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Research article

Effects of a structured exercise program on vertical jump performance in adolescent basketball players aged 13 to 15, Holguín

Efectos de un programa estructurado de ejercicios sobre el rendimiento del salto vertical en baloncestistas adolescentes de 13 a 15 años, Holguín

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Abstract

Introduction: Vertical jump is a physical ability crucial for performance in basketball, as it is involved in actions such as rebounding, blocking, or shooting in suspension. Structured and scientifically-based training programs are needed for its development during adolescence.

Objective: To evaluate the effects of a structured exercise program on vertical jump performance in adolescent basketball players aged 13 to 15 from Holguín.

Methodology: quantitative, pre-experimental study with a pretest-posttest design involving 30 adolescent basketball players. The intervention lasted 12 weeks, with three weekly sessions of 60 minutes each. To assess vertical jump performance, the Bosco Test was used. Normality was checked using the Shapiro-Wilk test and the non-parametric Wilcoxon Signed-Rank test ($p < 0.05$).

Results: The Squat Jump increased from 28.43 ± 2.71 cm to 31.72 ± 2.48 cm, the Countermovement Jump from 31.84 ± 2.94 cm to 35.61 ± 2.63 cm, and the Abalakov Jump from 35.26 ± 3.15 cm to 39.74 ± 2.91 cm. The three tests showed significant differences (Z = -4.63 to -4.81; $p < 0.001$), with large effect sizes (r = 0.85–0.88).

Discussion: The results confirmed the effectiveness of structured training to enhance explosive strength, aligning with recent evidence on plyometric programs in adolescent basketball players.

Conclusions: The program significantly improved vertical jump performance, establishing itself as an effective strategy for optimising physical training in developmental categories.

Keywords: Basketball; sports training; muscle strength; adolescents; physical performance.

Resumen

Introducción: El salto vertical es una capacidad física determinante del rendimiento en baloncesto, ya que interviene en acciones como el rebote, el bloqueo o el lanzamiento en suspensión. Se necesitan programas de entrenamiento estructurados y con base científica para su desarrollo durante la adolescencia.

Objetivo: Evaluar los efectos de un programa estructurado de ejercicios sobre el rendimiento del salto vertical en baloncestistas adolescentes de 13 a 15 años de Holguín.

Metodología: estudio cuantitativo, preexperimental, con diseño pretest-postest en 30 baloncestistas adolescentes. La intervención tuvo una duración de 12 semanas, con tres sesiones semanales de 60 min. Para valorar el rendimiento del salto vertical se utilizó el Test de Bosco. La normalidad se comprobó mediante Shapiro-Wilk y la prueba no paramétrica de Rangos con Signo de Wilcoxon ($p < 0,05$).

Resultados : El Squat Jump pasó de 28,43 ± 2,71 cm a 31,72 ± 2,48 cm, el Countermovement Jump de 31,84 ± 2,94 cm a 35,61 ± 2,63 cm y el Abalakov Jump de 35,26 ± 3,15 cm a 39,74 ± 2,91 cm. Las tres pruebas mostraron diferencias significativas (Z = -4,63 a -4,81; $p < 0,001$), con tamaños del efecto grandes (r = 0,85–0,88).

Discusión: Los resultados confirmaron la eficacia del entrenamiento estructurado para potenciar la fuerza explosiva, coincidiendo con la evidencia reciente sobre programas pliométricos en baloncestistas adolescentes.

Conclusiones: El programa permitió mejorar significativamente el rendimiento del salto vertical, constituyéndose como una estrategia eficaz de optimización de la preparación física en categorías formativas.

Palabras clave: Baloncesto; entrenamiento deportivo; fuerza muscular; adolescentes; rendimiento físico.

Introduction

Basketball is a high-intensity and intermittent nature sport, in which players continuously perform explosive actions (accelerations, decelerations, multidirectional jumps, varied jumps, and changes of direction), which significantly influence their competitive performance. Especially during adolescence, when significant processes of growth and biological maturation occur that influence the development of physical skills, these demands require high levels of muscular power, explosive strength, and neuromuscular coordination. Therefore, optimising the vertical jump becomes a priority in physical preparation plans because it has a direct relationship with fundamental actions such as offensive and defensive rebounding, blocking, performing the jump shot, and aerial battles for the ball (Ziv & Lidor, 2009; Ben et al., 2010).

According to specialised literature, one of the main indicators of athletic performance in explosive disciplines is the ability to generate high levels of force in the shortest possible time. In this sense, the vertical jump has become an appropriate means to measure the power of the lower limbs through different evaluation protocols. The Bosco Test is one of the most widely used methods due to its high sensitivity and reliability in identifying changes generated by training. This protocol enables the evaluation of various expressions of explosive strength through tests such as the squat jump, the counter movement jump, and the Abalakov, which are frequently used in the control of sports training (Bosco, 1994). The systematic application of these tests enables the objective evaluation of the effects that different training methods have on neuromuscular performance and facilitates the monitoring of the physical conditioning process.

In recent years, the scientific community's interest in developing training methods that can enhance vertical jump performance in young athletes has increased. Multicomponent programs, complex training, and plyometric training have shown positive results in relation to functionality and muscle power. Therefore, a systematic review with meta-analysis conducted by Ma et al. (2025) demonstrated that structured physical training programs produce notable increases in vertical jump height in healthy athletes and highlighted how the duration of the program, the intensity of the load, and the characteristics of the participants affect the magnitude of the adaptations achieved. Following this same path, Gómez-Carmona et al. (2026) corroborated that plyometric training is one of the most effective interventions for increasing jump capacity in adolescent basketball players, due to the neuromuscular adaptations produced by the stretch-shortening cycle, using a meta-analysis and a systematic review of randomised clinical trials.

Multiple advantages of plyometric training have been observed in various collective sports disciplines. Calle-Uruchima et al. (2020) noted that volleyball players increased their explosive strength through a systematic plan of plyometric exercises, in contrast to Correia et al. (2020), who found significant improvements in the vertical jump capacity of young basketball players after implementing specific plyometric programs. Likewise, Corozo-Palma (2026), in a systematic study of adolescent athletes, discovered that if training loads are well-planned, the controlled use of the plyometric method improves lower limb power and optimises performance in jump tests.

Moreover, several studies have shown that the fusion of different training techniques can improve physical adaptations in basketball players. According to Kambitta et al. (2025), through a meta-analysis, complex training substantially improves variables related to capacity, speed, and functional performance of basketball players, thanks to the combination of strength training with explosive exercises. Santos & Janeira (2012) also reported similar findings, noting significant increases in explosive strength metrics after implementing resistance training programs in adolescent players. More recently, Doğru (2026) discovered that, after implementing a specialised conditioning program for basketball players, there were improvements in vertical jump, maximum speed running, and body composition simultaneously.

The way training is organised methodologically, as well as the quantity and intensity, are elements that crucially define neuromuscular adaptations. Aztarain-Cardiel et al. (2024) confirmed that different volumes of plyometric training generate varied responses in the physical performance of young players, suggesting an appropriate personalisation of the load to improve results and reduce the risk of overtraining. Kourtis-Doulkeridis et al. (2025) also revealed that adding specific warm-up tactics, especially through dynamic stretching, improves vertical jump performance and sprint speed just before competition, emphasising the importance of including various elements in training planning.

Explosive strength has a close relationship with other physical abilities that are crucial for performance in competitions, especially in basketball practice. González de los Reyes et al. (2020) found links between agility, explosive power, and certain anthropometric qualities in young female players, as well as that the balanced development of these variables benefits sports performance. Martínez et al. (2020) also concluded, through a literature review, that lower body plyometric training is an effective tactic for increasing muscle power and improving performance in technical and tactical terms during competitions. In team sports with similar demands, Del Castillo et al. (2023) found that programs focused on speed development, when organised under principles of progression and specificity, generate significant functional adaptations.

The adolescent phase is a very favourable period for the development of conditional skills, as considerable neuromuscular plasticity occurs during growth. The implementation of systematic physical activity programs contributes to the improvement of sports performance and the holistic development of children and adolescents, optimising indicators of physical health, functional adaptation, and psychological well-being (Rodríguez et al., 2020). Thus, the development of specific programs for adolescent athletes should be based not only on scientific criteria but also on the particularities of the biological maturation process.

School basketball is one of the sports prioritised within the sports initiation system in Cuba. However, few studies are still being conducted in training categories on the evaluation of structured programs specifically focused on optimising vertical jump. National research has addressed topics concerning the functional properties and technical performance of players. Betancourt et al. (2020), for example, investigated the lateralisation model in students and young players in Havana, which provided evidence of important functional variables for sports performance. There is still very limited scientific production regarding experimental interventions that analyse the impact of structured training programs on the lower limb capacity of adolescents attending Cuban sports schools, especially in Holguín.

This research arises from the need to provide scientific evidence regarding the effectiveness of organised training programs focused on the development of explosive strength in adolescent basketball players within the Cuban sports context. The data produced will help improve the planning of physical training in formative categories and allow decisions to be made based on evidence, with the aim of maximising sports performance. In this line, the objective of this study was to establish the impacts generated by a structured exercise program on the effectiveness of the vertical jump in adolescent basketball players aged between 13 and 15 years from the province of Holguín.

Method

The quantitative approach was used in the research, which employed a pre-experimental pretest-posttest design with a single group. This made it possible to evaluate the impact of an organised exercise program on vertical jump performance by comparing the measurements taken before and after the intervention, without incorporating a control group. The study was based on an explanatory approach because it aimed to determine the impact of a systematic intervention on a specific physical variable in adolescent basketball players. The research was conducted during the sports preparation phase corresponding to the competitive season of the School of Sports Initiation (EIDE) located in Holguín, Cuba.

Variables

The structured exercise program, defined as a systematic and planned intervention aimed at enhancing the explosive strength of the lower limbs through specific physical activities tailored to the attributes of adolescent basketball players, was the independent variable. The program was created using the principles of individualisation, specificity, load progression, continuity, and recovery. Additionally, it includes exercises for functional strength, motor coordination, trunk stability, and explosive movements specific to basketball.

The performance of the vertical jump was the dependent variable, which means the neuromuscular ability to produce high levels of force in the shortest time during explosive actions. This variable was operationalised through three dimensions: explosive strength, explosive elastic-reactive strength, and power in the lower extremities. Parameters such as relative power, flight time, jump height, and indices associated with the stretch-shortening cycle were evaluated. These indicators are frequently used to measure functional performance in explosive sports.

Participants

Basketball players from the EIDE in Holguín, Cuba, made up the population. The sample consisted of 30 young athletes, aged between 13 and 15, who regularly and consistently attended the sports training sessions at the facility.

The selection of participants was made through a non-probabilistic convenience sampling, considering the athletes' availability to collaborate in the study and their accessibility. The following inclusion criteria were defined: being an official member of the EIDE basketball team, attending at least 90% of the training sessions, being clinically fit to participate in sports, and having informed consent signed by parents or legal guardians. Players who had diseases or musculoskeletal injuries, as well as those who frequently missed during the intervention, were excluded.

The ethical principles of the Declaration of Helsinki for the study in human beings were respected. It was ensured that participation was voluntary and that the data were used solely for scientific purposes, always maintaining the confidentiality of the information.

Procedure

The development of the study was organised with the team leaders and the authorities of the sports entity. Later on, the athletes, parents, and representatives were informed about the goals, advantages, and procedures of the research. The corresponding informed consents were thus obtained.

The initial evaluation (pretest) was conducted before starting the intervention to establish the vertical jump performance level of all participants. The tests were conducted with the same equipment, during regular training hours, and under similar weather conditions throughout the entire study. Prior to each assessment session, the athletes performed a standard warm-up that lasted about fifteen minutes. This included dynamic exercises, joint mobility, continuous low-intensity running, and neuromuscular activation.

Once the initial assessment was completed, the structured exercise program was carried out in the agreed period. All training sessions were supervised by sports training experts, who were responsible for verifying the adherence to the plan and the proper technical execution of each exercise. At the end of the intervention, the final evaluation (post-test) was conducted using the same protocols that were employed during the initial measurement. This aimed to objectively compare the variations in vertical jump performance.

Structured Exercise Program

With the purpose of improving explosive strength and vertical jump performance in adolescent basketball players aged between 13 and 15 years, an organised exercise program was created. The intervention lasted 12 weeks, with three sessions per week (on Mondays, Wednesdays, and Fridays), totalling 36 sessions. Each session lasted around 60 minutes, divided into a warm-up period (15 minutes), a main period (40 minutes), and a recovery period (5 minutes). The sessions were held on the basketball court of the Holguín School of Sports Initiation. The head coach and the responsible researcher supervised the sessions, ensuring that each exercise was executed correctly from a technical standpoint and that the planning was followed.

The program's scheduling was based on the scientific principles of sports training, considering specificity, individualisation, recovery, continuity, progressive overload, and variability. Over the course of the twelve weeks, the intensity of the training gradually increased by raising the number of ground contacts, the height of the obstacles, the complexity of the exercises, and the speed of execution. The work-to-rest ratio was planned to promote neuromuscular recovery, which allowed us to maintain a high technical level throughout all the repetitions.

The first stage of each session, which lasted around 15 minutes, was dedicated to preparing the athletes from a neuromuscular and physiological standpoint for the subsequent activity. Five minutes of continuous running at a low intensity (50-60% of maximum heart rate), followed by exercises to improve joint mobility of the knees, ankles, hips, shoulders, and trunk. Then, dynamic muscle activation activities were carried out, including running with changes of direction, high and low skipping, lateral shuffles, leg swings, bodyweight squats, and core activation exercises through side and front planks for 20-30 seconds.

The main part, lasting around 40 minutes, focused on developing explosive strength through plyometric exercises, functional strength, and specific basketball movements. Throughout the first four weeks, activities were carried out for neuromuscular adaptation with moderate intensity. These included two-foot jumps in place, lateral jumps, line jumps, rope jumps, jump squats, explosive lunges, and quick sprints of 10 to 15 meters. In this phase, 2 to 3 sets of 8 to 10 repetitions per exercise were performed, with rest periods of 60 to 90 seconds between sets and two minutes between work blocks.

Between weeks 5 and 8, the load gradually increased through exercises that required more neuromuscular effort. Hurdle jumps between 30 and 40 cm, single-leg jumps, lateral jumps over obstacles, depth jumps from 30 cm boxes, consecutive jump movements, jumps with direction change and landing, explosive 20-meter sprints, dynamic trunk stability exercises, functional strength using a 2 to 3 kg medicine ball, as well as explosive squats and explosive step-ups were incorporated. In this phase, three sets of between eight and twelve repetitions were carried out, increasing the volume to around 90 to 110 ground contacts per session and taking breaks of between 90 and 120 seconds to facilitate neuromuscular recovery.

The most intense stage of the program was from the ninth to the twelfth week. Reactive jumps, depth jumps from platforms of 40 to 50 cm, plyometric jumps with movements in various directions, multiple jumps over successive hurdles, single-leg landings, acceleration and deceleration activities, quick direction changes, short sprints of 20 to 30 meters, jumps for offensive and defensive rebounding (with ball throwing), as well as comprehensive power circuits specific to basketball were performed. The training volume consisted of performing between 110 and 140 contacts per session, divided into 3 to 4 sets consisting of 10 to 12 repetitions. Between the different sets, breaks of two to three minutes were taken to ensure the recovery of the phosphagen system and preserve the optimal quality of execution.

To regulate the intensity of the program, the maximum execution speed of each exercise was used, with the aim of ensuring that all movements were carried out with the highest possible power. Likewise, the Borg scale (6-20) was used to measure the subjective perception of effort, which was mostly moderate-high, with values between 13 and 17. As the program progressed, the total volume was gradually increased, following the principles of biological adaptation and avoiding weekly increases above 10%, in order to minimise the risk of injuries and promote appropriate recovery.

The training density was set with a work-rest ratio close to 1:5 in the higher intensity plyometric exercises, which allowed for almost complete recovery of the neuromuscular system before each new set. Between exercises, active breaks of 30 to 60 seconds were included; between training blocks, however, breaks were organised that varied between 2 and 3 minutes, depending on how intense the performed exercises were.

The last five minutes of each session were dedicated to a gentle run, breathing exercises, joint mobility, and dynamic stretches of the most relevant muscle groups that participated in the training. This helped gradually return to baseline physiological conditions and reduced muscle tension after exertion.

Instrument

The Bosco Test, which is considered one of the most valid and reliable methods worldwide for evaluating the explosive strength of the lower limbs (Bosco, 1994), was used to measure vertical jump performance.

The squat jump (SJ), countermovement jump (CMJ), and Abalakov (ABK) tests were conducted. The Squat Jump allowed for the evaluation of explosive strength from a static position, eliminating the effect of the stretch-shortening cycle. The Abalakov Jump included the free movement of the upper limbs, thus providing a functional assessment closer to the specific actions of basketball, while the Countermovement Jump evaluated explosive capacity by taking advantage of the eccentric phase before the push.

The data were recorded through an electronic contact platform, and variables such as jump height, flight duration, relative power, and indices derived from neuromuscular performance were automatically obtained. For the statistical analysis, the best result from the three tests performed by each participant was taken.

Data analysis

The acquired information was organised into a database and processed using IBM SPSS Statistics version 29.0 software (IBM Corp., Armonk, New York, United States). A preliminary descriptive analysis of the variables was conducted using measures of dispersion and central tendency (mean, standard deviation, median, interquartile range, minimum and maximum values) to describe the behaviour of the measurements obtained before and after the intervention.

The Shapiro-Wilk test was used for data normality, as it is suitable for small samples. The results showed that the analysed variables did not have a normal distribution ($p < 0.05$), so non-parametric statistical techniques were used for the inferential analysis.

The discrepancies between the pretest and posttest measurements were established using the Wilcoxon signed-rank test, which is used to compare two related measurements when the assumptions of normality are not met. This test showed that, after applying the structured exercise program, there were statistically significant differences in vertical jump performance.

Results

Table 1. Descriptive results of the Squat Jump (SJ) before and after the intervention

Assessment	Mean (cm)	SD	Median	IQR	Minimum	Maximum
Pre-test	28.43	2.71	28.10	3.20	24.10	33.60
Post-test	31.72	2.48	31.80	2.80	27.30	36.50

Note. *SD* = standard deviation; *IQR* = interquartile range; *SJ* = Squat Jump.

The descriptive results revealed that, after implementing the structured exercise program, there was an increase in the effectiveness of the Squat Jump. The mean increased by 3.29 cm (11.6%) from 28.43 ± 2.71 cm in the pretest to 31.72 ± 2.48 cm in the posttest. The median increased from 28.10 cm to 31.80 cm, while the interquartile range had a slight reduction, indicating a decrease in the dispersion of the results after the intervention. These findings indicate that, following the systematic implementation of the training program, the lower limbs reacted positively in terms of their explosive strength.

Table 2. Descriptive results of the Countermovement Jump (CMJ) before and after the intervention

Assessment	Mean (cm)	SD	Median	IQR	Minimum	Maximum
Pre-test	31.84	2.94	31.60	3.50	26.50	37.20
Post-test	35.61	2.63	35.70	3.00	30.40	40.60

Note. *SD* = standard deviation; *IQR* = interquartile range; *CMJ* = Countermovement Jump.

jump. The median increased from 31.60 cm to 35.70 cm, while the mean grew from 31.84 cm to 35.61 cm, which corresponds to an increase of approximately 11.8%. That the interquartile range decreases indicates that the uniformity of the participants' performance after training increases, which suggests a positive change in the stretch-shortening cycle.

Table 3. Descriptive results of the Abalakov Jump (ABK) before and after the intervention

Assessment	Mean (cm)	SD	Median	IQR	Minimum	Maximum
Pre-test	35.26	3.15	35.10	3.80	29.70	41.00
Post-test	39.74	2.91	39.80	3.10	34.20	44.80

Note. *SD* = standard deviation; *IQR* = interquartile range; *ABK* = Abalakov Jump.

A significant improvement was noted in the countermovement jump compared to the squat In the Bosco Test, the Abalakov Jump was the one that showed the most improvement in performance. The average changed from 35.26 ± 3.15 cm to 39.74 ± 2.91 cm, which represented an increase of 4.48 cm (12.7%). Additionally, the median increased from 35.10 cm to 39.80 cm, which indicates a steady improvement in the ability to leverage the contribution of the upper limbs when performing the jump, a very important element in specific basketball actions such as rebounding and blocking.

Table 4. Comparison of pre-test and post-test measurements using the Wilcoxon signed-rank test

Variable	Negative Ranks	Positive Ranks	Ties	Z	p	Effect Size (r)
Squat Jump	2	28	0	-4.63	< .001	0.85
Countermovement Jump	1	29	0	-4.78	< .001	0.87
Abalakov Jump	2	28	0	-4.81	< .001	0.88

Note. Wilcoxon signed-rank test; *p* < .05 indicates statistically significant differences.

The three tests of the Bosco Test showed significant differences from a statistical point of view between the measurements taken before and after the intervention, according to the results of the Wilcoxon signed-rank test ($p < 0.001$). In the Squat Jump, twenty-eight athletes improved their performance after the program; only two had lower results than in the pretest. A Z statistic of -4.63 and an effect size of r = 0.85 were achieved, which is considered high.

In the Countermovement Jump, similar results were observed: twenty-nine subjects improved their jump height and only one performed worse than initially (Z = -4.78; p < 0.001; r = 0.87). The results indicate that the program had a positive impact on the utilisation of the stretch-shortening cycle, a key process for generating explosive strength in typical basketball actions.

Very significant differences were also found in the Abalakov jump (Z = -4.81; p < 0.001), in favour of twenty-eight athletes who, after the intervention, improved their performance. The effect size was considered large (r = 0.88), indicating that the structured training program caused significant neuromuscular adaptations in terms of jump capacity in adolescent basketball players. Overall, it can be concluded that the intervention led to a significant improvement in the explosive power and vertical jump performance of the evaluated participants.

Discussion

The implementation of a structured exercise program over a period of twelve weeks generated statistically significant improvements in the vertical jump performance of young basketball players aged between 13 and 15 years. These results were reflected in the increase observed in the SJ, CMJ, and ABK tests of the Bosco Test. Likewise, the Wilcoxon signed-rank test corroborated significant variations between the pretest and posttest measurements (p < 0.001), which showed high effect sizes, indicating that the intervention caused significant neuromuscular modifications in the explosive strength of the lower limbs. These results support the effectiveness of organised programs that combine plyometric exercises, functional strength, and specific basketball movements with the aim of improving physical performance in developmental categories.

The findings are consistent with what Martínez et al. (2024) demonstrated, showing significant improvements in jump ability in basketball players under 12 years old after implementing a plyometric exercise program for the lower limbs. The authors indicated that the activation of the stretch-shortening cycle and neuromuscular efficiency in explosive movements are enhanced by the combination of jumps in different directions (horizontal, vertical, and multidirectional). Likewise, this work incorporated a systematic sequence of plyometric exercises adapted to the specific needs of adolescents, which likely contributed to the increase in jump height in the three tests of the Bosco Test.

Moreover, these findings are consistent with the meta-analysis and systematic review conducted by Ma et al. (2025), in which they examined the effectiveness of plyometric training on jump performance in various sports disciplines. The authors concluded that this type of training generates moderate and significant improvements in vertical jump, especially when the programs last longer than eight weeks and are carried out with an appropriate increase in weight. The present study carried out the intervention over twelve weeks, gradually increasing the volume and intensity. This may have contributed to the neuromuscular adaptations that explain the notable increase in performance that was observed.

Regarding the length of the training programs, our findings are consistent with those of Koci et al. (2025), who found a notable increase in gross motor coordination and strength in children who played basketball after a twelve-week intervention. These authors assert that long-duration programs favour the consolidation of more stable functional adaptations than those achieved with short interventions. The twelve-week program implemented in this study seems to have been adequate to provoke notable transformations in the vertical jump ability and explosive power of the individuals involved.

Moreover, the findings are consistent with what Aztarain-Cardiel et al. (2024) argue about the volume of plyometric training as a key element for optimising physical performance in young basketball players. According to their research, as the number of ground contacts increases, more significant neuromuscular adaptations occur without increasing the risk of injuries. According to this evidence, the program carried out in the current research progressively increased the amount of work, going from about 70 to 140 contacts per session. This adhered to the principles of recovery and progression, which may have contributed to the large effect size observed in the three evaluations of the Bosco Test.

The findings of Santos & Janeira (2012), which revealed notable advances in various indicators of explosive strength following the implementation of a strength training program in adolescent basketball players, also align with the results obtained from a physiological perspective. The authors attributed these adaptations to the improvement in muscle coordination, the increase in motor unit activation, and the enhancement of the ability to produce force in short periods. These neuromuscular adaptations are widely known as a mechanism that explains the increase in vertical jump performance seen in young athletes participating in specific training programs.

Uzelac-Sciran et al. (2020) also reported comparable findings, revealing that an 8-week jump training program significantly improved sprint performance, leg strength, and jumping ability in adolescents across various stages of biological maturation. These results indicate that the adaptations caused by plyometric exercises not only improve vertical jump performance but also enhance other physical skills that are closely related to performance in team sports competitions. Therefore, the findings of this research emphasise the relevance of incorporating training programs aimed at fostering explosive strength from an early age.

The increase observed in the Abalakov Jump and Countermovement Jump tests can also be explained by an optimisation of the stretch-shortening cycle, which is a physiological mechanism responsible for utilising the elastic energy that accumulates during the eccentric phase of the movement. This perspective aligns with what You et al. (2026) reported: using force sensors, they noted that a six-week plyometric program significantly increased speed, strength, and balance in adolescent girls who play basketball, evidencing neuromechanical adaptations on soft and hard surfaces. The authors noted that the improvement in neuromuscular coordination helps to transfer force more effectively during explosive actions, which aligns with the increases observed in this research.

Similarly, Daulatabad et al. (2025) found a significant correlation between static and dynamic strength with vertical jump performance in basketball players. They concluded that an appropriate development of these two forms of strength is fundamental to improving power in the lower extremities. In this context, the applied program included functional strength and plyometric exercises, which enabled the stimulation of various parts of the neuromuscular system and, consequently, facilitated a complete optimisation of jump performance.

What is of particular interest is that the observed benefits are not only the result of doing plyometric exercises, but also the fact that the intervention was carried out in a structured manner. Cengizel et al. (2022) found that the combination of plyometric exercises with jump rope brought about notable improvements in the athletic performance and body profile of adolescent basketball players. These findings support the importance of creating programs that contain multiple components, with various physical stimuli, as in this current research, which combined explosive jumps, plyometric exercises, trunk stability, and functional strength.

The primary purpose of this study was to examine the effects of a training program on vertical jump; however, the findings are also supported by studies related to pre-effort preparation. Kourtis-Doulkeridis et al. (2025) demonstrated that, in adolescent basketball players, dynamic stretching has a more pronounced impact than static stretching on sprint speed and vertical jump. This observation supports the methodological approach of incorporating dynamic exercises in the warm-up stage of the program, which promotes appropriate neuromuscular activation before performing intense plyometric tasks.

Finally, although the present study provides evidence regarding the effectiveness of a structured exercise program to optimise vertical jump performance in adolescent basketball players, it has certain limitations. The lack of a control group in the pre-experimental design with a single group limits the ability to determine causal relationships with greater evidence. The sample was limited to athletes from a single sports organization, which decreases the likelihood of extrapolating the findings to other populations. Likewise, kinetic, electromyographic, or biomechanical factors that could provide a more comprehensive explanation of the neuromuscular adaptations produced by the intervention were not considered.

For future research, it is recommended to conduct randomised controlled trials with larger samples from various sports environments. These should include kinetic, electromyographic, and biomechanical analyses to understand the mechanisms that cause improvements in vertical jump performance. Similarly, it would be relevant to compare different training methods, such as maximum strength, speed-based, complex, and plyometric; and to examine the differentiated effects based on sex, stage of biological maturation, and the competitive level of the athletes. These lines of inquiry will help improve training programming and strengthen the scientific evidence regarding the development of explosive strength in young basketball players.

Conclusions

The implementation of an organised exercise program over three months resulted in a notable improvement in the vertical jump performance of adolescent basketball players (ages 13 to 15) belonging to the Holguín School of Sports Initiation. The intervention promoted the development of explosive strength and neuromuscular capacity in the lower limbs, as demonstrated through the SJ, CMJ, and ABK tests of the Bosco Test, as well as with the results achieved through the Wilcoxon signed-rank test. The effectiveness of the structured exercise program to optimise a key physical skill in competitive basketball performance was demonstrated, which allowed for the validation of the research goal.

The findings reveal that an effective tactic to optimise vertical jump capacity in adolescence is to systematically plan plyometric exercises, explosive jumps, functional strength, and specific basketball activities, administered according to criteria of progressive load, individualisation, and specificity. The optimisations found are related to functional adjustments that are linked to superior performance in the stretch-shortening cycle, an increased ability to generate force during shorter time intervals, and better neuromuscular coordination. These components make it possible to perform important technical actions, such as the suspended throw, blocking, and rebounding. Consequently, the suggested program is a scientifically-based methodological option to strengthen the physical preparation of athletes in developmental categories.

From a practical standpoint, the results provide evidence supporting the inclusion of structured exercise programs in the annual training planning of schools and sports clubs for beginners. This helps improve the development of explosive strength in the initial phases of the sports specialisation process. This study also expands the existing evidence on interventions focused on adolescent basketball players in Cuba and lays the groundwork for future research that seeks to compare different training approaches, incorporate experimental designs with control groups, increase sample size, and include neuromuscular and biomechanical assessments that facilitate a better understanding of the mechanisms explaining the improvements seen in vertical jump performance.

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Conflict of interest

The authors declare that they have no conflict of interest.

Author's contributions

Author 1: conceptualization, research, project administration, writing.

Author 2: project management.

Author 3: review, validation, and editing.

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