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Director: Fernando Emilio Valladares Fuente

Email: fernando.valladares@upr.edu.cu

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Original article

Analysis of vertical jump of first category volley ball players

Análisis del salto vertical de voleibolistas de primera categoría

Análise do salto vertical de jogadores de Voleibol de primeira classe

José Carlos García Bohigas^{1*}  <https://orcid.org/0000-0002-5019-3774>

Yumilka Daisy Ruiz Loaces¹  <https://orcid.org/0000-0001-5571-3399>

Ídolo Gilberto Herrera Delgado¹  <https://orcid.org/0000-0003-3958-5774>

¹Cuban Sports Research Center (CIDC). Havana, Cuba.

*Corresponding author: josecgb95@gmail.com

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ABSTRACT

The jumping capacity in volleyball is closely linked to the force-speed capacity that players must possess to perform a wide number of jumps during a match. Hence, there are several questions of coaches to get their athletes to reach the top of the elite. The objective of the study presented is to analyze the indicators that influence the vertical jump with countermovement, for the improvement of physical preparation in volleyball player's first category of Havana, to be able to give treatment from the training session. For the acquisition of the data, a strength platform of German origin and the TEMPLO software with its respective Performance Analysis model were used. In this same order, descriptive statistics was applied to the data obtained, and the results are presented

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through graphs and tables, where the deficiencies in terms of jumping capacity for these players are shown, evidencing the lack of expertise in the transfer from the eccentric phase to the concentric and its result in the success of the game.

Keywords: Counter movement jump; Vertical jump; Volleyball.

RESUMEN

La saltabilidad en el voleibol está estrechamente vinculada con la capacidad de fuerza-velocidad que deben poseer los jugadores para realizar una amplia cantidad de saltos durante un partido. De ahí que sean diversas las interrogantes de los entrenadores para conseguir que sus atletas lleguen a lo más alto de la élite. El objetivo del estudio que se presenta versa en analizar los indicadores que influyen en el salto vertical con contramovimiento para el perfeccionamiento de la preparación física en jugadores de voleibol primera categoría de La Habana, para poder dar tratamiento desde la sesión de entrenamiento. Para la adquisición de los datos, se utilizaron métodos científicos tales como la observación, la medición con una plataforma de fuerza de origen alemán y el software TEMPLO con su respectivo modelo Performance Análisis y una entrevista a los entrenadores del equipo. En este mismo orden, a los datos obtenidos se les aplicó la estadística descriptiva y los resultados se presentan a través de gráficos y tablas, donde se muestran las deficiencias en cuanto a la capacidad de salto para estos jugadores, evidenciándose la impericia en la transferencia de la fase excéntrica a la concéntrica y su resultado en el éxito del juego.

Palabras clave: Salto con contra movimiento; Salto vertical; Voleibol.

RESUMO

A capacidade de salto no Voleibol está intimamente ligada à capacidade de força-velocidade que os jogadores devem possuir para executar um grande número de saltos durante uma partida. Assim, há várias perguntas que os treinadores têm de fazer a si próprios para garantir que os seus atletas cheguem ao topo da elite. O propósito do estudo aqui apresentado é analisar os indicadores que influenciam o salto vertical com contra movimento para a melhoria da preparação física dos jogadores de Voleibol de primeira categoria em Havana, a fim de poder proporcionar o tratamento a partir da sessão de treino. Para a aquisição dos dados, foram utilizados métodos científicos como a observação, medição com uma plataforma de força alemã e o software TEMPLO com o seu respectivo modelo de análise de desempenho e uma entrevista com os treinadores da equipa. Nesta mesma ordem, foram aplicadas estatísticas descritivas aos dados obtidos e os resultados são apresentados através de gráficos e tabelas, que mostram as deficiências em termos de capacidade de salto para estes jogadores, evidenciando a falta de habilidade na transferência da fase excêntrica para a fase concêntrica e o seu resultado no sucesso do jogo.

Palavras-chave: Salto com contra movimento; Salto vertical; Voleibol.

INTRODUCTION

The capacity to jump is one of the most important and determining qualities in several sports, within which volleyball is a great exponent, reflected in Cuban athletes, according to Henríquez, *García and Camejo, (2016)*. The vertical jump is present in numerous volleyball actions, hence its important role in the performance of the same, specifically



in the jump serve, the spike and the block, generating more options in obtaining the point, an aspect that affects the final performance of a volleyball player, along with other factors such as size, technical and tactical ability, temperament and physical performance. Maximum height in a single jump and jumping endurance are two elemental aspects for a volleyball player. A player of medium height can have the same reach as a taller player if he/she jumps higher (Castañeda and García, 2020).

Jumping in volleyball is of vital importance and is present in almost all game actions. For this, it is necessary to improve biomechanical variables, such as flight height, flight time, jump speed and power, that is, combination of speed and strength, Portela, Rodriguez and Pérez, (2018).

It is necessary to insist on the development of the vertical jump in volleyball, which despite being a subject of notable studies in many countries and from the perspective of training, it becomes one of the priority objectives for coaches of the aforementioned sport. It is in full agreement with Sánchez and Floría (2017), when they state that the improvement in vertical jumping is a common goal, both for researchers and for coaches and physical trainers of different sports modalities. The possibility to jump higher than the opponent can be a reason for success in athletic competitions, as well as an advantage over an opponent in team sports. In this same order, one of the conditioning factors demanded by the game of volleyball for all levels or sport categories is the power for the vertical jump. Without this condition, which is influential in four of the six elements of the game, players would be very limited in their technical-tactical actions, putting at risk the competitive results. This should be analyzed from a biological dimension, taking as indicators the parameters related to the physical performance of volleyball players, specifically analyzing the jumping strength, since it is a determinant game action for the sport Luarte; González and Aguayo, (2014).

The sport under study is developed in a complex way; when it is manifested in relation to the development of motor and functional capacities, there is a predominance of speed-strength endurance and coordination movements. The fundamentals of execution performed are of acyclic character and the combination of them is difficult to connect. There is a constant variation in the duration and capacity of the exercises, movements of different intensities, jumps, displacements, ball strikes that vary continuously during the game, Herrera (2015). The reason for the research presented is given by the unfavorable competitive results achieved by the first category team of Havana, which are closely related to the reality that shows the vertical jump in the set. Thus, diagnostic tests were applied and it was possible to detect the low levels of power that they present in the lower limbs, exhibiting very low heights in the vertical jump tests with one hand, as well as the low endurance of these throughout the game.

In addition, high contact times were observed with respect to the neuromuscular demands that must be met to perform the jumping action in the exercise of the Bosco Countermovement Test (CMJ).

What has been exposed up to this point directs the research to analyze the indicators that influence the vertical jump with countermovement for the improvement of physical preparation in volleyball players, first category, in Havana, as the objective of the study presented.



MATERIALS AND METHODS

Context and participants

The volleyball team under study is composed of 12 players. Of these, two are setters, four are receiving attackers, three are middle or first time attackers, two are diagonals or opposite the passer and one is a libero. The average age of these players is 23 years old. Of these, 82 % belonged to the Eide (Basic Sport School); of them, 4 entered the national pre-selection in youth categories. All of them are first category players representing Havana.

Methodology

The variable to be transformed in this research is identified as jump capacity, which is nothing more than the: complex quality of a ballistic explosive technical gesture, conditioned by a neuronal impulse that develops an immediate strength against the ground, from an individualized neuromuscular coordination in the shortest possible time, conscious of the action being performed.

In the process, technical ability was identified and defined as dimensions to achieve an approach to the reality that was researched: the level of technical execution that athletes should possess in attack, blocking and suspended serve, in correspondence with the experience acquired in their sports practice, which has to be complemented with *physical condition, where the behavior of performance indicators, speed, leg strength, coordination, flexibility and special endurance are specified.*

The above dimensions make it possible to assess the development achieved in the jumpin capacity and, at the same time, to establish the indicators, sub-indicators and evaluation criteria from which the questions shown in each instrument emerge.

In order to process the information, it was necessary to establish three levels of athletes' jumping capacity:

- High level of jumping capacity: composed of two categories, very adequate and adequate. (MA)
- Medium jumping capacity level: categorized as adequate. (A)
- Low jumping capacity level: composed of the categories of inadequate and unsuitable. (PA)

The identification of the previous levels of jumping capacity leads the researcher to judge the results of the diagnosis from an integrating position, where the deficiencies, insufficiencies and difficulties are identified, but also the potentialities and strengths of the subjects investigated in their sports practice.

The observation method is applied with the use of the registration model designed by the Cuban Volleyball Federation, which allows the recognition of the influential variables of the volleyball player's technical-tactical performance, assigning the symbols established to evaluate (+, -), as appropriate, the actions of the technical-tactical fundamentals of volleyball. Four competition games were observed where attention was paid to the indicators established in the research.



In this same order, the measurement method was applied, using the *Bosco Test*, a German strength platform and the *TEMPLO* software with its respective Performance Analysis model, where it was possible to corroborate the state of alactic anaerobic power in the athletes studied.

In addition, it was necessary to interview the coaches in order to know their work experience and the way of conducting the training to obtain the triumph, without damaging the quality and performance of the athlete.

RESULTS

The main difficulties shown in the observation carried out in the competition stage confirm that it is not possible to maintain the performance of the athletes in the competitive stage; that there is insufficient work for the development of jumping capacity in the training unit, it is showed insufficient work for the development of flexibility in the training unit and it does not seem to be take into account the results obtained or the evaluation of the pedagogical tests (Table 1).

Table 1. - Results of the dimensions and indicators in the observation

Variable	Dimensions	Criteria	MA	A	PA	I
Jumpcapaci	1	1.1.1	0	0	8	40
		1.1.2	0	0	16	32
		1.1.3	0	0	8	40
	2	1.2.1	0	0	8	40
		1.2.2	0	0	12	34
		1.2.3	0	0	16	32
Media					11,3333	36,3333
Standard deviation					3,93277	4,08248

Symbology: MA: Very Adequate, A: Adequate, PA: Poorly Adequate, I: Inadequate

The results of this instrument show that there are insufficiencies in all the established indicators and dimensions, highlighting as major difficulties that are not accentuated in their totality: the aspects of the work of the physical capacities, the treatment of methods and procedures attending to the current volleyball trends and the contextual needs of the territory, the advances and potentialities in the achievement of the sport, do not allow them to carry out a correct physical preparation of their athletes. Weak personalized attention to the athletes with perspective for the ascent to high performance (projective). In relation to this, there is insufficient treatment on the basis of the work of jumping capacity, *weak treatment to flexibility, not enough attention is given to the treatment of pedagogical tests*, including their evaluation and follow-up. It was necessary to apply the *Bosco test*, hence the most significant results (Table 2).



Table 2. - Results of the variables of Bosco's test used in the first category volleyball team of Havana

Indicator	PC	ABK	CMJ	SJ	CE	CC	DJ	TC	TV	RS
X =	87.7	55.2	43.2	37.2	6.21	11.80	55.3	0.314	0.670	1.84
D.S =	6.30	3.99	3.98	4.22	1.83	2.80	6.48	0.160	0.140	

Legend: Pc: body weight ABK: Abalakow CMJ: counter and movement and jump SJ: squat 90° flexion and jump CE: elastic capacity DJ: jump from different heights. TC: contact time. TV: flight time RSI: reactive strength.

This test is applied as a diagnostic to be able to make the training plan and the results will allow planning loads to develop the optimal ratio of the braking impulse and acceleration impulse phase and the reactive strength index in the vertical jump with countermovement in the volleyball players of the study sample.

It is also necessary to take into account the control of training in terms of the loads received, their psycho-functional-motor, technical-tactical and competitive effect, which, translated into the specialized physical preparation dimension, refers to: vertical reach with one-handed running, levels of manifestation of the different types of strength, such as: maximum, fast, explosive, isometric and endurance and resistance to fast strength.

It is also necessary to keep in mind the work to be accomplished in the speed, in segments up to 60 meters, in addition, in the work for the endurance as conditional capacity, including the motor skill through the mediation of the sports called auxiliary for the game of volleyball such as basketball and soccer and one of the most important aspects the work regarding the coordinative capacities and flexibility, which become in other neuromuscular manifestations such as: elastic capacity of the muscle, the reactive capacity, of synchronization of the muscle fibers, capacity to inhibit the protection mechanisms of the muscle, originating an action potential that happens in a vertical jump level, influencing all this process in the braking impulse phase and the acceleration impulse. The table shows that the CMJ and SJ values are lower than the requirements of a volleyball player, highlighting the need for intervention in them.

In correspondence with the information acquired, an interview was conducted with the trainers, revealing that the use of methods and procedures for technical, tactical and physical work in the training unit is incorrect; they refer to poor application of varied methods for the development of flexibility, an important element for jumping, insufficient application of methods for the development of speed, as well as insufficient treatment of explosive strength and its incidence on jumping capacity. They also refer incomprehension for the correct formulation of the physical objectives in the training unit, difficulty in the evaluation of the pedagogical tests, which limits the projection of the objectives, according to stages in the preparation of the athlete.

The elements analyzed allow attention to be paid to the most marked difficulties in the pedagogical, technical and methodological areas.



By establishing a methodological triangulation of the results described in the analysis of the instruments applied as part of the research process and as an expression of the systemic approach method in this area of research, the need for a transforming intervention is visible in the results of the instruments applied.

DISCUSSION

Current trends, according to the literature consulted, revolve around working with plyometric training to improve the indicators studied. However, it is necessary, before starting with plyometric training, to take into account the following precisions, recommended by (Muñoz, I. *et al.*, 2020), about a biomechanical evaluation and various pedagogical tests, the stability test, flexibility, both at a general and specific level, knowing that horizontal movements generate less trauma than vertical ones, the weight of the athlete, the amount of external load that is added as it can slow down the training by growing transversely the muscle and prevent the jumps to be performed with the required speed, the age is directly proportional to the intensity of the training, to name a few.

Many sports disciplines require high explosive strength production to perform some of their actions, such as for vertical jumping, (Picón, M. *et al.*, 2017). In this sense, in a recent review, Martínez, A., *et al.*, (2017) have highlighted the importance of vertical jump performance in volleyball, becoming necessary an adequate training and optimization of this capacity.

It is of vital importance the use of *plyometric training as a* fundamental part in the sports performance of volleyball players, according to (Fatouros, *et al.*, 2000); (García, *et al.*, 2016). This is related to reactive strength and stretching shortening cycle and the most appropriate methods to improve with vertical jumps, horizontal jumps and jumps in depth or drop jump, (Byrne, *et al.*, 2017).

It should be noted that although the accepted way to measure power in lower limbs is the Bosco CMJ jump test, because it is used for any study and for its simplicity of execution, the importance of the approach run prior to the jump cannot be ignored, nor the Abalakov jump (ABK) due to the movement exerted by the arms during the jump (Battaglia, *et al.*, 2014); (Flores, *et al.*, 2015). However, this relationship with the actual gesture of jumping in volleyball and due to the difficulty of repeating the conditions of the studies with these jumps, in which not only influences the capacity to generate strength, but the technique of each player, the relationship between the CMJ and the different jumps in volleyball is accepted as the best way to measure the achievements obtained from the EP (Ziv and Lidor, 2010).

Hence, with the culmination of a training process of the qualities of coordination, strength and speed, it allows the volleyball player to perform more efficient accelerations, that changes of direction can be performed more quickly, be more explosive in ballistic movements, be more skillful in the execution of jumps and throws, in short, be faster in general terms.



Therefore, plyometrics can be worked for the lower limbs, as well as for the upper limbs, obtaining great results. In this case, when evaluated in volleyball, reference is made to that of the lower limbs since it is related to the greater demands of the sport.

It is in full agreement with **Acero (2018)**, when he states...

"to be successful in sports, reactive strength and power are one of the most important characteristics. To optimally train these qualities, it is necessary to evaluate correctly, aiming at the sport discipline", emphasizing that for this the well-known *Bosco Test* is used, as one more tool.

Reactive strength is the capacity to absorb strength in one direction and apply more strength in the opposite direction or, what is the same, the capacity to change quickly from an eccentric action to a concentric action; its training has a direct transfer to speed, vertical jump and long jump, provided that the following phases are met: fast eccentric action, a short coupling phase and intense muscular action. Hence, the reactive strength index, which as mentioned above, provides the relationship between the contact time and the height reached in the jump, **Acero (2018)** proposes the use of the Reactive Strength Index (RSI) as a tool for monitoring Plyometric exercises.

The RSI, when used as a means of monitoring the load, allows a correct planning of plyometric training which, as it has been observed, fulfills a revealing objective within the preparation for volleyball athletes, since it is not only taken into account for the intensity of plyometric training, but the work must be well controlled since otherwise it can cause injuries in athletes. Regarding the study of the strategies used for the benefit of the aforementioned components in obtaining a high and sustained vertical reach with running, which have to do directly with the quality of the final product called jumping capacity, in the Cuban Sports Research Center, several researchers have been carried out concerning the planning of explosive ballistic type loads in the work with alterations between 70 % and 80 % of 1RM and other types of multiple jumps to produce a better vertical jump with the use of the Plyometric method.

The vertical jump is probably the most relevant power *test* protocol for the Volleyball player because it is a crucial skill of the sport (**Lidor and Ziv, 2013**). **Vargas (2008)** conducted a study with 12 college Volleyball players, where the jump *test* from squat (SJ) and countermovement jump (CMJ) were used considering a pretest and posttest after an intervention of a Plyometric training program. They found values in SJ 39.9 cm. (pretest) and 41.1 (posttest) and in CMJ 44.2 (pretest) and 46.4 (posttest). In turn, **Luarte and González (2014)** provide evidence with 12 female volleyball players belonging to the first volleyball team of the German Sport Club of Concepción, in which the SJ, CMJ and Abalakov (ABK) *tests* were used as measurements, as well as the elasticity index (ratio of values between the SJ and CMJ) and the index of the use of the arms (ratio of values between the CMJ and ABK). The female players were selected by playing position, the values found on average were 23.08 cm. (SJ), 28.50 cm. (CMJ) and 32.90 (ABK), with an average elasticity index (IE) 23.50 and arm utilization (UB) 15.54. Cuban volleyball has the potential to be a protagonist at the international level, as it has a significant physical amplitude.

The results obtained in this research correspond to the study of (**Ruiz Loaces, Y. 2017**), where a special competitive mesocycle is proposed for the increase and stability of the capacity that occupies in volleyball players of the Cuban national team, during ten microcycles before participating in the Olympic qualifier Rio 2016, which achieved surprising results.



It is in total agreement with (García, Herrera and Barrera, 2016) when they state that the volleyball player must be prepared to perform a large number of actions per game, very fast displacements, travel distances in repeated interventions, with violent changes of direction and sudden stops. Most of these actions are accompanied with jumps; these short and intense efforts are performed with the intervention of the neuromuscular system and anaerobic energy mechanisms, predominantly the alactacid.

The volleyball player must be prepared to perform a large number of actions per game, very fast movements, covering distances in repeated interventions, with violent changes of direction and sudden stops. Most of these actions are accompanied with jumps, these short and intense efforts are performed with the intervention of the neuromuscular system and anaerobic energy mechanisms, predominantly the alactacid.

About the Physical Preparation for volleyball players, Herrera (2015) states that the basic strength (increased until the performance stage), the use of the different manifestations of strength, such as: explosive, elastic, reactive, increased work in the degrees of anaerobic power, high development of coordination skills, basic and special speed, as well as its endurance, the first will be built in the stages preceding the high performance, maintaining it with other methods that enable recovery for the competition of the microcycle. As for the special one, it will increase ostensibly, as a result of the demands of the transformations that will occur in this sport: Stability and potentialities in jumping and Increase of the degrees of psychic capacity to withstand the psychological stress of the competitions that will possibly be carried out with a new format in the dynamics of the game.

In addition, it is important to take into account the criteria of Cometti (2007), when estimating the values achieved because, in the case of being similar in CMJ and ABK, it may be due to a lack of motor coordination of the upper train towards the lower train.

Something similar occurs with (Blasco, et al., 2017), when they warn that there could be other variables that interrelate in their execution such as the type of training, motor control, movement technique, anthropometric profile, intramuscular coordination, fatigue levels, etc., that could influence these results.

It is in full agreement with (Poveda, et al., 2013), when they emphasize that the jumping mechanism is a complex movement that requires a complex motor coordination between the upper and lower segments. Jumping tests are a validated tool for the assessment of the healthy athlete or the athlete who completes his or her readaptation. It should be interesting to have reference records that indicate if a player is close to those values and can return to competition, obviously, among other characteristics. It is also a great tool to evaluate lower limb power and to be able to design intervention strategies, which is the objective of the present work.

Hence, it can be considered for the planning, with perspective character, the direction that the physical preparation should take as a fundamental pillar of the Cuban school of male volleyball, the incorporation of technologies to the mentioned athletic base for the correct use of the plyometric method, which has evidenced in the population of Cuban volleyball players a high development of the capacity of vertical jump with running and its implementation on a large scale within the game.



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The authors declare not to have any interest conflicts.

Authors' contribution:

José Carlos García Bohigas: Conception of the idea, instrument making, statistic análisis, preparation of tables, graphs, and images, database preparation, review and final version of the article, article correction, authorship coordinator.

Yumilka Daisy Ruiz Loaces: Literature search and review, instrument making, compilation of information resulting from the instruments applied, statistic análisis, database preparation, drafting of the original (first version), review and final version of the article, translation of terms or information obtained, review of the application of the applied bibliographic standard.

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