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Systematization and Rationalization of Training for under 17 Female Volleyball Players through Specialized Plyometric Programs

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Abstract: *The main scope of this study is to use plyometric means in volleyball training, individualized according to the training period, in order to improve the strength-speed capacity from the point of multidimensional perspective. The longitudinal experiment took place during the competitive year 2022-2023 and consisted in the introduction of plyometric means in training, depending on the training period, the time allocated to the improvement of strength-speed capacity being 20 minutes. We mention that the research was carried out in the gym of Dacia Pitesti Technological High School. The statistical data were collected by using the "Kistler Force Measurement Platform - Quattro Jump v1.1.1.x". According to the results, we mention that through the use of specialized plyometric programs during training, we obtained significantly improved values in the final evaluation of the applied tests, through a significant percentage increase with a value between 7% and 25% in the group subjected to the experiment. Sports training for U17 female volleyball players is a systematic and continuous pedagogical process with the objective of improving the general motor capacity and in particular the strength-speed capacity, the functional and mental capacity, based on the adaptation of the body to the intense and maximum efforts. In conclusion, the use of specialized plyometric programs in the training of cadet female volleyball players (15-17 years), determines a faster and more extensive development of general physical training, ensures a good rest for the athletes and reveals a more efficient use of the time allocated to the training.*

Keywords: *volleyball; plyometrics; systematization; rationalization.*

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Introduction

Rationalization and standardization are methodical measures undertaken within the process of objectifying trainings and competitions. "This analysis process also reveals the inventory of those means with the greatest efficiency in each of the forms of organization and especially in the preparation for the competition" (Dragnea & Teodorescu, 2002).

Standardization carried out is based on the knowledge operations of the contests, the separation of the most important features and the transfer to exercises with a high degree of utility, which determines a pattern of their application with maximum efficiency (Arnauld, 2004).

The set of rationalized and standardized exercises is systematized according to certain criteria constituting a unitary system of actions, after the characteristics of the contests have been analyzed and separated (Marques Junior, 2019). The creation of exercise structures in the form of actuation systems is the duty of each specialist who selects and rationalizes the means according to the lessons, the most suitable means of training, in order to achieve the targeted objectives (Vişan & Cojanu, 2020).

A form of rationalization, standardization and finally establishing some training models is achieved through the method of a statistical correlation between two variables: preparatory exercise and competition performance.

The practice of training and especially the scientific research in this field have demonstrated that the statistical correlation procedure is essential in many sports branches in terms of establishing the most effective means and control samples (tests) (Dobre, 2020; Niculescu, 2009). However, it was found that the values of the correlation coefficient are different from one level of training to another.

At the level of high-performance teams in the game of volleyball, we witness an acceleration of the pace of play (Cojocaru & Cojocaru, 2021; Calleja-Gonzalez et al., 2019), an increase in the number of simulations in the attack and the modification of the distribution of attacking actions on the net, with the aim of increasing the degree of uncertainty and preventing the efficient organization of blocking action from the part of opponents (González, 2013). We can also see an

increase in the strength of the service, which is increasingly becoming an attacking weapon for the team.

The unilateral training of sportswomen leads only to the training of those deficient motor qualities, without realizing an individualized training that leads to an ability to adapt strategy and tactics during the competitive period (Weineck, 2003). Thus, in moments of equality, the team that has sportswomen with better physical training manages to mobilize its physical resources to change the game and win the match.

The modeling of general and specific physical training over a competitive year shows us the importance of motor qualities in general and strength in particular by clearly establishing the objectives and the means used (Harabagiu & Pârvu, 2023). In sports games, as well as in volleyball, most coaches do not train according to individual qualities and the specifics of the position.

A successful training of a volleyball team requires the coach to know its ergo genesis and the specific characteristics of each playing position, with the aim of applying the knowledge in training the athletes.

Plyometric exercises are those that cause the muscle to behave like a rubber band, because it is based on the SSC principle, which determines the execution with more power, compared to a normal muscle contraction (Mateescu, 2013). In other words, the greatest force occurs when the stretching movement is performed as quickly as possible (Wang, 2016).

When we talk about plyometric training we are talking about a fast and dynamic stretch that involves an eccentric action followed by a shortening action called concentric movement (Häkkinen et al., 1985). Repetitive jumps performed quickly or in an "explosive" form are elements on which this form of training is based (Cometti, 2005; Behrens et al. 2016). The elastic energy stored in the muscles is used to produce more force than can be provided by concentric action alone (Adam et al., 2018).

The complex and dynamic nature of the technique specific to the game of volleyball, as well as the importance that must be given to this factor in the training process (Pelin et al., 2018), respecting the content and requirements of performance sport, led us to document the ways of concrete training and to try to find solutions, in accordance with contemporary requirements, in order to optimize the methodology of physical training.

Methodology

Participants

The subjects of the research were the female volleyball team of LPS Viitorul Piteşti, the volleyball players (n=12) aged 15 up to 17 years old and with a motor experience of 4 - 5 years, who had competed in 2022 - 2023 in the Under17 category.

Instruments

The statistical data were collected by using the **Kistler Force Measurement Platform - Quattro Jump v1.1.1.x.**

The musculature of the lower body, isolated through the position of the arms with the palms lied on the hip, can characterize the entire motor behavior of the athlete tested by the relatively high ratio that this musculature has in relation to the total musculature of the whole body, but also by analyzing the phases, the kinematic and dynamic characteristics of the pulse and detachment from the ground.

The important parameters meant to be investigated are the following: the height of the center of gravity, as a result of pulse projection through a single maximum effort (Squat Jump SJ) or with the use of the muscle elastic component and take-off (Counter Movement Jump CMJ), or the average of the heights obtained by repeated jumps in different conditions of effort (Continuous Jump with Bent Legs Reference Cjbref, Continuous Jump with Bent Legs CJb, Continuous Jump with Straight Legs CJs), as a motor action, which by its form is part of some phases of the competition exercises of the basic techniques in volleyball and essential phases of the game.

Procedure

The longitudinal experiment took place during the competition year 2022-2023 and consisted in the introduction of plyometric means in the training, depending on the training period, the time allocated to the improvement of strength-speed capacity being 20 minutes. We mention that the research was carried out in the gym of the Dacia Pitesti Technological High School.

The implementation of the experimental program did not change the structure of the training itself, it was carried out according to the program and the training plan established for each period and stage of training, our intervention laying in the time dedicated for the general and specific physical training program.

The improvement of strength-speed ability was planned in correlation with other activities: technical-tactical exercises, speed and resistance training (Bompa, 2003a). If during the preparatory period we work to achieve a high level of strength and power during the competitive period, we focus on maintaining these indicators in order to achieve high performances in competitions. The transition period focused more on recovery and muscle relaxation.

Therefore, during the research we applied exercises aimed at ensuring the development of the muscles of the upper limbs (improving the strength and power of the arms for the attack and service shot), of the lower limbs (increasing power and explosiveness), of the back and abdomen.

The most important aspect of improving strength-speed ability was the choice of exercises and the creation of specialized training programs, because each player has different indices that need to be improved in order to be effective in the game (Weineck, 2003).

The range of tests and control samples, selected to be applied in practice and considered to be representative of the strength-speed capability assessment in this sample, were supported by the research subjects at the beginning (1 - 4 August 2022) and at its conclusion (6 – 8 June 2023).

Results

Jump height (h) is one of the indicators calculated by applying tests on the Kistler - Quattro Jump v1.1.1.x force measurement platform.

The Squat Jump (SJ) was the first test applied using this platform; it is a test of explosive (maximal) strength and the height indicator has registered a significant increase of 6.467 cm in the group subjected to the experiment.

The results of this test at the initial evaluation indicate for the research subjects an arithmetic mean value of 44.033 cm, with a standard deviation of 5.998 and a coefficient of variability with a value of 13.621, which falls within the average homogeneity degree.

As for the final testing, we may observe an upward evolution of the research subjects, who obtained an arithmetic mean of 50.5 cm. (table no. 1). The standard deviation has a value of 4.028, and the coefficient of variability (7.976%) falls within the degree of high homogeneity**.**

The value of the "t" test, resulting from the performances obtained by the experimental group at the initial and final testing is 2.967 and compared with that of "t" from Fisher's table corresponding to the number of cases (n-1 = 11) matches with the significance degree: significant <0.01.

Table no. 1 Results of the initial - final testing and the dynamics' evolution of the height indicator, in the "Squat jump (SJ)" test

Parameters	**Experimental group**	
	T_1	**T_2**
Average mean	44,033	**50,5**
Standard deviation	5,998	**4,028**
Maximum	55,600	**55,600**
Minimum	33,500	**44,700**
Average difference	**6,467 cm**	
Variability coefficient	13,621%	**7,976%**
Value of „t"	**2,967**	
p	**significant <0,01**	

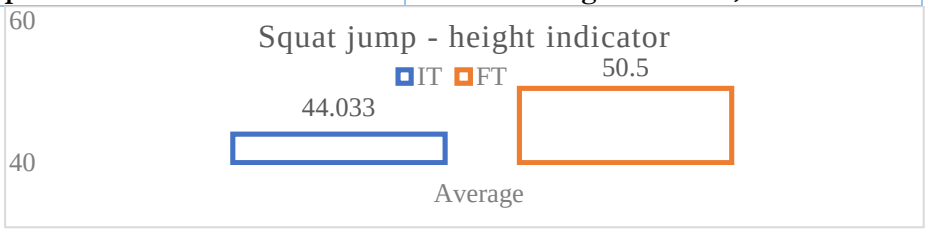


Figure no. 1 „SJ – height indicator" – chart of average means

As part of our research, we also applied the counter-movement jump (CMJ), which involves the evaluation of the explosive force (FE) of the legs and the capacity to reuse muscle elasticity, the capacity for neuro-motor recruitment, the capacity to use the viscose- elastic force in muscle tissue.

Analyzing the performances obtained by the research subjects in this test, we can notice that the performances obtained at the initial test record an arithmetic mean of 37.483 cm, a standard deviation of 5.028, and a coefficient of variability (13.414%) that indicates an average degree of homogeneity for the whole group.

The final testing reveals an improvement of 8,300 cm in terms of performance obtained by the subjects, with an average mean of 45,783 cm and a standard deviation of 4,581. The coefficient of variability at the final testing was 10.005%, recoding a higher value

compared to the initial testing (13.414%), which means a high homogeneity degree for this testing.

The values of "t" were 4.878 (significant p<0.001) for the experimental group.

Table no. 2 Results of the initial – final testing and the dynamics' evolution of the height indicator, for the "Counter movement jump (CMJ)" test

Parameters	**Experimental group**	
	T_1	**T_2**
Average mean	37,483	**45,783**
Standard deviation	5,028	**4,581**
Maximum	47	**55,600**
Minimum	29,200	**40,500**
Average difference	**8,300 cm**	
Variability coefficient	13,414%	**10,005%**
Value of „t"	**4,878**	
p	**significant <0,001**	

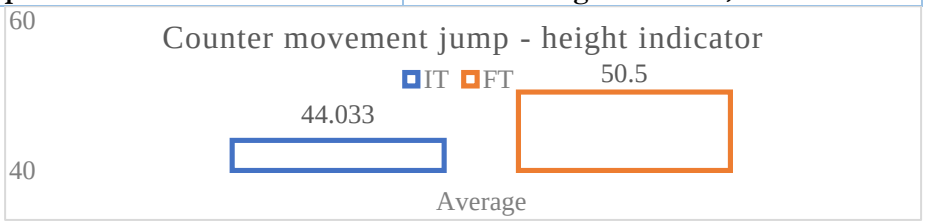


Figure no 2 „CMJ – height indicator" – chart of average means

The third test applied on **Kistler Force Measurement Platform - Quattro Jump v1.1.1.x.**, was **continuous jump with bent legs reference (CJbref)**, which describes the mechanical power of the lower body.

Analyzing the results obtained by the experimental group, we observe an average value at the initial test of 25.066 cm, a deviation of 2.896 and a coefficient of variability within the average homogeneity degree (11.553%).

At the final test, the research subjects recorded an average of 26.533 cm, thus obtaining a progress of 1.533 cm. The standard deviation had a value of 3.083, and the coefficient of variability 11.619%, also being at an average homogeneity.

The value of "t" for the experimental group is 1.202 (insignificant).

Table no.3 Results of the initial - final testing and the dynamics' evolution of the height indicator, for the "Continuous jump with bent legs reference (CJbref)" test

Parameters	**Experimental group**	
	T_1	**T_2**
Average mean	25,066	**26,533**
Standard deviation	2,896	**3,083**
Maximum	28,9	**30,2**
Minimum	18,1	**18,8**
Average difference	**1,533 cm**	
Variability coefficient	11,553%	**11,619%**
Value of „t"	**1,202**	
p	**insignificant**	

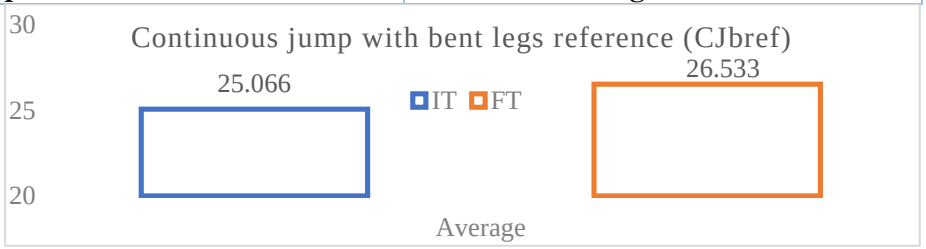


Figure no. 3 "CJbref – height indicator" – chart of average means

In the **jump with bent legs (CJB) test**, which involves the mechanical power of the lower body, the values obtained during the initial testing show us an average mean of 26.366 cm. At the final test, the tested athletes achieved a progress of 2.692 cm, so the average mean was 29.058 cm.

Regarding the coefficient of variability, it recorded an average homogeneity in the group subjected to the experiment (13.915%, 12.588%).

The value of the "t" test measuring the performance obtained by the experimental group at the initial and the final testing is 1.723, this value compared to that of "t" in the Fisher's table corresponding to the number of cases, in column n-1 = 11 for the significance degree of <0.05, tells us that the differences are statistically significant.

Table no.4 Results of the initial - final testing and the dynamics' evolution of the height indicator, for the "Jump with bent legs (CJB)"test

Parameters	Experimental group	
	T_1	T_2
Average mean	26,366	**29,058**
Standard deviation	3,669	**3,658**
Maximum	30,4	**33,3**
Minimum	17,7	**20,3**
Average difference	**2,692 cm**	
Variability coefficient	13.915%	**12,588%**
Value of „t"	**1,723**	
p	**significant <0,05**	

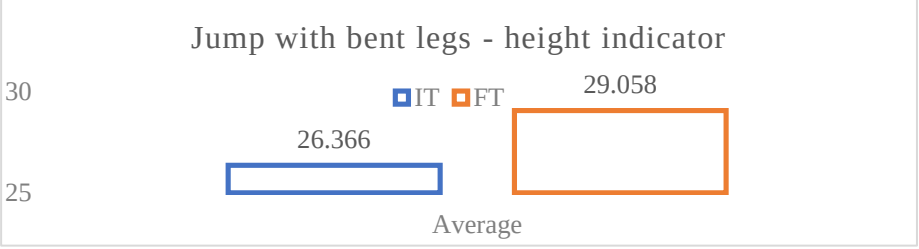


Figure no. 4 "CJB – height indicator" – chart of means

Another test applied on the platform was **the continuous jump with straight legs (CJS) (reset test)** which involves the evaluation of muscle elasticity for the leg extensors, the jumping technique and the tolerance to the extended impact, as well as the amount of fast fibers.

In this test, the experimental team obtained a progress of 2.871cm, the standard deviation had a value of 2.916, and the coefficient of variability shows an average homogeneity in the initial test (IT = 11.136%) and a high homogeneity in the final test (FT = 10.952%).

The value of "t" in Fischer's table is 2.185 (significant $p<0.05$) for the experimental group.

Table no. 5 Results of the initial - final testing and the dynamics' evolution of the height indicator, for the test "Continuous jump with straight legs (CJS) (test of reset)"

Parameters	**Experimental group**	
	T_1	**T_2**
Average mean	26,183	**29,05**
Standard deviation	2,916	**3,231**
Maximum	29,6	**33.1**
Minimum	19,7	**25,5**
Average difference	**2,867 cm**	
Variability coefficient	11,136%	**10,952%**
Value of „t"	**2,185**	
p	**significant <0,05**	

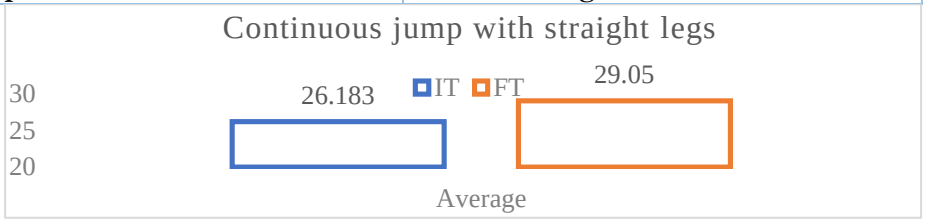


Figure no 5 "CJS – height indicator" – chart of average means

Discussions

The main idea of the hereby study it was how to use plyometric means in volleyball training, individualized according to the training period to improve the strength-speed capacity for show the big importance role of physical training in a multidimensional perspective.

The means aimed at improving strength-speed capacity through the implementation of specialized plyometric programs have been adapted to the objectives and requirements of each training period.

We can say if we consider that it is sufficient to increase the demands and workloads to systematically cause adequate adaptation of the body and, thus, the development of the sought-after physical quality, then we have a too simplistic approach. Such a system only works as long as the individual is able to withstand this accumulation of constraints; otherwise the training is not a linear phenomenon: it is characterized by periods of stagnation, regression, during which it is necessary, on the contrary, to lighten the workload to make them assailable for the athlete (González, 2013).

For this reason, it proves indispensable to foresee the forms of training through which we will avoid that the athlete would face different forms of fatigue (Drikos et al., 2019).

Also, a large number of authors believe that the purpose of any exercise used in preparation is to produce specific protein synthesis, which leads to the improvement of physical skills, formation of sports qualities and increase of the possibilities of mobilizing the motor potential which, in the end, have the effect of efficient manifestation of the performance capacity (Zatsiorsky et al., 2020).

This study is in accordance with another research (Bompa, 2003b), which shows that a proper systematization and rationalization of the means of preparation cover the needs of the volleyball game, also including the selection in relation to the dominant composition of motor qualities and preparation phase, so that players can reach their maximum potential, with an essential role in achieving performance.

Numerous authors believe that the strength-speed relationship can be developed through plyometric programs from the beginning of the training; the period of the actual work at each age will depend on the level of motor training of the athletes and the objectives of each training lesson. It is recommended that the main emphasis in the use of means for the development of strength-speed capacity be placed on the preparatory period of the annual sports training, although their application in the rest of preparation periods is not excluded (Loturco et al., 2015).

We mentioned another important aspect for this study, all participants gave their informed consent for participating in the study (were informed of the withdrawing possibility, with no other consequences on their status etc.), and we have individual form completed for each participant in the experiment.

Conclusions

In conclusion, we proceeded the application of exercises meant to ensure the development of the muscles of the upper limbs (improving the strength and power of arms for the attack and service shot), of the lower limbs (increasing power and explosiveness), of the back and abdomen, to show the big importance role of physical training in a multidimensional perspective.

Also, starting from the main scope we can say in conclusions the systematization and rationalization of the means of developing strength-

speed capacity must be selected according to the objectives of each individual training lesson, depending on the level of motor or technical-tactical training of the cadet athletes, depending on the training period the volleyball players are at, as well as the level of their sports training.

The training process of cadet volleyball players (15-17 years old), it is necessary to pay more attention to the development of an effective and complex training plan, which contains effective methods and means appropriate to the specifics of training; they contribute to increase the motor potential in general and the level of strength – speed ability, in particular.

The results of this study through the use of specialized plyometric programs during training, we have improved the strength-speed capacity of cadet volleyball players (15-17 years old), by improving their indices. The values obtained at the final evaluations of the applied tests, aimed by the proposed programs, increased in percentage by a value between 7% and 25% in the group subjected to the experiment.

The main conclusion for our study is, if we use a specialized plyometric programs in the training of cadet female volleyball players (15-17 years), will determines a faster and more extensive development of general physical training, ensures a good rest for the athletes and reveals a more efficient use of the time allocated to the training.

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