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Original article

The eccentric-concentric phase and the index of strength reactivates in the jump with counter movement in volleyball players

La fase excéntrica-concéntrica y el índice de fuerza reactiva en el salto con contra movimiento en voleibolistas

A fase excêntrica-concêntrica e o índice de força reativa no salto de contra-movimento nos jogadores de vôlei

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ABSTRACT

The aim of this work is to analyze the relationship between the eccentric-concentric phase and the reactive strength index in the vertical jump with countermovement of the first category volleyball team in Havana. For this purpose, reference is made to the meaning of the different components of muscular contraction in sports activity, as well as other types of muscular contractions for dynamic work. The methods used were theoretical and empirical, such as historical-logical, inductive-deductive, analysis-synthesis, documentary review, measurement and mathematical-statistical; the latter for the tabulation and arrival of results. McCall's scoring method was used to determine the evaluation of the selected indicators, where the values observed above the mean are taken into account, which have positive standard scores, while the values below the mean have negative standard scores. A comparison is made with other research, exceeding in the case of males by 0.8 cm. With respect to the Cuban average, there is a difference of 0.7 cm. with respect to the Spanish average of 0.13 cm. and when analyzing the international reference, the difference is between 8 and 13 cm. The information achieved facilitated the correct planning and its intensification in the loads with weights in the zone of maximum, fast and explosive strength for the increase of the vertical jump in volleyball athletes, reflected in the competitive result of the team.

Keywords: Eccentric-concentric phase; Reactive strength index; Vertical jump; Jump with counter movement; Volleyball.

RESUMEN

El trabajo que se presenta tiene como objetivo analizar la relación existente entre la fase excéntrica-concéntrica y el índice de fuerza reactiva en el salto vertical con contra movimiento del equipo de voleibol, de la primera categoría de La Habana. Para ello, se hace referencia al significado de los diferentes componentes de la contracción muscular en la actividad deportiva, así como otros tipos de contracciones musculares para el trabajo dinámico. Los métodos empleados fueron de nivel teórico y empírico, tales como histórico-lógico, inductivo-deductivo, análisis-síntesis, revisión documental, la medición y los matemáticos-estadísticos; estos últimos para la tabulación y arribo de resultados. Se utilizó el método de puntuación de McCall para determinar la evaluación de los indicadores seleccionados, donde se tiene en cuenta los valores observados por encima de la media, los cuales tienen puntuaciones estándar positivas, mientras que los valores por debajo de la media tienen puntuaciones estándar negativas. Se realiza una comparación con otras investigaciones, sobrepasando en el caso de los varones por 0.8 cm. Con respecto a la media cubana, hay una diferencia de 0.7 cm. con respecto a la media española de 0.13 cm. y al analizar la referencia internacional, la diferencia está entre 8 y 13 cm. La información alcanzada facilitó la correcta planificación y su intensificación en las cargas con pesas en la zona de fuerza máxima, rápida y explosiva para el incremento del salto vertical en los atletas de voleibol, reflejado en el resultado competitivo del equipo.

Palabras clave: Fase excéntrica-concéntrica; Índice de fuerza reactiva; Salto vertical; Salto con contra movimiento; Voleibol.

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RESUMO

O objetivo deste trabalho é analisar a relação entre a fase excêntrica-concêntrica e o índice de força reativa no salto vertical com contra-movimento da equipe de vôlei da primeira categoria de Havana. Para este fim, é feita referência ao significado dos diferentes componentes da contração muscular na atividade esportiva, assim como outros tipos de contrações musculares para o trabalho dinâmico. Os métodos utilizados foram de nível teórico e empírico, tais como histórico-lógico, indutivo-dedutivo, análise-síntese, revisão documental, medição e matemática-estatística; este último para a tabulação e chegada dos resultados. O método de pontuação de McCall foi usado para determinar a avaliação dos indicadores selecionados, onde os valores observados acima da média são levados em consideração, que têm pontuação padrão positiva, enquanto os valores abaixo da média têm pontuação padrão negativa. É feita uma comparação com outras pesquisas, superando em 0,8 cm no caso dos homens. Em relação à média cubana, há uma diferença de 0,7 cm. em relação à média espanhola de 0,13 cm. e quando se analisa a referência internacional, a diferença está entre 8 e 13 cm. As informações obtidas facilitaram o planejamento correto e sua intensificação nas cargas com pesos na zona de força máxima, rápida e explosiva para o aumento do salto vertical em atletas de vôlei, refletido no resultado competitivo da equipe.

Palavras-chave: Fase excêntrica-concêntrica; Índice de força reativa; Salto vertical; Salto de contra-movimento; Vôlei.

INTRODUCTION

Prioritizing explosive strength and its correct training with the use of the plyometric method for the improvement of jumping capacity in high competition is an effective way because it increases explosive strength, by using the elastic and contractile component of skeletal muscle, an action that is generated by producing a concentric contraction preceded by an eccentric contraction (Siff & Verkhoshansky, 2004; Cometti, 2007; Flanagan and M. Comyns, 2008; García *et al.,* 2014; Bustos, 2019).

In this order, strength training with eccentric loading generates great tensions in the musculature, establishing neural adaptations, given by eccentric exercise, due to the fact that they improve the nerve impulse response from the spinal cord, as well as the development of a better synchronization of muscle fiber activation and an increase in the recruitment of fast-acting type II fibers (McHugh, 2003).

Thus, eccentric training of a muscle group improves the speed of its concentric contractions (Sheppard and Young, 2010), being a specific training that has been shown to be effective for faster neuromuscular adaptations (Seynnes, de Boer & Narici, 2007), it can also increase the muscle's threshold of rupture and its capacity to absorb loads (LaStayoet *al.,* 2003), it can selectively affect fast twitch fibers (Carreño and López, 2003). This training performed in isoinertial devices can improve aspects related to the sport, such as speed in changes of direction in the 20-meter speed test, in the height of the Counter movement Jump and in the distance in triple jump (Navarro, 2015), in addition to increasing muscle strength, joint speed and, additionally, the synthesis of collagen in the connective tissue, which allows a better functioning of the tendon, fundamental for the prevention of injuries.

Hence, it is important to take into consideration the concept of Herrera (2003), where he states that plyometrics is that active expression of the muscles in which an eccentric-concentric contraction is performed as fast as possible, originating a muscular potential that depends on a manifestation of strength and speed.

Furthermore, it is of utmost importance, when approaching this field in sports research, to have theoretical references regarding the study of the subject in question; such is the case of the reactive manifestation: which is nothing more than the strength generated by the muscle as a reaction to an external strength that modifies or alters its own structure.

For Acevedo (2008), the "reactive ability of the muscle in different situations of muscular contraction is defined as the specific capacity to develop a high impulse of strength, immediately after a sudden mechanical muscle stretch, that is to say, it is the capacity to pass quickly from eccentric to concentric muscle work.

These expressions are directly related to the capacity to jump, which are determinant at the time of performing, specifically, a jump to attack, which depends on the impulse run, the union of both feet at the moment of jumping with the shortest possible delay and a subsequent take-off, which must be coordinated with the pass made at the instant of attacking (Flanagan and Comyns, 2008).

It is necessary to mention that strength is the expression of the muscular action generated when performing a contraction, so it is important to know the different types of muscular contraction in sports activities:

- Isometric: In this type of strength no external work is generated (work = 0), although the muscle produces contraction.
- Concentric: Also called concentric dynamics, in which external work is produced during contraction in which the muscle is shortened (positive work).
- Eccentric: Also called eccentric dynamics, in which during contraction an external work is produced in which the muscle lengthens (negative work) (García *et al.*, 2014).

It should also be mentioned that there are other types of muscular contractions for dynamic work, such as: isokinetic contraction, in which the movement of the joint is maintained at a constant speed; isoinertial contraction, in which the resistance, against which the muscle must contract, remains constant; isotonic contraction, in which the tension is constant throughout a range of joint movement.

It is important to note that concentric, isometric and eccentric contractions, in human movements, rarely occur in isolation, i.e., one type of contraction is preceded by a different one.

When dealing with training volumes, it is essential to use the polymetric method, which has been the most suitable in volleyball players for the progress of jumping, with a view to a competition, particularly in university student athletes, where their time is limited by this condition and they can train between 10 and 14 hours a week.

With the constant demand of each exercise to be performed at the highest speed in the field of physical preparation, both general and special, for the gain of power for the vertical jump, whatever is most important for the development of the muscles involved in the jump, We are talking about the abdominal area, the paravertebral and pelvic girdle muscles, as well as those of the lower extremities (anteroposterior) where, in the normal training routine, special attention is paid to the hamstrings and quadriceps and other muscles located in that area.

In this way, two important purposes are achieved for the good functioning of the capacity that occupies: to strengthen these muscular planes and to avoid the ailments in the zone of the articulation of the knee.

All this occurs because the body segments are constantly subjected to strengths of different magnitudes such as jumping, changes of direction, running and even gravity, which stretches the muscle. At these times, the muscles are working eccentrically and immediately concentrically. The combination of eccentric and concentric actions is a natural type of muscle function known as CEA. Hence, that rapid eccentric contraction (the muscle is being stretched), immediately followed by a rapid concentric muscle contraction (the muscle is contracting), which are coordinated in a specific action time that allows taking advantage of the muscular elastic capacity in the concentric phase of the movement, which allows the player to jump more and solve the situation within the game.

Some studies, such as the one carried out by Cormie, Mc Bride & McCaulley (2009), state that the use of the accumulated elastic energy and, therefore, the height of the jump increases the faster the eccentric phase of the jump is, as well as the transition between this phase and the subsequent concentric phase.

In volleyball, it is important to work on the gain of higher levels of power, which improve the jumping for each of the specific actions within the game.

This facilitated a study of the men's university volleyball team of Havana since, despite having an average height with respect to the other teams participating in the national championship, their performance is not correct during the execution and result of the game actions, evidenced mainly in the power of jumping at the time of blocking.

That is why, it is presented as an objective to analyze the existing relationship between the eccentric-concentric phase (CEA) and the index of reactive strength in the vertical jump with countermovement of the first category volleyball team of Havana. Such results will allow to order in a significant way the training loads for a period of 10 to 12 weeks of work and to receive an adaptive response that will satisfy the team's results in the upcoming competitions.

MATERIALS AND METHODS

Context and participants

The volleyball team 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. These players, according to their role in the

game, have personalized characteristics, physical, technical, tactical, psychological and one of the most important aspects, that of competitive responsibility.

Methodology

In order to know the relationship between the eccentric-concentric phase and the reactive strength index, the vertical jump with countermovement was applied in the 1st category volleyball team. For the realization of the test, the loads applied the previous week were consulted in order to have knowledge of the state in which the athletes were. It is important to inform that the indicators shown in the following table were evaluated (Table 1).

Table 1. - Indicators used for the study of strength

PC (N	MC (Kg	FM (N)	FMR (%)	Imp. (Ns)	RFD(N/s	RSI
Body weight	Body Mass	Maximum Strength	Relative Maximum Strength	Impulse (Area under the curve	Speed of Strength Development	Reactive Strength Index
V (m/s)	**Alt (m)**	**TC (s)**	**TV (s**	**FE (s)**	**FC (s**	**IF (s)**
Speed	Jump hieght	Contact Time	Flight Time	Eccentric phase of the movement	Concentric phase of the movement	Braking impulse

To evaluate the results obtained by the athletes from the height of the jumps, it was used McCall's statistical scoring method, a quality model, used to evaluate the final product of a software based on quality factors, divided into important criteria that in turn, are broken down into metrics, from which users can evaluate the quality of the final product of a software, with the objective of having an evaluation of an athlete with respect to the others, i.e., evaluate the sample against itself.

McCall scoring method

In statistics, the standard score is the signed number of standard deviations, according to which the value of an observation or data point is above the mean value of what is being observed or measured. Observed values above the mean have positive standard scores, while values below the mean have negative standard scores. The standard score is a quantity to dimensional, obtained by subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation. This conversion process is called standardization or normalization (Equation 1).

$$z_i = \frac{x_i - \bar{x}}{S} \quad (1)$$

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The Z-value provides an evaluation of how off-target a process is operating.

In educational evaluation, the T-score is a standard Z-score shifted and scaled to have a mean of 50 and a standard deviation of 10. They are useful for comparing, for example, different people on the same measure or the same person on different measures (Equation 2).

$$z_i = \frac{x_i - \bar{x}}{s} * 10 + 50 \quad (2)$$

Where:
Xi: Raw score;
X: Sample mean;
S: Standard deviation.

Likewise, the following evaluation scale was taken into account (Table 2).

Table 2. - Evaluation scale for the sample

Values	**>75**	**66-75**	**56-65**	**46-55**	**36-45**	**26-35**	**<26**
Eval.	Excellent	Very good	Good	Regular	Bad	Very bad	Terrible

RESULTS AND DISCUSSION

Once the test was applied to the players, the following results were observed (Table 3).

Table 3. - Results obtained by the athletes on the platform, in the vertical jump with Counter movement Jump

No.	PC (N)	MC (Kg)	Countermovement Jump (CMJ)																
			FMax (N)	Fmed (N)	FMR (%)	Imp. (Ns)	RDF (N/s)	RSI	V (m/s)	Alt (m)	TC (s)	TV (s)	Puntos	Eval.	FE (s)	FC (s)	IF (s)	IA (s)	IF/IA
1	925	94.3	2504	1284	270.8	301.0	17811	0.655	3.31	0.55	0.840	0.670	65	Bien	0.586	0.254	0.147	0.254	0.58
2	889	90.6	2470	1156	278.0	254.2	13855	0.440	2.94	0.42	0.951	0.584	41	Mal	0.627	0.324	0.175	0.324	0.54
3	1031	105.1	2265	1361	219.7	288.5	9923	0.443	2.90	0.39	0.877	0.563	36	Mal	0.558	0.319	0.218	0.319	0.68
4	795	81.1	2035	1009	255.9	236.4	38018	0.408	3.02	0.45	1.105	0.606	47	Regular	0.843	0.262	0.185	0.262	0.71
5	872	88.8	2406	1206	276.0	277.6	16960	0.634	3.22	0.53	0.832	0.656	61	Bien	0.547	0.285	0.156	0.285	0.55
6	952	97.0	2753	1351	289.2	271.0	39547	0.600	2.89	0.41	0.680	0.577	40	Mal	0.447	0.233	0.125	0.233	0.54
7	772	78.6	1822	1017	236.2	241.9	19644	0.521	3.17	0.51	0.989	0.648	58	Bien	0.657	0.332	0.188	0.332	0.57
8	851	86.7	2093	1121	246.1	256.0	6555	0.475	3.05	0.45	0.949	0.606	47	Regular	0.655	0.294	0.209	0.294	0.71
9	730	74.4	1878	989	257.3	207.0	13105	0.511	2.89	0.41	0.799	0.577	40	Mal	0.507	0.292	0.154	0.292	0.53
10	860	87.7	2237	1173	260.1	248.6	23189	0.578	2.94	0.46	0.795	0.612	49	Regular	0.499	0.296	0.153	0.296	0.52
11	765	78.0	1828	1022	239.0	239.6	10868	0.578	3.16	0.54	0.932	0.663	63	Bien	0.635	0.297	0.197	0.297	0.66
12	841	85.7	2222	1132	264.6	257.6	13311	0.553	3.12	0.49	0.885	0.632	54	Regular	0.536	0.349	0.214	0.349	0.61
Media	857	87.3	2209	1152	257.7	256.6	18566	0.533	3.05	0.47	0.886	0.616	50		0.59	0.29	0.18	0.29	0.60
Desv.	85.9	8.8	293	130.6	19.9	25.373	10454	0.080	0.14	0.06	0.110	0.037	10		0.10	0.03	0.03	0.03	0.07
Mediana	856	87.2	2230	1144	258.7	255.100	15408	0.537	3.04	0.46	0.881	0.609	48		0.57	0.30	0.18	0.30	0.57
Min.	730	74.4	1822	989	219.7	207.0	6555	0.408	2.89	0.39	0.680	0.563	36		0.45	0.23	0.13	0.23	0.52
Max.	1031	105.1	2753	1361	289.2	301.0	39547	0.655	3.31	0.55	1.105	0.670	65		0.84	0.35	0.22	0.35	0.71

In the table, there are different indicators that evaluate the vertical jump developed by each athlete. In general, an evaluation is given based on McCall's Z score. It can be seen that only four athletes are above the average of the group, obtaining an evaluation of good, four remained in regular and four were evaluated as bad.

It was interesting to make a comparison of the average obtained, based on the heights of the jumps, with those proposed by other authors in their respective research (Table 4).

Table 4. - International benchmarks for elite male volleyball players (Ruiz, 2017)

	CMJ (m)
CUB	0.54
E SP	0.60
Internacional	0.55-0.60

It is observed that the mean of 0.47 m. obtained is below that obtained by Herrera (2010). With respect to the Cuban, there is a difference of 0.7 cm. compared to the Spanish of 0.13 cm. and between 8 and 13 cm. compared to the international.

Centeno Prada (2013) presents reference values of the Bosco Test in a population of Andalusian athletes. In the case of volleyball, the average jump heights are found to be 0.47 meters for the vertical jump with countermovement. The ages oscillate around 26 years old, the weight 86.55 kg and the height 187.64 centimeters. This is below that proposed by Ruiz (2017), (Table 5).

Table 5. - CMJ references, established by Garrido *et al.,* (2012), where several sports are included

	n	CMJ (m)	
		Media	Desv. Estan.
Global	645	0.36	7.25
Varones	458	0.39	5.83
Mujeres	187	0.29	5.23

This comparison shows that the team studied for this research exceeds the values reported by these authors, exceeding the global average by 0.11 cm. and in the case of males by 0.8 cm. The female was discarded, since this research does not cover that sex.

In this same order, other criteria were evaluated, such as those of Garrido *et al.,* (2012), who developed a publication showing (Table 6):

Table 6. - CMJ benchmarks, established for a sample of volleyball athletes

	n	CMJ (m)	
		Media	Desv. Estan.
Global	71	0.43	6.14

However, in these values the ages and categories of the athletes with whom the study was carried out are not recorded.

In the same way, in most of the works, the variables analyzed are jump height, strength and power. The publications do not specify to which categories the researched athletes belong, however, Cuban athletes have exclusive genetic characteristics, which place them above other populations in the world ranking, in relation to jumping capacity. The processed data also facilitate a more specific analysis of each one of the indicators, as is the following case (Figure 1).

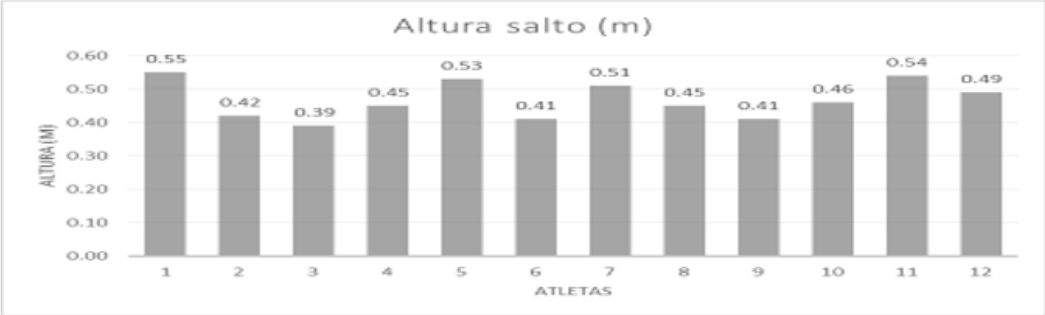

Fig. 1. - Jumps heights of the investigated athletes

The figure shows the different heights in the jumps of the athletes, it can be observed that the best results are those above 0.50 m. and as it was already known, the average of the group is 0.47 m. In critical case, athlete No. 3 is found, of which a more detailed study will be made later.

As can be seen from the results, those players who obtain less than 0.50 meters in the height of the jump, certainly need to improve their explosive strength, their quick strength and the speed of their movements when performing a block or attack, as well as an unexpected displacement in the defense of the field.

In Figure 2, it is observed that athletes 1, 5, 7, 11 and 12, exceed 50 points, however, the rest of the athletes remain below this average. It is necessary to mention that, from this type of evaluation, a counterpart is always sought, which means that, if one part of the athletes is with a good evaluation, the other part of these should be evaluated poorly, in a score range of 0-100 points and as described above, there is a scale that evaluates this sample (Figure 2).

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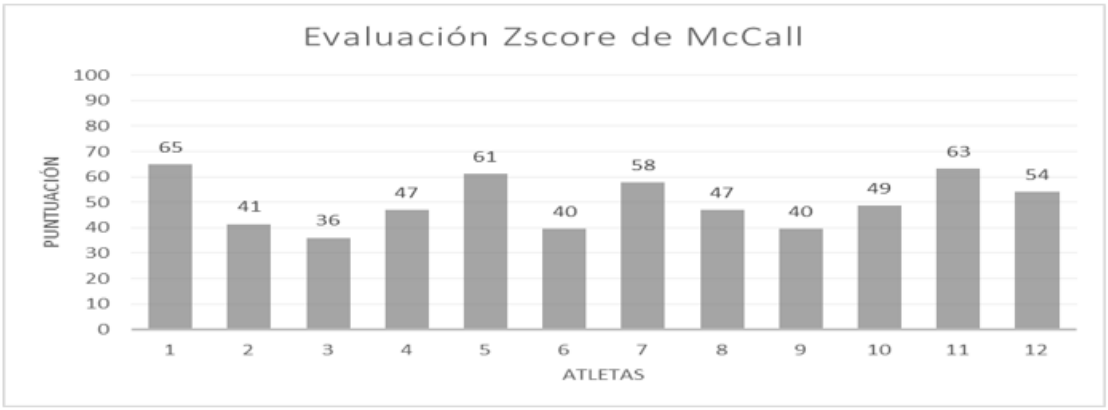

Fig. 2. - McCall's Zscore evaluations of the athletes researched

In the case of speed (Figure 3), it can be noted that the same athletes who reached evaluations above 50 points are those who exceed 3 m/s, the rest do not achieve good speeds, which is fundamental in the case of volleyball, product of the characteristic actions of this game, seen in the attacks from the net and, sometimes, much faster from the back (positions 6 and 1) where the speed of movement is expressed in all its magnitude as part of the element of surprise (Figure 3).

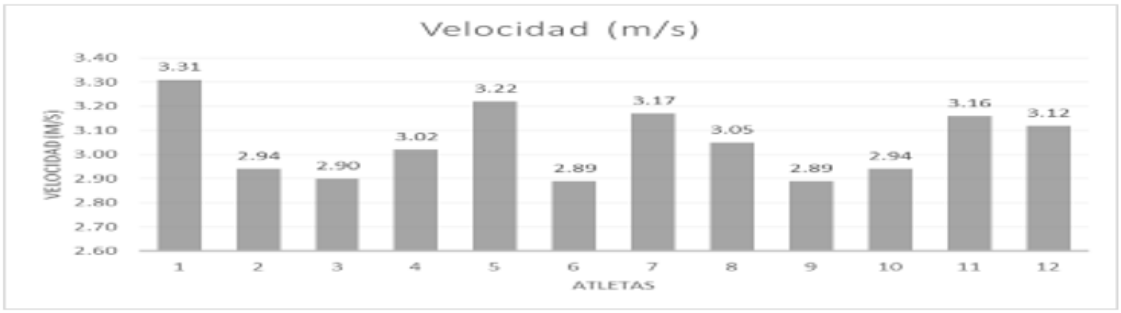

Fig. 3. - Speeds developed by the researched athletes

When observing the reactive strength index (Figure 4), it can be seen that the best results are above 0.600, as is the case of athletes 1, 5 and 6. Athletes 2, 3 and 4 present a poor relationship between the contact time and the height obtained in the vertical jump with countermovement.

This means that the longer the first phase lasts, the lower the height of the jump, and in turn, the shorter the contact phase, the greater the probability of jump height.

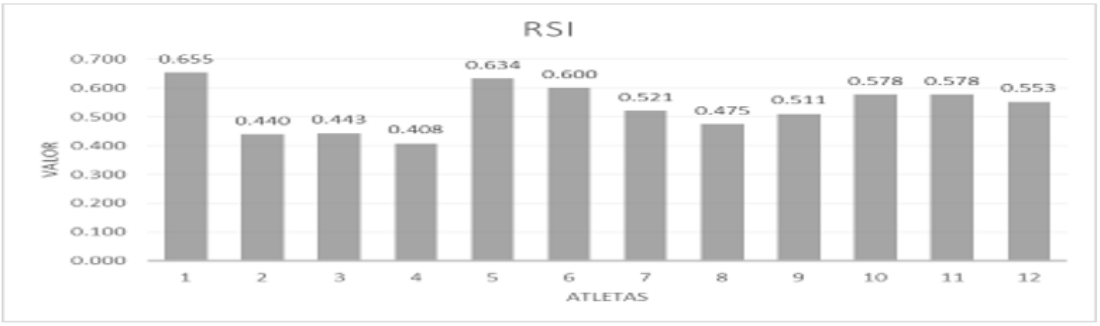

Fig. 4. - Reactive strength index presented by the athletes researched

In the case of the contact time of these last mentioned athletes, they present considerably high contact times, especially athlete 4 who, as can be seen in the graph, is the one who shows the lowest RSI. The flight times present difficulties as well, so the jump height is affected. The levels of strength gradients in the future should be part of the preparation of these volleyball players, as the need for a more systematic work in the way of strength work is appreciated.

This sometimes happens in different types of players, in some cases they are very young and have not received for a certain time the load that determines the progress of the capacity; in others, they train far from their potential possibilities, bringing a setback, it also exists when there is an excess of maximum load, since the muscle will grow transversely and not longitudinally.

What should always exist is the methodological indications that place them on the desired path, depending on the case they are in.

For the team researched, it is more convenient for the contact time (Tc in Spanish) to be between 0.800 and 0.840 and the flight time (Tv in Spanish) at 0.659 with an SD of ±0.29.

As seen in Figure 5, the athletes are outside the ideal range, proposed by G. Hochmuth in 1981 and cited by Bohigas (2019), indicating that the braking impulse phase is too long. This produces loss in the coupling phase or transition from the braking impulse phase to the acceleration impulse. Producing too much or too little elastic energy, which cannot be used in the concentric phase of the movement and thus fails to start at a higher level of strength as expected (Figure 5).

Trainings that include the ABC of speed athletics, in short distances, would be the most recommended to educate this motor action, in addition, exercises with the ladder or other obstacles would help this phase, so important for the vertical jump, contribute to obtaining a better range to attack, block or serve from jumping tennis (Ruiz, 2017).

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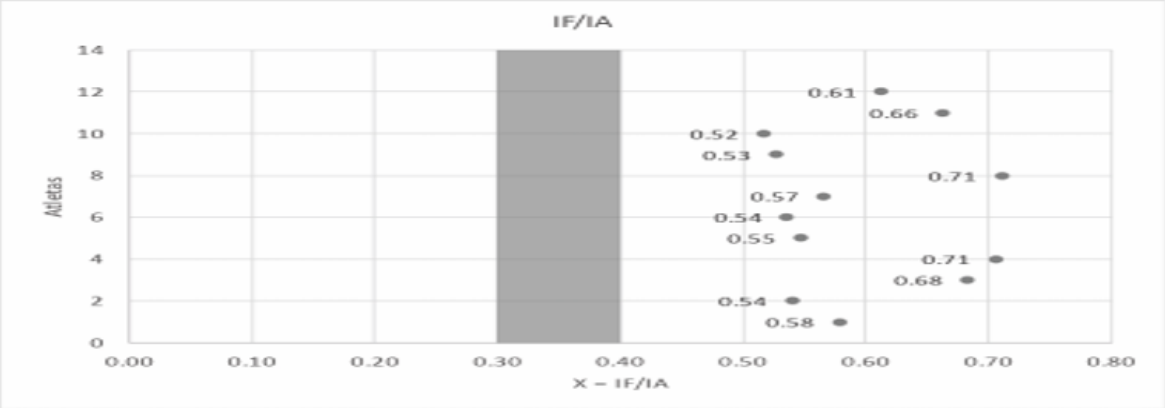

Fig. 5. - Relationship between braking impulse phase and acceleration impulse phase for the athletes researched

It would be interesting to know what percentage increases the height of the jump. However, it will be taken into account, in other cases, to evaluate the elastic capacity by means of the difference between the jump with countermovement and the Squat Jump to see at another time the continuation of this research.

It is corroborated that the athletes are outside the optimal range for the transfer from one phase to the other; but in the case of Figure 6, the speeds presented by each of them are also shown, it is observed that athletes 2, 6, 9, 10, are closer to the marked area, however, they present low speeds, which could be solved with speed work between 5 and 30 meters (Figure 6).

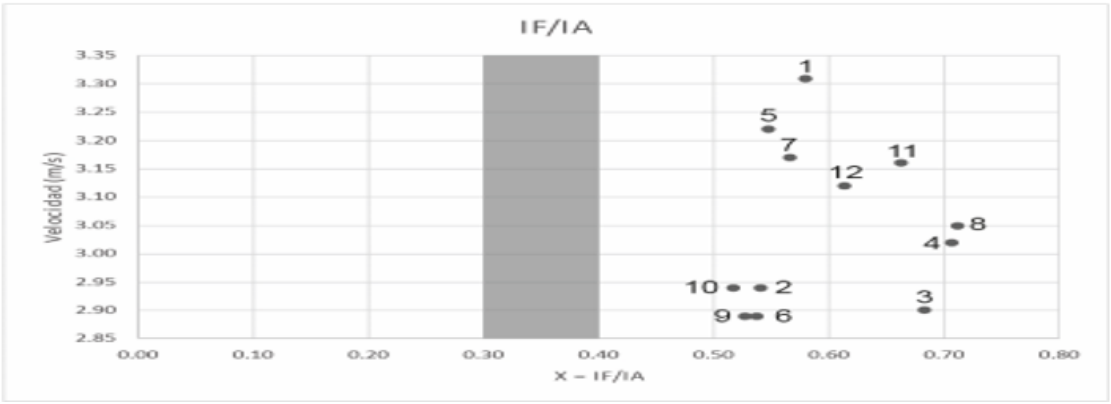

Fig. 6. - Relationship between the braking impulse phase and the acceleration impulse phase with respect to the velocity developed by the athletes researched

Players 1, 5, 7, 11, 12, are the ones who developed more speed, but surely, with maximum strength and explosive strength work in a combined way, they could face in a more complete way the demands given by the sport of volleyball.

In the case of volleyball players 4 and 8, they are the ones who are farthest away from a correct relationship, in works on the basis of basic strength in all its expression and plyometric exercises, very specifically in the muscles that oppose the movement; this could bring great improvements in the evolution of these volleyball players.

On the other hand, there is the case of athlete No. 3, who presents very low speed, in addition to presenting a transition between phases with large losses. It could be said that his physical preparation is minimal, he does not meet the necessary requirements. This is the athlete who is in the worst shape with respect to his team, so he needs a specialized dedication with work in the gym, where the bases are created for him to be able to face training at the level of the first category of volleyball.

CONCLUSSIONS

The study carried out allowed to define the need to intensify the loads with weights in the zone of maximum, fast and explosive strength, as well as with the trainings that include the ABC of speed athletics in short distances of 30, 20 and 10 meters in speed running. Continue working with the skill exercises on the ladder, gaining frequency of movements and fast contact phases so as not to produce loss in the coupling phase or transition from the braking impulse phase to the acceleration impulse, as well as in the program of preparation for the vertical jump with running, in addition, special attention should be paid at the time of the coupling action between the eccentric-concentric phase and the action of arms for the jump.

REFERENCES

Acevedo Suarez, D. Y., Hincapie Muñoz, F. M., & Sanchez Pizarro, J. A. (2008). *VALORACIÓN DE LA MANIFESTACIÓN REACTIVA DE LA FUERZA DE LOS MIEMBROS INFERIORES A LAS INTEGRANTES DE LA SELECCIÓN ANTIOQUIA DE VOLEIBOL CATEGORIA JUNIOR RAMA FEMENINA* [Tesis en opción al título de Especialización en Educación Física: entrenamiento deportivo, UNIVERSIDAD DE ANTIOQUIA]. http://viref.udea.edu.co/contenido/pdf/169-valoracion.pdf

Clemente, J. A. C., & Calbet, J. A. L. (2003). Variables de interés en el estudio de los efectos del ejercicio excéntrico sobre el rendimiento deportivo. Revisión bibliográfica. *Apunts. Educación física y deportes*, *2*(72), 62-69. https://www.raco.cat/index.php/ApuntsEFD/article/view/301348

Cormie, P., McBride, J. M., & McCaulley, G. O. (2009). Power-time, force-time, and velocity-time curve analysis of the countermovement jump: Impact of training. *Journal of Strength and Conditioning Research*, *23*(1), 177-186. https://doi.org/10.1519/JSC.0b013e3181889324

Flanagan, E. P., & Comyns, T. M. (2008). Utilización del Tiempo de Contacto y el Índice de Fuerza Reactiva para Optimizar el Entrenamiento del Ciclo de Estiramiento-Acortamiento Rápido. *PubliCE*, *0*. https://g-se.com/utilizacion-del-tiempo-de-contacto-y-el-ndice-de-fuerza-reactiva-para-optimizar-el-entrenamiento-del-ciclo-de-estiramiento-acortamiento-rapido-1082-sa-X57cfb271ba443

García-Pinillos, F., Martínez-Amat, A., Hita-Contreras, F., Martínez-López, E. J., & Latorre-Román, P. A. (2014). Effects of a contrast training program without external load on vertical jump, kicking speed, sprint, and agility of young soccer players. *Journal of Strength and Conditioning Research*, *28*(9), 2452-2460. https://doi.org/10.1519/JSC.0000000000000452

Garrido Chamorro, R. P., González Lorenzo, M., Expósito, I., Sirvent Belando, J., & García Vercher, M. (2012). Valores del Test de Bosco en Función del Deporte. *PubliCE*. https://g-se.com/valores-del-test-de-bosco-en-funcion-del-deporte-500-sa-T57cfb2715112d

Herrera, Delgado, I. G. (2003). *Los fundamentos teóricos metodológicos para el desarrollo de la capacidad de salto en voleibolistas élite* [Tesis en opción al título de Doctor en Ciencia de la Cultura Física].

LaStayo, P. C., Woolf, J. M., Lewek, M. D., Snyder-Mackler, L., Reich, T., & Lindstedt, S. L. (2003). Eccentric muscle contractions: Their contribution to injury, prevention, rehabilitation, and sport. *The Journal of Orthopaedic and Sports Physical Therapy*, *33*(10), 557-571. https://doi.org/10.2519/jospt.2003.33.10.557

McHugh, M. P. (2003). Recent advances in the understanding of the repeated bout effect: The protective effect against muscle damage from a single bout of eccentric exercise. *Scandinavian Journal of Medicine & Science in Sports*, *13*(2), 88-97. https://doi.org/10.1034/j.1600-0838.2003.02477.x

Navarro, F. (2015). La fuerza. *Apunts Educación Física*, *7*(8), 20-25.

Prada, C., & Antonio, R. (2013). *Valores de referencia para saltos en plataforma dinamométrica en una población de deportistas andaluces* [Programa de Doctorado en Salud y Deporte, Universidad Pablo de Olavide. Departamento de Deporte e Informática]. https://rio.upo.es/xmlui/handle/10433/781

Rodríguez, D. C. B. (2019). *PROGRAMA DE ENTRENAMIENTO DE FUERZA EXCÉNTRICA Y PLIOMETRÍA SOBRE LA POTENCIA, VELOCIDAD E ÍNDICE ELÁSTICO EN SELECCIONADOS DE LA PONTIFICIA UNIVERSIDAD JAVERIANA.* [Trabajo de grado presentado como requisito parcial para optar al título de: Magister en Ciencias del Deporte, UNIVERSIDAD DE CIENCIAS APLICADAS Y AMBIENTALES U.D.C.A, FACULTAD DE CIENCIAS DE LA SALUD]. https://repository.udca.edu.co/bitstream/11158/2087/1/DIANA%20BUSTOS%20TESIS%202019%20MAESTRIA%20FINAL.pdf

Rojas, G., Contreras, D., & Granados, O. (2006). Análisis del índice de elasticidad y fuerza reactiva, bajo el concepto de longitudes y masas segmentales de los miembros inferiores. *Revista Digital Efdeportes*, *11*(96), Article 96. https://www.efdeportes.com/efd96/masas.htm

Ruiz Luaces, Y. D. (2017). *La preparación para el desarrollo de la saltabilidad en voleibolistas cubanos* [Tesis en opción al título de Master en Ciencia en Metodología del entrenamiento deportivo para la alta competencia].

Seynnes, O. R., de Boer, M., & Narici, M. V. (2007). Early skeletal muscle hypertrophy and architectural changes in response to high-intensity resistance training. *Journal of Applied Physiology (Bethesda, Md.: 1985)*, *102*(1), 368-373. https://doi.org/10.1152/japplphysiol.00789.2006

Sheppard, J. M., & Young, K. (2010). Using additional eccentric loads to increase concentric performance in the bench throw. *Journal of Strength and Conditioning Research*, *24*(10), 2853-2856. https://doi.org/10.1519/JSC.0b013e3181e2731b

Siff, M. C., & Verkhoshansky, Y. (2004). *SUPERENTRENAMIENTO*. Editorial Paidotribo. http://www.paidotribo.com/entrenamiento-deportivo/497-superentrenamiento.html

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