Increasing the spectacularity of this game, coupled with its spread across the continents, has had repercussions on the organization of handball at junior level. New methods have emerged, which performance players perform with high craftsmanship, doubled by special physical qualities. **Methodology** : the experiment took place between September 2016- Juin 2017, in the city of Suceava, with 3 players specialized on the wing position from the under 18 team Suceava Sports High School. During this period the team maintained its regular training program, the wings following our proposed program to analyze its effect on improving the tracking parameters. We estimate that using efficient means of action and adapting them to the post of the wing player will increase the performance of the game and individual value to handball players specializing in the wing. **Results:** the mean results recorded at the technical level, show good differences between initial test (IT) and final test (FT): - dribling among the rounds: IT= 6,21±0,009 sec., and FT= 5,80±0,02 sec.; - passing in two out of the way: IT= 5,16±0,005 sec., and FT= 4,80±0,01 sec.; - triangle shift, gate throw: IT= 12,48±0,01 and FT= 12,0±0,01, show a breakthrough in all the sustained samples and the statistical analysis demonstrates a homogeneity of the research group. Given the importance of the "wing" role

in organizing and directing the field play in this paper, I presented the tasks in the post, determined by the action areas and the contribution in the attack phases. **Conclusions:** we can assert that the hypothesis from which I left is confirmed and the purposes of the work have been achieved. I think the study has achieved its goal by showing: optimization of the training, due to the selected means of action, the fulfillment of the tasks of the wings in the post, resulting from the registration of the actions in the attack, as well as the efficiency in their areas of action, as revealed by the research.

Keywords: game, performance, methods.

Introduction

Performance sports (in our case, handball) is a component of general education, being an activity by which, under the guidance of a specialized professor, physical exercise is organized in an well-planned way, capitalizing on the motor activity in various forms in order to optimize the morpho-functional and psychological development of motoring capacity, in order to achieve a sporting ideal.

Handball is known as a fast-paced, spectacular development and in line with "the evolution of human material, with its improvement". (Abalaşei, Beatrice, 2012, P.12). The level of performance achieved at the current stage, both internationally and internally, is very high and can only be achieved by players whose performance capability is particularly high and steadily increasing.

The field of game technology has expanded a lot. New methods have emerged, which performance players perform with high craftsmanship, doubled by special physical qualities.

The sphere of individual and collective tactics has also been enriched, and the solutions for solving various game tasks are increasingly diversified.

These changes in the world of seniors' handball have obvious influences in the preparation of future athletes, children's and junior echelons in order to be able to successfully make the exchange of tomorrow at the level of the representative teams.

Handball specialists consider "selection an important point for handball performance"(Cercel, P., 1983). For this it must look for

the most efficient organizational forms for attracting and grinding the most endowed elements: vocational high schools, sports clubs, sports associations, etc. Even though at the moment it is difficult to achieve such an objective in school, with a small number of physical education lessons, but we believe that a good opportunity to work more efficiently, including the game of handball, would be to increase the number of lessons of physical education and sports or the obligation of the school sports circle (Ardelean, Mert, Miuţa, 2016).

Increasing the spectacularity of this game, coupled with its spread across the continents, has had repercussions on the organization of handball at junior level.

The content of the technical and tactical training at each stage of the handball base of the performance handball is presented in the game and player models developed for each value level. The technical and tactical components of the models were determined both by the child's age specificity and the requirements imposed by the technical skills of the handball content (Mihăilă, 2014).

At the level of novice children, there is a minimal model of play, a model whose technical - tactical content is much simplified in relation with children 's possibilities. For the other echelons, intermediate models have been developed. Their technical and tactical content increases gradually, both quantitatively and as a degree of difficulty, until juniors level I, it is foreseen to acquire the model of play for handball performance.

"The wings are players with a good skill in handling the ball, with an extraordinary ability to accelerate in small space, to execute drive actions and good throwers at the gate from the angles of the field." (Balint, E., 2004, p.18). Therefore, in the following subchapters we will present the content of the tasks of the players specialized in the extreme post, in accordance with the types of training.

In preparing a handball team and especially players specializing in the extreme, special attention will be paid to the most effective exercises and their application must respect the physiological bases of developing different motor skills. Such a junior class II

will continue to work for speed and skill training (started with children), but work will be done to improve strength and resilience.

For speed training, the basic moral quality in achieving the performance of athletes specializing in the extreme, the priority means will be exercises in the form of competitions and different stages in which the speed capacity is demanded to the maximum.

It will introduce the training method with repetitions - usually by repeating short trials at maximum speed, repeating equal distances running at high intensities (Nicu, A., 1993, p. 340).

Material and method

We estimate that using efficient means of action and adapting them to the post of the extreme player will increase the game's performance and individual value to handball players specializing in the extreme.

The experiment was organized at the juniors' team I of Suceava Sports High School in the competition year 2015 - 2016. The athletes from this group went through the stages of the final selection (although the selection is a continuous process) so that they are now considered complete players, fulfilling the requirements of the handball performance. It should also be noted that the core participated in the mini-hockey, beginner and junior competitions III and II, which means that they also gained a competitive experience as part of the training.

The training took place on the ground and in the gymnasium hall. Both the material endowment and the quality of it proved to be appropriate.

Training scheduling focused on the structure of the school year and the competition calendar of the Romanian Handball Federation (https://frh.ro).

To improve the performance of the experiment group we used some tools such as: - speed 5x30m; - pentasalt, - 3x200 m; - throwing the handball from different distances; - 505 agility test; - Illinois test.

The nature of our research is of an applicative type, aiming at using the obtained results and interpreting their modification in the sports practice of the extreme Romanian players and not them only.

Results obtained are quantitative and form a series of data for each studied feature of athletes. These are absolute values, being evaluated directly (Tintiuc et al., 2011). Also, in order to better highlight the results obtained, we calculated the parameters of the central tendency but also indicators of data scattering or variability, at three specific control tests in handball.

The results of the research evaluations were noted on the result sheets and then centralized with statistical processing software.

The centralization and processing of the results was done with Microsoft Excel 2010 and GraphPad Prism 6 software.

Results and discussions

The results recorded at the technical level show a breakthrough in all the sustained samples and the statistical analysis demonstrates a homogeneity of the research group. Below there are the results recorded for each sample.

Dribling among the probes: the initial test result is 6.21 “, the final test is 5.8” and the progress is 0.41 “. The statistical indicators have the following values: In the initial test, the standard deviation (As) is 0.009, the average error (Em) is 0.0005 and the coefficient of variation (CV) is 0.13. Thus, the final As test is 0.02 Em is 0.001 and Cv is 0.34.

Passing in two out of the way: the initial test result is 5.16 “, the final test is 4.8” and the progress is -0.36 “. The statistical indicators show the following values: At the initial test, the standard deviation (As) is 0.002, the average error (Em) is 0.0002 and the coefficient of variation (Cv) is 0.09. At the final test As is 0, 01 Em is 0.0005 and Cv is 0.20.

Triangle shift, gate throw: The initial test result is 12.48 “, the final test is 12.0” and the progress is 0.48 “. The statistical

indicators show the same values: both initial and final testing: the standard deviation (As) is 0.01, the average error (Em) is 0.0005 and the coefficient of variation (Cv) is 0.08 (Tables 3 and 4).

Table no. 1. Statistical analysis at technical level tests.

Indi-cators statistics	Dribblling among the rounds		Pass in two of the way		Move in the tringle, throw at the goal	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
X	6,21	5,80	5,16	4,80	12,48	12,0
Sd	0,009	0,02	0,005	0,01	0,01	0,01
Em	0,0005	0,001	0,0002	0,0005	0,0005	0,0005
Cv	0,13	0,34	0,09	0,20	0,08	0,08

The experience of the first players analyzed and tested is considerably evident compared to the newly introduced athletes.

The psychomotor qualities are superior, close to the player's performance profile and in accordance with the requirements of the sport microcosm.

The rationale for the creation of 3 players came from the need to apply the means of action in training, correlated with the individualization and the principle of comparison. There is a more careful and motivated participation of the first three players, existing in the investigative approach initiated a year ago.

Continuity can give real data, the longitudinal experiment comes to support the variety of application of actuation means and the accuracy of the evaluation.

Moreover, the calculation of the variability coefficient results in the context of a larger group.

In order to improve the tested parameters we also added new means.

The results of the athletes of the experimental group registered at the initial testing, in accordance with the standards set

by specialists and the characteristics of the position, reveal a good preparation of the wings, compared to the benchmarks described in the theoretical part, as shown in the following table.

Table 2. Wing player results from the experiment group, initial testing

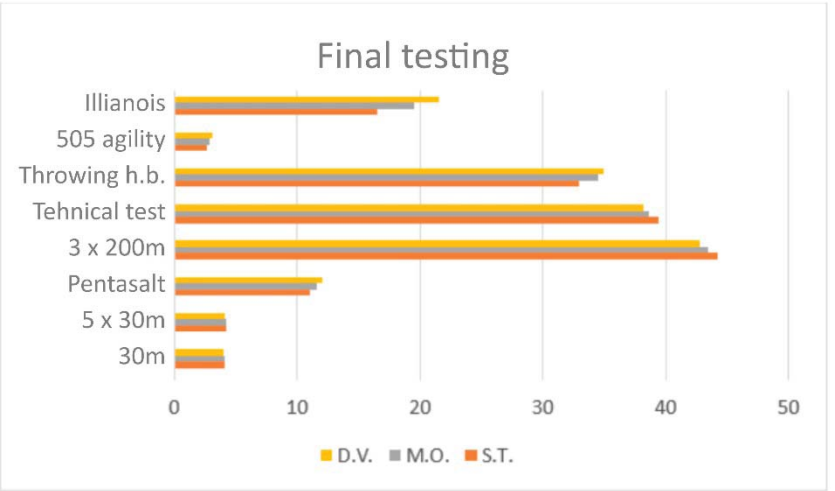
Sample/ topic	30m (s)	5x30m (s)	Pent-asalt (m)	3 x 200m (s)	Tech-nical test (s)	Thro-wing h.b. (m)	Test 505 agility	Test Illianois
S.T.	4”3	4”5	9,80	46”8	41”2	31,0	2,79	17,8
M.O.	4” 2	4”4	10,30	46”0	40” 2	32,0	2,84	21
D.V.	4” 2	4”3	10,80	45”8	41” 6	31,5	3,12	22,9

At the end of the experiment, the final testing of the subjects of the experiment group was performed, using the same evaluation samples. The results recorded for each player are recorded in the following table.

Table 3. Wing players results of the experiment group, final testing

Sample/ topic	30m (s)	5 x30m (s)	Pent-asalt (m)	3 x 200m (s)	Tech-incal test (s)	Thro-wing h.b. (m)	Test 505 agility	Test Illianois
S.T.	4” 1	4” 2	11,10	44”2	39” 4	33,0	2,65	16,5
M.O.	4” 1	4” 2	11,60	43”4	38” 7	34,5	2,84	19,5
D.V.	4” 0	4” 1	12,10	42”8	38” 2	35,0	3,12	21,6

We found that following the application of the didactic strategy experienced in this group, a significant increase of results is obtained, after the period of application of specific exercises: if in the Illianois test, the ST subject obtained the value 17, 8, in the final test the result is 16, 5. Subjects MO and DV, progress by 1.5 s and 3.4 s, respectively.



Graph 1. Peculiarities of the level of specific training, final testing.

The graphical representation of the obtained results, compared to the initial testing, is an x-ray of the evolution of the players at the age of accumulation. We notice a good agility and the detachment of the ST player from the values of the group.

The arithmetic mean and the coefficient of variability are kept within the limits of the group homogeneity values, except for the Illinois test, demonstrating the accuracy of the preparation and the setting of objectives in accordance with the requirements of the job performance profile.

Conclusions

The training program has resulted in good results, but any planning can not achieve perfection, requiring continuous improvements, gait adjustments and additions in line with the requirements of modern handball.

The way of conceiving the work and the stages in its execution sought to meet the requirements of a methodical - scientific work in the field of physical education.

Given the role of the "extreme" role in organizing and directing the field play in this paper, I presented the tasks in the post, determined by the action areas and the contribution in the attack phases. I can assert that the hypothesis from which I left is confirmed and the purposes of the work have been achieved.

I want to emphasize the particular concern I have expressed about the deepening of the current trends in handball performance and the theoretical grounding of the theme. The "bibliography" contains the titles of the best handball specialists.

The wing player's actions are based on the initiative, good maneuvering and possession of the ball, rich tactical knowledge and a variety of technical techniques without and with the ball.

To train and deepen the knowledge of the wing we intertwined the analytical method with the global one. Through the analytical method we sought to deepen individual tactical actions, tactical combinations of two players as well as the basic movements of ball and semicircle players. Through the global method and training modelling, the integration of the wing player into the game phases was pursued.

In conclusion, I believe that the study has achieved its objective by showing: the optimization of the training due to the selected means of action, the fulfilling of the tasks of the extremes in the post (resulting from the registration of the actions in the attack, as well as the efficiency in their areas of action) things proven by the research (it is possible that in other circumstances, at the level of another female handball team, the results are different, therefore, the results of the research are not general, but only indicative).

References:

1. Abalașei, B. , (2012). *Introducere în antrenamentul jocului de handbal,* Editura Lumen, Iași,
2. Ardelean V. P., Mert C., Miuta C., (2016). *Study regarding the impact of the number of physical education classes at primary*

level, Arena – Journal of Physical Activities, 5/2016, pp 143-154,

3. Balint, E., (2004). *Instruirea în jocul de handbal-conținut tehnic,* Editura Universității Transilvania din Brașov,
4. Cercel, P., (1983). *Handbal – antrenamentul echipelor masculine,* Editura Sport – Turism, Bucureşti,
5. Galea I., Ardelean V. P., Istvan G., (2010). *Metodologia cercetării ştiinţifice în Educaţie Fizică şi Sport: sinteze şi aplicaţii*, Editura Universităţii" Aurel Vlaicu", Arad,
6. Mihăilă I., (2014). *Technical Training Methods for Increasing the Junior Handball Teams,* Procedia - Social and Behavioral Sciences 116 (2014), pp. 2004 – 2009,
7. Nicu, A., (1993). *Antrenamentul sportiv modern*, Editura Editis, București,
8. Tintiuc, D., Raevschi, E., Grossu, I., Grejdeanu, T., Vicol, C., Margine, L., și Badan, V., (2011). *Biostatistica. Metodologia cercetării științifice,* Editura Universității de Stat de Medicină și Farmacie „Nicolae Testemițianu", Chișinău.
9. https://frh.ro/documente/rapoarte/Norme%20de%20control%202013-2014.pdf

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