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Original article

Biomechanical indicators for the selection of talents in Colombian schoolchildren from 11 to 15 years old

Indicadores biomecánicos para la selección de talentos en escolares colombianos de 11 a 15 años

Indicadores biomecânicos para a seleção dos talentos em escolares colombianos de 11 a 15 anos

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ABSTRACT

The selection of talents is carried out on the basis of biological, psychological, sociological and technical indicators. The objective of the study was to establish the level of correlation between running speed and some jumps for the selection of children sprinters in athletics. It is a descriptive, cross-sectional and correlational study, in which 335 children of both sexes from 11 to 15 years old participated. They were evaluated through tests such as weight and height, Abalakov jumps, unilateral right, unilateral left, bilateral and the bilateral deficit was calculated for which the contact platform was used. As results, it is highlighted that the biomechanical indicators, both in jumping height and in calculated power, increase with chronological age, although some variables show a decrease at 15 years. In the bilateral deficit, the results were rated as lower fair for girls and fair for boys. The correlation analysis between jumps and running speed showed significant correlations in girls ($p<0.01$) in the right unilateral jump in height and power, left unilateral jump in height and bilateral jump in power. In boys, correlations were found at the level ($p<0.01$) in Abalakov jump power, right unilateral jump power, left unilateral jump power, and bilateral jump power. In conclusion, according to the results and the literature, it can be stated that the jumps can be used as indicators in the selection of talents.

Keywords: Selection of talents; Biomechanical indicators; Schoolchildren.

RESUMEN

La selección de talentos se realiza sobre la base de indicadores de tipo biológico, psicológico, sociológico y técnico. El objetivo del estudio fue establecer el nivel de correlación entre la velocidad de carrera y algunos saltos para la selección de niños velocistas en atletismo. Es un estudio descriptivo, transversal y correlacional, en el que participaron 335 niños de ambos sexos de 11 a 15 años. Se evaluaron a través de pruebas como el peso y la talla, los saltos de Abalakov, unilateral derecho, unilateral izquierdo, bilateral y se calculó el déficit bilateral para lo cual se usó la plataforma de contactos. Como resultados, se destacan que los indicadores biomecánicos, tanto en altura saltada como en potencia calculada, se incrementan con la edad cronológica, aunque algunas variables muestran una disminución a los 15 años. En el déficit bilateral, los resultados se calificaron como regular inferior para las niñas y regular para los niños. El análisis de correlación entre los saltos y la velocidad de carrera mostró en las niñas correlaciones significativas ($p<0,01$) en el salto unilateral derecho tanto en altura como en potencia, salto unilateral izquierdo en altura y salto bilateral en potencia. En los niños, se hallaron correlaciones a nivel ($p<0,01$) en el salto Abalakov potencia, en el salto unilateral derecho potencia, en el salto unilateral izquierdo potencia y en el salto bilateral potencia. En conclusión, de acuerdo con los resultados y la literatura, se puede afirmar que los saltos pueden ser utilizados como indicadores en la selección de talentos.

Palabras clave: Selección de talentos; Indicadores biomecánicos; Escolares.

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RESUMO

A seleção de talentos é realizada com base em indicadores biológicos, psicológicos, sociológicos e técnicos. O objetivo do estudo era estabelecer o nível de correlação entre a velocidade de corrida e alguns saltos para a seleção de crianças praticantes de sprinters no atletismo. É um estudo descritivo, transversal e correlacional, no qual participaram 335 crianças de ambos os sexos com idades compreendidas entre os 11 e os 15 anos. Foram avaliados através de testes tais como peso e altura, saltos Abalakov, unilateral direito, unilateral esquerdo, bilateral e o défice bilateral foi calculado utilizando a plataforma de contato. Os resultados mostram que os indicadores biomecânicos, tanto em altura saltada como em potência calculada, aumentam com a idade cronológica, embora algumas variáveis mostrem uma diminuição aos 15 anos de idade. No défice bilateral, os resultados foram classificados como média mais baixa para as raparigas e média para os rapazes. A análise de correlação entre salto e velocidade de corrida mostrou correlações significativas ($p<0,01$) em raparigas em salto unilateral direito tanto em altura como em potência, salto unilateral esquerdo em altura e salto bilateral em potência. Nos rapazes, foram encontradas correlações de nível ($p<0,01$) no salto Abalakov no poder, no salto unilateral direito no poder, no salto unilateral esquerdo no poder e no salto bilateral no poder. Em conclusão, de acordo com os resultados e a literatura, pode afirmar-se que os saltos podem ser utilizados como indicadores na seleção de talentos.

Palavras-chave: Seleção de talentos; indicadores biomecânicos; Crianças em idade escolar.

INTRODUCTION

The purpose of selecting talents is to find children and young people with the best capabilities for the successful practice of a sport. The selection of talent for sport has used a large number of *tests* and indicators that allow the search for talent in a more objective, reliable and valid way. These tests are often grouped into biological components (anthropometric, growth and development), motor (assessment of physical capabilities), technique, learning capability, sociological, psychological and biomechanical indicators are also used. According to Jova, (2018), a talent selection process must include indicators and dimensions that describe the characteristics of the sprinter athlete. For Guerra, *et al.,* (2018), the study of biomechanical variables that influence the race contributes to optimizing the athlete's preparation and constitutes methodological indicators for the search and selection of talents.

Since the 1960s, jumps have been used as a means of preparing athletes and as tests to control the training process. The assumption from which this study starts is that jumps can also be used in talent selection processes, especially in events such as speed in athletics that are characterized by explosive strength. However, jumping and particularly the plyometric method must be used with care in children and young people, due to the growth and development of the body at these ages.

Jumps are a manifestation of explosive strength and have been extensively studied in order to provide greater knowledge and methods for the preparation of rapid strength athletes. Bahamondes-Ávila, *et al.,* (2018) managed to establish high levels of relationship between anthropometric indicators with power levels, expressed in the explosive strength measured in the squat jump and the countermovement jump.

Power is important in rapid strength sports; these include speed racing. Agudo, *et al.,* (2018) evaluated the effects of training on acceleration and power in young people aged 13 to 14 years, finding a significant improvement in the tests: 20 m (5.37 %), 10 m (3. 46 %) and long jump without impulse (5.22 %), likewise, the increase in size was (1.27 %) and in weight (2.47 %).

Another method to evaluate potency is through the study of the bilateral *deficit.* Whitcomb, (2021) found the presence of the *deficit* bilateral during isometric leg press finding no reduction in muscle activity in bilateral contraction compared to unilateral; no significant differences were found between cortical hemispheres between bilateral and unilateral contractions, suggesting that the *deficit* is not due to interhemispheric inhibition. A meta-analysis conducted by Núñez, *et al.,* (2021), which sought to determine the effects of different strength training protocols on short *sprint* (10 m) and vertical jump (countermovement) performance in professional soccer players, found that different strength-oriented training plans improved performance, since it does not seem to depend on the training strategy.

However, Bishop, *et al.,* (2021) found that a larger bilateral *deficit* is associated with faster turnaround performance, but not linear speed, which may be due to the individual nature of the bilateral *deficit.* Pérez-Landaluce, (2015) found no bilateral *deficit* in the maximum isometric strength or in the maximum dynamic strength, nor in the mean power or in the maximum power, at any percentage of the maximum repetition. According to Ojeda-Aravena *et al.,* (2021), the bilateral *deficit* is negatively related to the performance of the speed of the change of direction and the 5 m. *sprint* in karate fighters, in aspects related to health and daily life.

This research was carried out with untrained schoolchildren aged 11 to 15 years. The objective of the study was to establish the level of correlation between running speed and some jumps for the selection of children sprinters in athletics.

MATERIALS AND METHODS

It is a descriptive, correlational and cross-sectional study, with a quantitative approach. A total of 148 girls and 187 boys were studied for a total of 335 schoolchildren, from 11 to 15 years of age, who study at the "Francisco de Paula Santander" Educational Institution, in the Municipality of Galapa, Atlántico. The random sample of schoolchildren was selected from grades 6 to 9; they met the criteria of good health, age, sex and informed consent. The measurements were made during the Physical Education class schedule, with the collaboration of the teachers, at the beginning of the class.

The assessment of the children was carried out through jumping tests, of easy coordination and learning by children and those that represented less risk to health. From each schoolchild, the current body mass in kg. and height in cm. were taken. The criteria for performing the Abalakov jumps , unilateral right, unilateral left and bilateral jump, were explained to the students ; each made three maximum vertical jumps per trial in this same order. In addition, the time in the 20-m test was measured and the speed was calculated.

The jumps were performed on the contact platform. In the Abalako *test,* the child enters the platform, stands with the feet slightly apart and at a signal bends the legs and jumps up as high as possible, with the help of the arms, the lower limbs are maintained in this exercise extended and falls in the same place. Right unilateral jump is the realization of a jump only with the right foot; It is performed on the contact platform, with a previous jump to move forward, from the outside to the inside of the platform and then a jump up inside the platform with the greatest possible strength. Left unilateral jump is the performance of a jump with only the left foot. Bilateral jump is performed on the contact platform, with a previous jump to move forward, from outside to inside the platform and then a jump up, inside the platform, with the greatest possible strength using both feet at the same time. The percentage of the bilateral *deficit was determined* and finally the speed was correlated with the biomechanical indicators.

For the measurement of the jumps in the sample of schoolchildren, an equipment that consists of a contact platform was used, Cronopic intelligent unit , connected to a computer with the Chronojump software for data ccollection and analysis. Both jump height and power were recorded by the Chronojump software, power was calculated using the following formula (Equation 1)

$$P = mass * g * (falling\ height + 1{,}226 * flight\ time^2 / contac\ time \quad (1)$$

Where:
P = power
and the fallingheight is 0. The result is expressed in watts.

Acero and Acero (2013) describe the development of a method to study the bilateral *deficit* and present research results with athletes from different sports, ages and performance levels. The equation with which the data were analyzed was the following: (Equation 2)

$$\%DBL = \frac{Bilateral - (unilateral\ derecho + unilateral\ izquierdo)}{Bilateral} x100 \quad (2)$$

A descriptive and correlational statistical analysis was performed using Pearson's correlation coefficient. For data processing and analysis, Word, Excel and SPSS Version 20 programs were used.

RESULTS

Tests were applied to each of the schoolchildren selected in the sample. Measurement of weight, height, 20 m *test* of race and the registration of other data was made on the first day and on the second day the jumps were made. The results of the tests carried out on schoolchildren of both sexes are presented below (Table 1).

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Table 1. - Results of the biomechanical tests in girls aged 11 to 15 years

Age(years)	Abalakov test		Unilateral Right		UnilateralLeft		Bilateral		% Bilateral Deficit
	Height	Power	Height	Power	Height	Power	Height	Power	
11 (n=15)	22.03 ±5.30	343.10 ± 144.69	14.70 ± 3.01	472.28 ± 245.70	13.89 ± 1.95	380.63 ± 153.08	23.42 ± 3.14	577.37 ± 209.88	-23.59 ± 22.89
12 (n=31)	23.96 ± 5.53	433.01 ± 85.95	15.63 ± 3.58	552.63 ± 234.09	14.99 ± 3.32	499.30 ± 112.08	24.95 ± 5.36	762.08 ± 214.98	-25.22 ± 23.71
13 (n=55)	25.03 ± 6.59	455.56 ± 103.75	16.92 ± 4.66	528.19 ± 158.93	16.25 ± 4.37	543.11 ± ±306.62	26.66 ± 4.68	788.85 ± 269.39	-25.68 ± 29.30
14 (n=36)	21.69 ± 6.66	474.27 ± 117.06	17.62 ± 4.80	670.50 ± 313.78	16.80 ± 5.18	552.29 ± 136.59	27.30 ± 6.23	934.63 ± 393.85	-26.53 ± 22.49
15 (n=11)	24.38 ± 4.82	551.34 ± 107.25	15.30 ± 5.38	512.01 ± 126.57	15.12 ± 7.44	492.83 ± 164.41	24.67 ± 7.75	804.01 ± 288.08	-22.07 ± 18.35

Abalakov jump in girls show a continuous increase between 11 years with 22.03 cm. and the 13 years with 25.03 cm. on average; at 14 years, the lowest value is presented with 21.69 cm., to increase at 15 years with 24.38 cm. Although the general trend is to increase the jumped value with age, the lowest value is found at 14, which may be due to the composition of the sample studied (Table 1).

Abalakov jump in girls presents a tendency to grow continuously from 343.1 w at 11 years to 551.34 w, at 15 years on average.

It is known that power is closely related to body weight, which can influence the results and as the weight of schoolgirls grows with age, power also increases, likewise these higher power values allow schoolgirls to perform certain tasks that require rapid strength (Table 1).

The results of the right unilateral jump in girls show an upward trend of 14.7 cm on average at 11 years up to 17.62 cm. at age 14, presenting a low value of 15.3 cm. at 15 years old. The height jumped with a single limb is lower because it loads all the body weight on a single limb, in addition to increasing the coordination difficulty to perform the jump (Table 1).

The results expressed by the girls in the power of the right unilateral jump show that, although they grow with age, there is no continuous trend of increase. At 11 years of age, the value of power is 472.28 w and at 14 years of 670.5 w on average, as the maximum value achieved. The power values depend on the body weight of schoolgirls and reflect the ability to perform rapid strength exercises (Table 1).

The results of the girls in the left unilateral jump show as a trend the constant growth of the values with 13.89 cm. at 11 years up to 16.8 cm. at age 14 on average, to decrease to 15.12 cm. at 15 years old. The values reflect the strength capability in the lower limbs and the level of coordination that the schoolgirls present (Table 1).

The results of the girls in the power generated in the left unilateral jump show an upward trend from 11 years with a value of 380.63 w up to 552.29 w at 14 years, decreasing at 15 years to 492.83 w. These values are lower on average than those recorded with the lower right limb, which may reflect the dominance of the right side in most schoolchildren over the left side (Table 1).

The results in the bilateral jump (executed with both lower limbs) reflect higher values with an increasing trend of 11 years with 23.42 cm. up to 27.3 cm. at 14 years, to decrease at 15 years with 24.67 cm. These values are higher on average than those recorded in the Ablakov jump, despite the similarity of the two *tests*, which may be due to the initial step that the schoolchildren must take to execute the movement (Table 1).

The results of the power expressed by the girls in the biliteral jump test reflect as a trend the continuous growth of the values from 577.37 w at 11 years to 934.63 w at 14 years on average, and then fall at 15 years with 804.01 watts of power. These values far exceed those recorded in the Abalakov jump, which may be due to the initial step that the schoolchildren must take to execute the movement (Table 1).

The estimation of the percentage of the bilateral *deficit* that the girls present (the difference of the sum of the unilateral jumps and the bilateral jump) is interpreted as follows: The values between higher are considered deficient and if they tend to 0 they are considered more efficient. In this case, the values vary from -23.59 to -26.53%, which can be classified as lower regular, due to the magnitude of the difference between the results (Table 1).

Abalakov jump show an increasing trend from 11 years with 27.29 cm. up to 14 years with 30.83 cm. on average, to decrease slightly at 15 years. A more pronounced jump is observed from 13 to 14 years old, surely due to the growth and development processes that schoolchildren go through at these ages (Table 2).

Abalakov jump show an increasing trend from 388.58 w at 11 years to 568.78 w at 15 years on average. Power is influenced by body weight and is one of the reasons why power increases and weight increases with age in school children; furthermore, it is due to biological maturation processes that improve the function of the muscular system and prepare it for rapid strength exercises (Table 2).

The results in the right unilateral jump manifested by the children vary from 18.48 cm. at 12 years old up to 21.82 cm. at 14 years on average, without a continuity in the increase. This may be due to the size of the sample and the influence of the growth and development processes that occur at these ages (Table 2).

The results of power in the right unilateral jump of children show a tendency to increase with age, from 350.95 w at 11 years to 622.29 w at 15 years on average. Power is closely influenced by body weight, which is why the increase in weight with age and the growth and development processes of schoolchildren can contribute to the results found (Table 2).

Table 2. - Statistical results of biomechanical tests in children

Age (years)	Abalakov test		Unilateral Right		UnilateralLeft		Bilateral		% Bilateral Deficit
	Height	Power	Height	Power	Height	Power	Height	Power	
11 (n=13)	27.29 ± 6.06	388.58 ± 88.63	19.64 ± 2.76	350.95 ± 153.16	20.79 ± 5.56	476.52 ± 218.24	33.56 ± 4.37	696.46 ±312.89	-20.50 ± 15.27
12 (n=42)	27.51 ± 7.94	421.18 ± 117.2	18.48 ± 4.18	455.41 ± 233.48	17.89 ± 4.07	522.72 ± 403.21	29.83 ± 6.39	692.54 ± 259.82	-23.61 ± 20.67
13 (n=58)	27.63 ± 7.32	462.13 ± 124.17	19.57 ± 5.07	475.61 ± 181.22	19.31 ± 5.51	551.77 ± 356.63	32.89 ± 5.44	766.26 ± 316.28	-18.66 ± 23.29
14 (n=51)	30.83 ± 8.24	553.83 ± 133.66	21.82 ± 4.38	546.81 ± 165.72	22.57 ± 5.26	602.86 ± 197.55	36.24 ± 5.67	917.45 ± 277.41	-22.98 ± 17.31
15 (n=23)	30.48 ± 9.03	568.78 ± 162.73	21.35 ± 5.49	622.29 ± 295.94	20.71 ± 4.82	646.27 ± 467.24	34.43 ± 7.24	865.68 ± 272.91	-24.07 ± 21.92

The results of the left unilateral jump in children vary from 17.89 cm. at 12 years old up to 22.57 cm. at 14 years on average, without a marked trend. These results may be due to the size of the sample studied and the biological maturation processes that influence physical capabilities at these ages (Table 2).

Results for children's unilateral left jump power show a tendency to increase continuously with age, from 476.52 w at 11 years to 646.27 w at 15 years on average. This is surely influenced by the increase in body weight with age and biological maturation processes that improve the function of the locomotor system (Table 2).

The results in the bilateral jump in children vary from 29.83 cm. at 12 years up to 36.24 cm. at 14 years on average, without a definite trend. These values exceed the results achieved by schoolchildren in the Abalakov jump as a similar test, possibly due to the execution technique of the jump that includes a previous step (Table 2).

The results of power in the vertical jump in children show a tendency to grow from 692.54 w at 12 years to 917.45 w at 14 years on average. These results may be influenced by growth and development processes and by the increase in body weight of schoolchildren at this age (Table 2).

The results of the bilateral *deficit* presented by the children vary from -18.66 % at 13 years (best result) to -24.07 % at 15 years (worst result) on average. The values are classified as regular due to the wide differences between the strength shown by the students in the sum of the two unilateral jumps and the bilateral jump (Table 2).

Correlation analysis

In girls, the correlation analysis of the biomechanical variables against the time of the race in 20 m. and the speed of the 20-m race, significant correlations ($p<0.01$) were found with the following variables: unilateral right jump in height and power, unilateral left jump in height and bilateral jump in power; Correlations at the $p<0.05$ level were found in the left unilateral jump height and in the bilateral power jump.

In the children, the correlation analysis of the biomechanical variables against the variables of time and speed in the 20-m race, significant correlations ($p<0.01$) were found in the following variables: in the jump Abalakov power, in the right unilateral jump power, in the left unilateral jump power and in the bilateral jump power and correlations at the $p<0.05$ level in the right unilateral jump power.

DISCUSSION

Strength capabilities are increased in two main ways. Due to the influence of structural and functional changes in the body, especially during puberty and adolescence. And due to the effects of training and the environment that strength the neuromuscular system to develop. The results of the present research verified the increases in strength in the ages of 11 to 14 years mainly, represented in the jump height and power. The results of the jumping tests show differences as age increases, probably induced by growth and development processes, by the influence of the environment and by ethnic factors.

As a result of research with high-level 100 m sprinters, Loturco et al. (2015) recommend that squat jumps (SJ), countermovement jumps (CMJ) and horizontal jumps (HJ) be incorporated into the training and *testing* of sprinters, because they present high correlations with real times in 100 m., with values of -0.82, -0.85 and -0.81, respectively. Also Markstrom, Olsson (2013) found that the drop jump (DJ), squat jump (SJ), and countermovement jump (CMJ) tests can predict the performance of sprinters; found that the strength variable CMJ peak strength (PF), relative to body weight, significantly predicted maximal running speed performance in sprinters.

In other researches, Giampiero, *et al.,* (2020) indicate that the bilateral *deficit appears to* depend on the motor task, the type of muscle contraction and the training load. In general, faster athletes are more powerful than slow ones. Candia-Lujan, *et al.,* (2018) and Carr, *et al.,* (2020) have shown in other studies that the gender of the participants does not influence the magnitude of the bilateral index in the muscles used for jumping. Cofre, *et al.,* (2018) found that professional soccer players do not present a bilateral *deficit* in jump height and present a lower bilateral *deficit* in power; which associates the training level with a reduction or absence of the bilateral *deficit.*

According to Serrato, (2018), with the maturation process there is a continuous development of power due to muscle development. A study carried out with children aged 10 to 18 years from a soccer school showed a good correlation between the evolution of power and chronological age when power in the countermovement jump (CMJ) was assessed. Isidoria *et al.,* (2018), in a study to detect sports talents in athletics, found that for 10-year-old girls the most outstanding tests were speed and endurance, while in 11-year-old boys they were speed tests and long jump without impulse running, demonstrating the importance of rapid strength tests at these ages.

The literature reports the increased use of jumps to assess the capabilities of children and athletes. In the evaluation of performance and selection of talents, the most referenced jumps are the vertical jump and the long jump without impulse running, but not the unilateral jumps or the bilateral jump, which leads to their use being proposed.

In conclusion, it can be stated that in girls the results of the jumps show a linear growth with chronological age up to 14 years, a setback is observed at 15 years. In children, an irregular increase in results was found, both in jump height and in calculated power.

The bilateral *deficit* that evaluates the difference in strength between the unilateral jumps and the bilateral jump resulted in girls being rated as regular lower and boys as regular, showing that there are deficiencies in the magnitude of strength of the lower limbs of children.

Correlation analysis showed that there are associations between jumping performance and children's race speed. In general, it can be stated that the described jumps that lead to determining the bilateral *deficit* can be used in the selection of talents for the sport.

The jumps in which jump height and power are valued constitute an important indicator for coaches to find children with the greatest potential for rapid strength sports.

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