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Analysis of the Abalakov jump using a dynamographic platform in Cuban male volleyball players

Análisis del salto Abalakov mediante una plataforma dinamográfica, en voleibolistas masculinos cubanos

Análise do salto de Abalakov utilizando plataforma dinamográfica em jogadores de voleibol masculino cubanos

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ABSTRACT

In volleyball, one of the determining factors for performance is jumping power. Technical elements such as blocking, attacking, tennis serve, and jump floating often depend on the potential of the lower extremities to solve technical and tactical problems. Therefore, their



control and evaluation are essential in the planning and execution of the training process. For this purpose, the Bosco test is frequently used, among whose variables is the Abalakov test. The objective of this research was to describe the values of the indicators of the Abalakov test variable in top-level male volleyball players from Havana. To this end, a study was conducted in 2022 on 16 top-level male volleyball athletes from Havana, using a dynamic platform. The main research methods and techniques from theoretical level were analytical-synthetical, inductive-deductive and the comparative one, and from the empirical level, document analysis and measurement, as well as descriptive statistical methods. Descriptive statistics, reflected in tables, and multiple correlation of the data resulting from the Abalakov jump test were applied to the data obtained. The results were evaluated using Herrera's (2010) international reference scale. Significant results were obtained in Abalakov, with an average height reached of $0.58 \text{ m} \pm 0.05 \text{ m}$, with 10 volleyball players above the average, of which 6 generated more than 0.10 m of gain in arm coordination.

Key Words: Power of the lower extremities, jump, Abalakov test variable, volleyball

RESUMEN

En el voleibol, una de las capacidades determinantes del rendimiento es la potencia de salto, y los elementos técnicos como el bloqueo, ataque, saque de tenis y de floting en salto, en muchas ocasiones dependen de la potencialidad de las extremidades inferiores para resolver problemas técnico-tácticos; por lo que su control y evaluación es indispensable en la planificación y ejecución del proceso de entrenamiento. Para ello, es muy recurrente el uso del test de Bosco, entre cuyas variables se encuentra el test de Abalakov. El objetivo de esta investigación fue describir los valores de los indicadores de la variable del test de Abalakov, en voleibolistas masculinos de primera categoría de La Habana. Para ello, en el año 2022, se realizó un estudio a 16 atletas mediante el uso de una plataforma dinamográfica. Los métodos y técnicas principales de investigación utilizados del nivel teórico fueron el analítico-sintético, el inductivo-deductivo y el comparativo; del nivel empírico, el análisis de documentos y la medición, a los datos obtenidos se les aplicó la estadística descriptiva reflejada mediante tablas y la correlación múltiple de los datos. Se



obtuvieron resultados significativos en el Abalakov, con un promedio de altura alcanzada de $0.58 \text{ m} \pm 0.05 \text{ m}$, con 10 voleibolistas por encima del promedio, de ellos seis generaron más de 0.10 m de ganancia en la coordinación de brazos.

Palabras Clave: potencia de los miembros inferiores, salto, variante del test Abalakov, voleibol

RESUMO

No voleibol, uma das habilidades determinantes do desempenho é a potência do salto, e elementos técnicos como bloqueio, ataque, saque e flutuação do salto frequentemente dependem do potencial dos membros inferiores para resolver problemas técnicos e táticos. Portanto, seu monitoramento e avaliação são essenciais no planejamento e execução do processo de treinamento. Para tanto, utiliza-se frequentemente o teste de Bosco, cujas variáveis incluem o teste de Abalakov. O objetivo desta pesquisa foi descrever os valores dos indicadores da variável do teste de Abalakov em jogadores de voleibol masculino de alto nível de Havana. Para tanto, foi realizado um estudo com 16 atletas em 2022, utilizando uma plataforma dinâmica. Os principais métodos e técnicas de pesquisa utilizados no nível teórico foram analítico-sintético, indutivo-dedutivo e comparativo. No nível empírico, análise documental e mensuração, foram aplicadas estatísticas descritivas aos dados obtidos, refletidas em tabelas e correlação múltipla. Resultados significativos foram obtidos no teste de Abalakov, com altura média alcançada de $0,58 \text{ m} \pm 0,05 \text{ m}$, com 10 atletas de voleibol acima da média, seis dos quais geraram mais de 0,10 m de ganho na coordenação dos braços.

Palavras-chave: potência de membros inferiores, salto, variante do teste de Abalakov, voleibol



INTRODUCTION

Jumping capacity is a fundamental indicator for assessing the specific physical preparation of any athlete. This ability is significantly influenced by other physical capacities, such as flexibility, coordination, strength in its various forms, and speed.

These factors are crucial in the use of explosive strength during any movement. In volleyball, jumping capacity is closely related to the strength and speed players must possess to perform multiple jumps throughout a match. For this reason, coaches face various questions about how to help their athletes reach the highest elite level (García et al., 2021).

The vertical jump is a crucial component of volleyball, present in numerous game actions, playing a vital role in technical performance, especially in situations such as spiking and blocking; but also, in serving and passing actions, the higher the jump, the more scoring opportunities it generates.

For this reason, jumping in volleyball has been the main subject of numerous studies and, from a physical training perspective, has become one of the priority objectives for coaches. Jumping is a basic ability inherent to the human species that involves taking off from the ground, where the body remains momentarily suspended in the air. Jumping is understood as a movement that requires taking off from the ground with both legs (Larovere, 1999, as cited in Pérez et al., 2022).

According to Herrera (2020), among the specific physical abilities required by volleyball players, the vertical jump with a run is undoubtedly the most decisive for achieving adequate preparation. This ability requires optimal levels of strength, speed, coordination, and flexibility, all of these interrelated capacities, for the effective production of muscular power in the lower limbs. Each sport implements methods and tests to evaluate them, in order to adjust the necessary physical aspects during the different phases of training planning.

One of the most recognized tests in the world for evaluating jumping ability is the one created by Bosco. This researcher has been one of the authors who has most deeply studied



this motor ability. He himself designed the test that bears his name in 1983, which brings together a series of exercises with individual characteristics each.

Portela et al. (2022) point out that numerous studies conclude that there is no accepted test for evaluating anaerobic power. For this reason, it is recommended to avoid referring to the energy source or capacity required, as well as the strength used in said activity. Instead, it is more appropriate to focus on the mechanical manifestation or external expression of movement, such as jumping ability, which is fundamental to modern volleyball.

In this regard, Castañeda and García (2020) indicate that volleyball has been the subject of numerous studies focused on evaluating athletes' jumping ability, with the aim of making accurate diagnoses of their performance. Furthermore, they emphasize that jumping is a multi-joint action that requires not only high levels of strength, but also adequate motor control, as well as effective intramuscular and intermuscular coordination.

Therefore, it is crucial to understand and optimize these aspects, as they are essential to improving player performance and maximizing their potential on the court.

Similarly, Castro et al. (2023) present a methodology aimed at increasing jumping capacity, using basic exercises that coincide with those used in the evaluation tests. The results obtained are highly significant, reinforcing the idea that increasing vertical jump requires designing highly specific exercises that directly affect the components and influence the activation mode and the quality being examined.

Improving the components of physical preparation at high-performance levels for volleyball becomes a fundamental link for athletic success. Adequate training improves individual abilities and enhances the team's collective performance (García and García, 2023).

In this context, the assessment of physical fitness variables is essential in the process of planning and periodizing physical loads to achieve high levels of performance. Assessing power and explosive strength in athletes is a key component for optimizing athletic



performance in disciplines such as volleyball, where these physical capacities are crucial for executing technical abilities.

In this sense, Abalakov Jump Test (ABK) is a valuable tool, as its fundamental purpose is to assess explosive strength and maximum power of the lower extremities. Named after the scientist who first introduced it in 1938, this test provides crucial information about a player's physical condition.

This research arose from the need to analyze the vertical jump variables that affect the performance of male volleyball athletes in Havana, in collaboration with the Cuban Sports Research Center (CIDC in Spanish). This initiative is integrated into the load control process during the implementation of a training mesocycle, which facilitates the adaptation and customization of interventions according to the specific needs of the team.

Abalakov jump (ABA in Spanish) was selected as a fundamental tool for this assessment, given its close connection to the most important technical actions in volleyball, such as attacking, blocking, and serving. The effective execution of these abilities depends largely on the explosive capacity of the lower limbs, making the ABA a critical indicator of a player's physical potential. Therefore, the objective is to describe the values of the ABK variable indicators in top-level male volleyball players from Havana.

MATERIALS AND METHODS

To conduct the ABA analysis of male volleyball players from Havana, the test was conducted on July 11, 2022, at 9:00 a.m., on the court of the Manuel Fajardo University of Physical Culture Sciences (UCCFD in Spanish).

To obtain the data, a German-made Kraftmessplatte - Contemplas dynamographic strength platform was used, with a 3D calibration system, equipped with two high-frequency cameras that allowed real-time observation of the athlete's jump execution.



The collected data was transmitted to a state-of-the-art laptop, where specialized software called TEMPLO was used, along with the Performance Analysis model. This software made it possible to measure the athlete's neuromuscular characteristics during the test in real time.

The various indicators analyzed were processed using formulas integrated into the software, which facilitated obtaining accurate and relevant results on the jump's performance.

The study population consisted of 16 volleyball players from the experimental group of the Lower Extremity Strength project. All participants were top-level players; 94% were trained at the Comprehensive Sports School (EIDE in Spanish), most of them from the province of Havana. Forty-three percent had been involved in high-performance sports at some point in their athletic careers. The average age of this population was 25 years, ensuring they were at an optimal stage for the evaluation of physical and technical performance.

As part of the jump assessment protocol at the Center for Sports Research and Development (CIDC), four jumps corresponding to Bosco's original test (1983) were performed. Each of these jumps provided a series of specific values that, when combined with other jump-related variables, allowed for the generation of complex variables due to the interaction between them.

To carry out the Bosco Test, fundamental aspects were considered, such as:

- Load regulation, a minimum period of 48 hours was established before the test in a low to sub-medium intensity zone.
- Minimize the number of jumps performed in other training sessions during those days.
- Prohibition of jumping 24 hours before the test.
- Rigorous control of pedagogical tests and the workload at that time.
- Information provided to the athlete about the test and its importance, at least two microcycles beforehand.



The results obtained were analyzed using various theoretical methods to arrive at precise conclusions. Furthermore, observations during warm-ups and technical performances revealed key aspects for describing the variables studied in this research.

Table 1 shows the jumps in the Bosco test, in the Abalakov variable (ABK).

Table 1. Bosco Test jumps on the platform

EXERCISES	Quality examined	Activation mode
Squat Jump (SJ)	1-Explosive strength. 2- Nervous recruitment capacity. 3-Expression in % of FT fibers.	-Concentric work
Countermovement Jump (CMJ)	Elastic-Explosive-Reactive Strength. 2-Nervous recruitment capacity. 3-Reuse of elastic energy.	-Elastic-Explosive-Reactive.
Abalakov (ABK)	Elastic-Explosive-Reactive Strength. 2-Nervous recruitment capacity. 3-Reuse of elastic energy. 4-Arm coordination.	-Elastic- Explosive-Reactive.
Drop Jump (DJ)	Elastic-Explosive-Reactive Strength.	-Elastic-Explosive-Reactive

Methodology:

The ABA is a high vertical push-up, starting from an upright position with the help of the arms, then moving downwards until reaching a 90° knee flexion. The capacity examined was elastic-explosive-reactive strength, nerve recruitment capacity, elastic energy reuse and arm coordination, being the Elastic-Explosive-Reactive activation modality. The arm utilization index (IUB (%)) was obtained from the difference between the ABA and CMJ, multiplied by 100 and divided by the CMJ, $(ABA-CMJ \times 100 / CMJ)$

This jump, due to its execution, closely resembles volleyball movements, such as the attack, block, pass, and jump serve, where the arms are used to gain energy during this motor action. This approach, from a biomechanical perspective, is known as leveraging the kinematic chain.



From the data provided by the platform in the jump (Abalakov) six variables were chosen from 20 possible for the present article.

- 1- Knee flexion angle at the lowest point: Bosco (1990) suggests that the ideal angle that develops the greatest strength is 90°, while Zanón (1990) delimits the optimal range of flexion for the vertical jump at 90-120°.
- 2- Force development ratio (FDR) N/s: This is the proportion, rate, or speed of strength development. The higher the value, the greater the recruitment of motor units in the movement.
- 3- Height (ms): A higher height indicates better utilization of the stretch-shortening cycle. In this case, this height is measured by the flight time. Using the equation (Bohigas, 2019, p. 37)

$$h_t = \frac{1}{2} g \left(\frac{t_v}{2} \right)^2 = \frac{g(t_v)^2}{8}$$

- 4- Maximum speed (m/s): This indicates the speed achieved during the concentric movement. The greater the speed, the more likely the athlete is to transfer the mechanical energy into the height of the jump.
- 5- Reactive Strength Index (RSI): for training to be truly effective, it is essential to correctly determine this value, Gutiérrez et al. (2015) . It is calculated from the height reached in the vertical jump, between the contact time prior to takeoff.
- 6- Arm Coordination: It is the relationship in centimeters of the use of the arms for the vertical jump (Castro et al., 2023) .

RESULTS

Table 2 presents the correlation between the variables selected for this research, providing a detailed analysis of the relationships between the knee flexion angle at its lowest point, ground reaction strength (RDF in Spanish), jump height, maximum speed achieved, explosiveness index (RSI), and jump capacity (CB). The correlation coefficients obtained offered insight into how these variables interacted with each other, which was critical to understanding the factors that influenced jump performance.



Table 2. Correlation between the variables chosen for the research

Correlation coefficient						
	Knee flexion angle lowest point	RDF (N/s)	HEIGHT (m)	Max. Speed (m/s)	RSI	CB (m)
Knee flexion angle lowest point	x	-0.162	0.157	0.333	0.451	-0.101
RDF (N/s)	x	x	0.295	0.250	0.169	0.145
HEIGHT (m)	x	x	x	0.835	0.671	-0.154
Max. Speed (m/s)	x	x	x	x	0.512	-0.507
RSI	x	x	x	x	X	0.285
CB (m)	x	x	x	x	X	x
IUB (%)	x	x	x	x	X	x

Examining the correlation coefficients presented in the table, it was evident that the knee flexion angle at its lowest point showed a weak negative correlation with jump height (-0.101) and a moderate positive correlation with the explosiveness index (RSI) (0.333). This suggested that an increase in flexion angle may have been associated with a slight decrease in the height achieved, while a higher RSI was related to better jump performance.

On the other hand, ground reaction strength (GRF) showed moderate positive correlations with both jump height (0.835) and maximum speed (0.512). This indicated that greater GRF and speed were strongly linked to an increase in jump height. However, a moderate negative correlation was also observed between GRF and jump capacity (-0.507), suggesting that as the strength generated during takeoff increased, there may have been a decrease in jumping capacity.

Maximum speed showed a strong correlation with height reached, which was justified by the fundamental role of speed as a key component of power. Although RDF did not show a significant relationship with any of the variables studied, it was important to highlight that



motor unit recruitment influenced muscle response speed, as these units are adapted to this type of work.

The RSI emerged as the variable most closely related to the other six variables analyzed, due to its direct interaction with contact time and height. The results indicated that athletes with an RSI greater than 0.700 ms achieved heights greater than 0.60 cm, which placed them within the medium or upper range of the international reference scale proposed by Herrera (2010).

Meanwhile, table 3 presents the results obtained from the men's volleyball team in the analysis of variables specific to jumping and ABA physical performance. Data on the lowest knee flexion angle, ground reaction strength (GRF), height reached, maximum speed, explosiveness index (RSI), and jump capacity (CB) for each athlete were included, as well as descriptive statistics summarizing the group's overall performance.

Table 3. Results of the (ABA) in the men`s volleyball team

Athletes	GAME FUNCTION	ABA-specific variables					Combined Variables
		Knee flexion angle lowest point	RDF(N/s)	Height (m)	Max Speed (m/s)	RSI	
1	CENTRAL	77.1	53011	0.53	3.28	0.523	0.10
2	ASSISTANT	71.2	44761	0.64	3.33	0.752	0.18
3	OPPOSITE	92.3	17176	0.61	3.48	0.726	0.06
4	PIN	72.7	15771	0.52	3.05	0.532	0.14
5	PIN	87.5	12341	0.58	3.48	0.631	0.08
6	OPPOSITE	72.6	18268	0.65	3.52	0.730	0.07
7	OPPOSITE	63.2	12738	0.53	3.08	0.470	0.08
8	ASSISTANT	80.6	53560	0.62	3.54	0.830	0.09
9	OPPOSITE	67.4	62291	0.61	3.47	0.480	0.05



10	CENTRAL	73.5	11699	0.54	3.29	0.48 3	0.07
11	ASSISTANT	72.4	8196	0.50	3.19	0.490	0.09
12	ASSISTANT	71.3	19179	0.59	3.35	0.605	0.10
13	ASSISTANT	83.4	15981	0.53	3.06	0.512	0.11
14	ASSISTANT	83.0	12413	0.63	3.59	0.634	0.05
15	ASSISTANT	73.2	16030	0.62	3.48	0.654	0.07
16	ASSISTANT	82.5	23685	0.58	3.28	0.873	0.14
AVERAGE		76.5	24819	0.58	3.34	0.620	0.09
MEDIAN		73.4	16603	0.59	3.34	0.618	0.09
MODE		#N/A	#N/A	0.53	3.48	#N/A	0.07
MAXIMUM		92.3	62291	0.65	3.59	0.873	0.18
MINIMUM		63.2	8196	0.50	3.05	0.470	0.05
STANDARD DEVIATION		7.72	17698	0.05	0.18	0.131	0.04

When analyzing the results of the Abalakov test in the men's volleyball team, presented in table 3, it was observed that the average knee flexion angle was 76.5°, with a range that varied between 63.2 and 92.3°, which suggested considerable variability in the jumping technique among the athletes.

The average ground reaction strength (RDF) was 24,819 N/s, with a notable maximum of 62,291 N/s being reached in one of the players, indicating that some athletes generated significantly more strength during take-off, which positively influenced their performance.

Regarding the height reached, the average was 0.58 cm with a maximum of 0.65 cm; although some athletes achieved notable heights, there was room for improvement. The maximum average speed recorded was 3.34 m/s, with a range between 3.05 m/s and 3.59 m/s, crucial for optimizing performance in jumps and attacks. The average burst index (RSI) was 0.620 ms and showed notable variability, with a maximum reached of 0.873 ms; this was crucial for evaluating the players' explosiveness and reactive capacity.

However, jump capacity (BC) presented a low average (0.09 m). It was also observed that, regarding the recommendations by Bosco and Zanon (1983) regarding the best angles



(between 90° and 120°) for exerting greater strength during a jump, the athletes studied did not take them into account; although their lack of knowledge regarding the load levels and knee flexion technique used in squatting, as used in these recommendations, should have been taken into account.

A comparative analysis between athletes two and six revealed interesting differences: while athlete two had an RDF of 44.761 N/s and reached a height of 0.64 cm at a maximum speed of 3.33 m/s, athlete six had a lower RDF (26.493 N/s) but managed to take off at a slightly higher height (0.65 cm) and at a lower maximum speed (3.14 m/s), illustrating how speed could have dominated the increase in motor unit recruitment.

Finally, comparative ranges were established with other populations using the international reference table proposed by Herrera (2010), which allowed to better contextualize the results obtained in this study and highlight potential areas to improve team performance, through specific training.

Table 4 shows an international reference scale for different types of jumps, including the static vertical jump (SJ), the countermovement jump (CMJ), and the ABA. This classification is divided into five categories: High, Medium, Low, Very Low, and Extremely Low, each with specific performance ranges in centimeters.

Table 4 provided a comparative framework that allowed athletes' performance to be evaluated based on their jumping capacities, thus facilitating the identification of areas for improvement and the establishment of training goals. Using this scale, coaches and athletes were able to contextualize the results within an international standard, which was essential for optimizing physical and technical performance in explosiveness and power sports.



Table 4. International reference scale

Jump type (cm)	High	Average	Low	Very Low	Extremely Low
SJ	56 ≥ 60	50 - 55	45 - 49	40 - 44	35-39
CMJ	55 - ≥60	50 - 54	45 - 49	40 - 44	35-39
ABA	65 - ≥70	60 - 64	55 - 59	50 - 54	45 - 49

Prepared by Herrera (2010)

In the table, each athlete studied was evaluated according to the classification achieved:

- In the high category, one athlete (6)
- In the middle category, six athletes (2, 3, 8, 9, 14 and 15), of which four were only 2 cm away from each other, needed to reach the maximum performance scale in the jump.
- In the lower category, three athletes (5, 12, and 16) ranged in height from 58 to 59 cm. It's important to note that these three members were very young and played different positions on the team. Athlete 12, when he began his career in indoor volleyball, was part of the national beach volleyball team. Athlete 16, meanwhile, trained as a libero on the national junior team and stood out for his remarkable power in a position where jumping wasn't a key ability.

In the very low category, six athletes (1, 4, 7, 10, 11, and 13) achieved lower results in maximum speed during the movement in this study. These athletes had difficulties with speed and coordination work. The duration of contact time could influence the improvement in reactivation activity (RSI) and, in turn, the height reached when jumping, as explained above in the correlation of variables. Any exercise that promotes the recruitment of fast motor units (FT fibers) contributed to improving the vertical jump.

At the bottom of the classification ladder, there were no exponents in the team studied, which demonstrated an equality in the work on jumping ability in this population.



The CB and IUB in athletes 3, 5, 6, 9, 10, 14, and 15 should have improved; their gains were very poor compared to the sample itself, due to poor synchronization of specific movements during the gesture studied. An improvement in these aspects increases the likelihood that the gain in kinetic energy provided by the connection of muscle groups will be transformed into greater mechanical energy, which means greater height in the jump.

In this regard, it was considered that in a training process where the objective was the mobilization of fast-type muscle fibers to improve the vertical jump, the following scheme should be taken into account.

ESQUEMA DE LA MOVILIZACIÓN DE LAS FIBRAS MUSCULARES ANTE DIFERENTES ESTIMULOS PARA EL DESARROLLO DE LA POTENCIA PARA LA CAPACIDAD DE SALTO (Herrera 2021). Basado en el esquema de Gayton 2012

T. de Fibras	Tipo I	Tipo II a	Tipo II x	Tipo II b
Tiempo de contracción	Lento	Moderadamente rápido	Rápido	Muy rápido ***
% del estímulo	30-60	70-80	80- 90	100 ***
Tamaño de la motoneurona	Pequeño	Mediano	Grande	Muy grande
Resistencia a la fatiga	Bastante alta	Alta	Media	Baja ***
Tipo de Potencia	Baja	Media	Submáxima	Máxima
Máximo tiempo de uso	2 – 30min y mas	15seg	10seg	5seg ***
Fuerza producida	Resistencia	Resistencia de Potencia	Rápida	Explosiva ***
Tipo de impacto	Bajo	Medio	Alto	Máximo
Consumo y producción	Consume ácido láctico	Produce ácido láctico y adenosín trifosfato	Consume adenosín trifosfato	Consume adenosín trifosfato
Volumen del entrenamiento	Grande	Intermedio	Intermedio-mínimo	Mínimo ****

Figure 1. Diagram of muscle fiber movement. Gayton (2012).

DISCUSSION

The ABA has emerged as a fundamental tool for assessing the physical performance of volleyball players, especially in relation to critical technical actions such as attacking, blocking, and serving. In recent years, several studies have underscored the importance of this test as a reliable indicator of explosiveness and muscular power, two essential attributes for success in volleyball.



In the study conducted by Buchheit et al. (2018) it is highlighted that vertical jump capacity is a significant predictor of performance in specific game actions, such as attacking and blocking. By measuring the height reached during a vertical jump with a specific technique, the ABA allows coaches and trainers to obtain quantifiable data on athletes' explosive power. This information is crucial for designing personalized training programs that optimize these abilities.

In this regard, Peña et al. (2023) recommend conducting further research focused on explosive strength in this age group, taking into account both the sporting experience and physiological development of each individual. Furthermore, it is essential that training programs integrate other elements, such as strength and speed training, nutrition, and mental health, as these factors can impact explosive strength.

Other recent research has explored the relationship between ABA technique and the biomechanical demands of volleyball. Such is the case of García et al. (2021), who point out that ABA not only assesses explosive strength but also reflects technical aspects of jumping that are relevant to in-game actions. For example, good ABA performance can be correlated with proper attacking and blocking technique, suggesting that improving this ability can translate into better match performance.

Thus, a clear link is established between the technical assessment of ABA and its direct impact on athletic performance, reinforcing the need to integrate these approaches into training programs. For Henríquez et al. (2022), the vertical jump test is a valuable tool in contemporary volleyball for assessing leg power. Through this test, the physical trainer can design a strength and speed program that seeks to optimize players' physical performance on the court.

It's clear that implementing the vertical jump test is fundamental to volleyball physical preparation, as it not only measures athletes' explosive capacity but also provides key information for personalizing and improving their training. This can lead to superior performance during matches and contribute to team success.



However, it is crucial to keep in mind the limitations of using the ABA alone as an indicator of overall volleyball performance. Although this test provides valuable information on explosive capacity, other factors such as aerobic endurance, agility, and technical abilities are also essential for a player's overall performance. Therefore, it is recommended to use the ABA in conjunction with other physical and technical tests to obtain a more comprehensive assessment.

Although the vertical jump test is undoubtedly important for measuring explosive power in volleyball, its use should be complemented by other physical and technical assessments. This ensures a more holistic view of a player's performance and allows coaches to develop more balanced and effective training programs that address all the dimensions necessary for success in the sport.

CONCLUSIONS

Athletes who reached the high and medium categories on Herrera's (2010) international reference scale demonstrated a reactive jump index above 0.700, indicating notable physical performance. Furthermore, the maximum speeds achieved in this research were evaluated with a Good rating, suggesting a significant competitive level.

Statistical analyses revealed significant correlations between the variables studied. The strongest relationship was found between jump height and maximum speed, with a correlation coefficient of 0.835. This suggested that as jump height increased, so did the athlete's maximum speed.

On the other hand, the correlation between jump height and the reactive jump index was 0.671, indicating a moderately positive relationship and highlighting the importance of these parameters as key indicators of athletic performance. Furthermore, it was observed that arm coordination during the jump contributed to a gain in meters ranging from 0.05 m to a maximum of 0.18 m. This finding underscored the importance of optimizing the movement's kinematic chain to improve jumping performance, suggesting that proper technique could significantly influence the results.



These parameters were considered valuable references for future research and training programs, providing a framework for assessing and improving physical performance in volleyball and other related sports.

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The author declares that there are no conflicts of interest.

Author's contribution:

The author is responsible for writing the work and analyzing the documents.



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