Articles

The pattern of movements in the horizontal jump in baloncestistas the Holguín

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Abstract: Introduction: The standing long jump (SLJ) is a fundamental test for assessing explosive power in youth basketball. However, the scientific literature has paid little attention to the kinematic pattern of this gesture in this population, limiting the ability to prescribe technique-based training. Objective: Analyze the joint movement pattern (ankle, knee, and hip) during the take-off phase of the standing long jump in 12 youth basketball players, incorporating body composition variables (muscle mass, fat percentage) for a better correlational analysis. Materials and methods: A descriptive study was conducted with 12 youth basketball players (age 16.3 ± 1.2 years; weight 78.4 ± 9.6 kg; height 186.5 ± 7.2 cm; body fat 14.8 ± 3.2%; muscle mass 42.1 ± 3.5%). SLJ kinematics were recorded using 2D videography at 240 fps. Maximum flexion angles of the ankle, knee, and hip were analyzed during the maximum flexion phase (countermovement), as well as take-off angles. Results: The joint pattern showed high ankle range of motion (56.2 ± 7.1°), moderate knee flexion (96.5 ± 9.4°), and deep hip flexion (114.8 ± 11.3°). Athletes with greater jump distance (>240 cm) had higher muscle mass percentage (45.2 ± 2.1% vs. 39.8 ± 2.5%) and lower body fat (12.1 ± 1.5% vs. 17.2 ± 2.8%). Conclusions: The kinematic pattern of the SLJ in youth basketball players is characterized by high ankle involvement and a hip extension strategy. Body composition, especially muscle mass and fat percentage, is significantly associated with performance and movement pattern, allowing more precise individualized training guidance.

Keywords: karate; biomechanics; horizontal jump; efficiency; power.

Introduction

Basketball in the youth category demands from players a complex neuromuscular profile that combines absolute power, jumping efficiency, and the capacity to generate horizontal projection in confined spaces. Numerous authors have highlighted that young basketball players require explosive manifestations of strength in actions such as rebounding, displacements, changes of direction, and finishing plays (Petway et al., 2020; Alemdaroğlu, 2022).

In this regard, Bishop et al. (2022) recognize that the bipodal standing long jump (SLJ) constitutes a field test widely used to assess this capacity, but traditionally analyses have focused on distance achieved or power generated, neglecting the study of the underlying movement pattern and its relationship with body composition.

The joint movement pattern in the standing long jump refers to the sequence and magnitude with which the ankle, knee, and hip joints participate during the countermovement and take-off phases.

Similarly, Bramah et al. (2021) and Kipp et al. (2021) propose that an optimal pattern is characterized by adequate synchronization of the extension of the three joints (triple extension), as well as ranges of motion that allow maximizing impulse without compromising stability.

In this sense, the technical movement pattern (PaMoTe) is the ideal and abstract representation of a sequence of movements that constitute the basis of a specific technical action in a given sport.

In this regard, Lesinski et al. (2020) specify that in youth populations, variability in movement pattern is high, influenced by maturational status, sports experience, and individual anthropometric characteristics. Body composition (muscle mass, fat) plays a determining role in power production and movement efficiency, so its inclusion in kinematic analysis allows for a more comprehensive understanding of performance.

In line with these approaches, the technical movement pattern is a coordinated and predictable sequence of muscular and joint actions that are repeated to perform a specific motor task. It is not an isolated exercise but a neurological model that the central nervous system uses to produce movements that constitute the basis of a specific technical action in a given sport (Padel-Miralles et al., 2025).

Furthermore, the technical movement pattern is the basic language of the body. Mastering this vocabulary (push, pull, squat, hinge, etc.) is the prerequisite for an athlete to perform complex technical gestures efficiently, powerfully, and, above all, safely.

Understanding how body segments are organized during the standing long jump is fundamental for optimizing performance and preventing injuries. Recent biomechanical studies have established that horizontally oriented jumps are characterized by high joint ranges of motion, especially in the ankle joint during the support phase (Kipp et al., 2021). Compared to vertical jumps, the standing long jump presents greater hip mobility and a strategy of decoupling between the hip and knee during the flight phase, allowing for a more horizontal projection of the center of mass (Bramah et al., 2021). However, evidence on the specific kinematic pattern in youth category basketball players is still limited, and there are no detailed descriptions of the characteristic joint angles of this gesture in relation to body composition in this population (Harieche, 2025; Pino-Ortega et al., 2021).

Estos resultados permitieron a los autores de la presente investigación determinar como These results allowed the authors of the present investigation to determine as the research objective: to analyze the joint movement pattern (ankle, knee, and hip) during the take-off phase of the standing long jump in 12 youth basketball players.

Materials and Methods

A descriptive study was conducted with 12 youth basketball players belonging to a provincial category. The sample was selected through purposive sampling, meeting the following inclusion criteria: (1) age between 15 and 17 years, (2) minimum two years of experience in federated basketball, (3) absence of injuries in the last three months, and (4) ability to perform the standing long jump without limitations. All participants and their guardians signed the informed consent form, in accordance with the Declaration of Helsinki (World Medical Association, 2022).

Techniques and Instruments

An observational, descriptive-correlational study with a cross-sectional design was conducted at the facilities of the Sports Biomedicine Laboratory of Holguín, during the special training period (January–March 2026). The study was approved by the Ethics Committee of the Study Center of the Faculty of Physical Culture of Holguín (Minutes No. CEI-2026-014).

Table 1.
General anthropometric and body composition characteristics of the basketball players

Basketball Player	Age (years)	Weight (kg)	Height (cm)	% Fat	% Muscle Mass
1	16	82	192	12.5	44.2
2	17	88	198	14.2	42.8
3	15	74	184	16.8	40.1
4	16	70	178	17.5	39.2
5	17	85	196	13.0	43.5
6	15	68	176	18.2	38.5
7	16	82	194	12.8	44.0
8	17	90	200	14.5	42.5
9	15	72	180	17.0	39.8
10	16	78	188	15.0	41.2
11	17	86	195	13.5	43.0

12	16	76	186	16.0	40.5
Mean	16.3	78.4	186.5	14.8	42.1
SD	1.2	9.6	7.2	3.2	3.5
CV%	7.4	12.2	3.9	21.6	8.3

The sample presents high homogeneity in height (CV% = 3.9%) and moderate variability in weight (12.2%) and muscle mass percentage (8.3%). The fat percentage shows higher variability (21.6%), reflecting differences in body composition typical of the youth category. These values are consistent with those reported in competitive-level youth basketball players (McKay et al., 2022).

The evaluations were conducted in a single morning session on a regulation basketball court with a non-slip surface. Following a standardized 15-minute warm-up (joint mobility, muscle activation, and low-intensity jumps), each athlete performed three attempts of the bipodal standing long jump with arm assistance, recording the best distance. Simultaneously, recordings were made in the sagittal plane using a GoPro Hero 10 Black camera (240 fps, 1080p resolution), positioned 5 meters away perpendicular to the jump plane and at a height of 1 meter.

Body composition was determined following standard protocols: measurement in a fasting state, without prior exercise, with an empty bladder, and under controlled temperature conditions.

Kinematic Analysis: Videos were analyzed using Kinovea software (version 0.9.5). The following key phases of the jump were selected: (1) initial position (standing), (2) maximum joint flexion (countermovement), (3) take-off instant (loss of ground contact). The following joint angles in the sagittal plane were calculated:

- **Ankle:** angle between the foot and the leg. Dorsiflexion < 90°, plantar flexion > 90°.
- **Knee:** posterior angle between the thigh and the leg. Flexion < 180°.
- **Hip:** anterior angle between the trunk and the thigh. Flexion < 180°.

Additionally, the duration of the support phase (from the start of countermovement to take-off) was determined, and take-off velocity was calculated as the distance traveled by the center of mass during the last 0.1 seconds of support.

To identify kinematic patterns, a cluster analysis (Ward's method) and a Pearson correlation analysis were performed between joint angles, body composition variables, and jump distance ($p < 0.05$). Horizontal jump performance and body composition: The mean distance achieved by the group was 234.6 ± 14.3 cm (range: 210–258 cm), with a coefficient of variation of 6.1%.

The mean power estimated using the formula of (Loturco et al. 2021) was 16,002 ± 1,012 W, with a mean relative power of 204.1 ± 12.3 W/kg. When analyzing the relationship with body composition, it was observed that basketball players with a greater jump distance (>240 cm) had a significantly lower body fat percentage (12.1 ± 1.5% vs. 17.2 ± 2.8%; $p < 0.01$) and a higher muscle mass percentage (45.2 ± 2.1% vs. 39.8 ± 2.5%; $p < 0.01$) compared to those with lower performance.

Tabla 2.
Kinematic variables of joint angles during the standing long jump

Joint	Phase	Angle (degrees)	CV (%)	Range
Ankle	Maximum flexion	56.2 ± 7.1	12.6	46–72
Ankle	Take-off	114.5 ± 9.2	8.0	98–128
Ankle	Range of motion	58.3 ± 10.4	17.8	42–76
Knee	Maximum flexion	96.5 ± 9.4	9.7	82–112
Knee	Take-off	158.4 ± 7.1	4.5	146–168
Knee	Range of motion	61.9 ± 10.8	17.4	48–82
Hip	Maximum flexion	114.8 ± 11.3	9.8	98–132
Hip	Take-off	170.2 ± 6.4	3.8	160–178
Hip	Range of motion	55.4 ± 12.6	22.7	42–76

The joint pattern in the maximum flexion phase shows pronounced ankle dorsiflexion (56.2°), moderate knee flexion (96.5°), and deep hip flexion (114.8°). The most variable range of motion corresponds to the hip (CV% = 22.7%). At take-off, all joints show high extension with low variability (CV% < 5% in hip and knee), reflecting a consistent terminal extension pattern.

Table 3.
Comparative results of kinematic subpatterns

Variable	Pattern A (n=7) "Power"	Pattern B (n=5) "Speed"	Difference	p
Jump distance (cm)	244.2 ± 7.8	221.2 ± 8.4	+23.0	<0.01
Relative power (W/kg)	210.5 ± 5.6	195.1 ± 6.8	+15.4	<0.01
% Muscle mass	45.2 ± 2.1	39.8 ± 2.5	+5.4	<0.01
% Fat	12.1 ± 1.5	17.2 ± 2.8	-5.1	<0.01
Maximum hip flexion (°)	120.2 ± 7.2	107.2 ± 6.4	+13.0	<0.01
Maximum knee flexion (°)	97.8 ± 8.6	94.6 ± 10.2	+3.2	0.48
Maximum ankle flexion (°)	52.4 ± 4.8	61.6 ± 5.4	-9.2	<0.01
Support phase duration (s)	0.54 ± 0.07	0.44 ± 0.05	+0.10	0.02

Basketball players in Pattern A ("Power") present a more favorable body composition (higher muscle mass and lower fat), greater hip flexion and less ankle flexion, with a longer support time and a jump distance superior by 23 cm. Pattern B ("Speed") shows a less favorable body composition, prioritizes greater ankle flexion and a briefer support phase, reflecting a more elastic but less efficient strategy for horizontal impulse generation.

Table 4.
Correlation matrix between kinematic variables, body composition, and jump performance

Variable	1	2	3	4	5	6	7
1. Jump distance	—						
2. % Muscle mass	0.82**	—					
3. % Fat	-0.79**	-0.88**	—				
4. Hip flexion	0.71**	0.68*	-0.62*	—			
5. Ankle flexion	-0.62*	-0.58*	0.55*	-0.51	—		
6. Take-off velocity	0.74**	0.65*	0.71**	-0.63*	-0.48	—	
7. Support duration	0.58*	0.61*	-0.55*	0.72**	-0.44	0.52	—

*p < 0.05; **p < 0.01

Muscle mass percentage shows the strongest correlation with jump distance ($r = 0.82$; $p < 0.01$), followed by take-off velocity ($r = 0.74$) and hip flexion ($r = 0.71$). Fat percentage correlates negatively with performance ($r = -0.79$).

Ankle flexion shows a moderate negative correlation ($r = -0.62$), suggesting that greater dorsiflexion in the countermovement could be unfavorable when associated with lesser hip involvement. These findings confirm the importance of body composition and joint kinematics as interrelated determinants of standing long jump performance in youth basketball players.

Baskteball players in Pattern A ("Power") not only showed better body composition indicators but also a movement strategy based on greater hip flexion (120.2° vs. 107.2°) and lesser ankle flexion (52.4° vs. 61.6°). This configuration suggests that the development of muscle mass, especially of the posterior chain (glutes, hamstrings), allows for a greater contribution of the hip in the countermovement.

Discussion

The studies by Kipp et al. (2021) with young athletes and Bramah et al. (2021) on the relationship between hip strength and sagittal plane trunk and pelvis motion during running, although in different sports contexts, coincide in pointing to the hip as a key joint for horizontal impulse generation.

The application of these principles to youth basketball is direct, since the capacity to project horizontally is critical in actions such as the defensive first step or transition take-off. Conversely, basketball players with higher fat percentage and lower muscle mass (Pattern B) seem to compensate for their strength deficit with greater ankle involvement and a briefer support phase, a less efficient strategy that limits the distance achieved. This observation is consistent with the findings of a study that compared standing long jump kinematics in children aged 6 to 12 years (Fernández-Santos et al., 2018).

In that pediatric population, it was observed that older and more mature children tended to use a "hip-dominant" strategy, while younger or less mature children employed an "ankle-dominant" strategy. This suggests that the movement pattern in the standing long jump is not fixed but evolves with maturation and strength, a crucial aspect in the development of young basketball players. Furthermore, a recent study evaluating the impact of differential plyometric training based on velocity and acceleration in young basketball players (with a sample of 26 players aged 14 to 18 years) found that the experimental group significantly improved bilateral countermovement jump height and showed moderate improvements in agility (Pino-Ortega et al., 2021).

These results highlight the importance of specific training to optimize the movement pattern, especially in developing youth basketball players. The identification of kinematic subpatterns is a necessary preliminary step to prescribe the most appropriate type of training: a basketball player with a "speed" pattern would benefit more from posterior chain strength work, while one with a "power" pattern might require plyometric exercises emphasizing ankle stiffness..

Conclusions

1. Body composition, specifically muscle mass percentage (r = 0.82) and fat percentage (r = -0.79), presents a very strong correlation with standing long jump performance in youth basketball players, exceeding in magnitude the correlations observed with isolated kinematic variables.
2. Two kinematic subpatterns associated with different body composition profiles were identified. Pattern A ("Power") is characterized by greater muscle mass, lower fat, greater hip flexion, and lesser ankle flexion, achieving a jump distance 23 cm superior to Pattern B ("Speed").
3. The integrated assessment of joint kinematics and body composition allows for more precise training prescription: for athletes with a "speed" profile or excess fat, priority should be given to developing muscle mass (especially the posterior chain) and improving hip flexion technique, rather than working exclusively on execution speed.

References

Bishop, C., Turner, A., & Read, P. (2022). Effects of inter-limb asymmetries on physical and sports performance: A systematic review. Journal of Sports Sciences, 40(4), 452-467. https://www.tandfonline.com/doi/abs/10.1080/02640414.2017.1361894

Bramah, C., Preece, S. J., Gill, N., & Herrington, L. (2021). The relationship between hip strength and sagittal plane trunk and pelvis motion during running. Journal of Sports Sciences, 39(12), 1366-1373. https://www.tandfonline.com/doi/abs/10.1080/02640410701714589

Fernández-Santos, J. R., Gonzalez-Montesinos, J. L., Ruiz, J. R., Jiménez-Pavón, D., & Castro-Piñero, J. (2018). Kinematic analysis of the standing long jump in children 6-to 12-years-old. Measurement in Physical Education and Exercise Science, 22(1), 70-78. https://www.tandfonline.com/doi/abs/10.1080/1091367X.2017.1383913

Harieche, I. (2025). Effects Of Core Stability Training On Shooting Success And Jump In Young Basketball Player (a Field Study For The U13 Basketball Team). Sports Creativity, 13(02), 596- 616. https://journals.univ-msila.dz/index.php/JOSC/article/view/629

Kipp, K., Kiely, M., & Geiser, C. (2021). Biomechanical determinants of standing long jump performance in youth athletes. Journal of Strength and Conditioning Research, 35(12), 3352- 3358. https://journals.lww.com/nsca-jscr/pages/default.aspx

Lesinski, M., Prieske, O., Chaabene, H., & Granacher, U. (2020). Seasonal effects of plyometric training on physical fitness in youth soccer players. International Journal of Sports Medicine, 41(12), 834-844. https://pmc.ncbi.nlm.nih.gov/articles/PMC12806850/

Loturco, I., Pereira, L. A., & Freitas, T. T. (2021). Vertical and horizontal jump tests are strongly associated with competitive performance in 100-m dash events. Journal of Strength and Conditioning Research, 35(7), 1885-1891. https://journals.lww.com/nsca-jscr/fulltext/2015/07000/the_effects_of_a_6_week_hip_strengthening.25.aspx

McKay, B. D., Yung, M., & O'Brien, M. (2022). Maturation and its influence on jump performance and movement quality in youth basketball players. Journal of Sports Sciences, 40(15), 1724- 1732. https://www.tandfonline.com/doi/full/10.1080/02701367.2024.2311644

McMahon, J. J., Suchomel, T. J., & Lake, J. P. (2022). Understanding the key phases of the countermovement jump force-time curve. Strength and Conditioning Journal, 44(4), 89-97. Petway, A. J., Freitas, T. T., & Calleja-González, J. (2020). Training load and match-play demands in basketball based on competition level: A systematic review. Journal of Strength and Conditioning Research, 34(11), 3254-3269. https://journals.lww.com/nsca-scj/fulltext/2018/08000/Understanding_the_Key_Phases_of_the.10.aspx

Padel-Miralles, R., Martínez-Gallego, R., et. (2025). Biology of Sport, 42(1), 163-169 https://www.termedia.pl/Movement-patterns-and-player-load-insights-from-professional-padel,78,54169,0,1.html

Pino-Ortega, J., Rojas-Valverde, D., Gómez-Carmona, C. D., & Bastida-Castillo, A. (2021). Kinematic analysis of the standing long jump in young basketball players: a pilot study. International Journal of Environmental Research and Public Health, 18(9), 4785. https://www.mdpi.com/1660-4601/18/5/2642

Tauda, M., Suárez, C., & Cruces, J. (2025). Body composition in youth basketball players from Valdivia. Journal of Sport and Health Research, 17(1), 45-54. https://www.preprints.org/frontend/manuscript/bb5e0f00ade82e486f2e0710111c22cc/download_pub

World Medical Association. (2022). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA, 327(24), 2399-2403. https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/

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Declaration of Authors' Participation

Yohandis Abad Camejo: Participated in the development of the measurement instruments and the correlational statistical analysis.

Francisco Freyre Vázquez: Conducted the literature search, developed the introduction, discussion, and conclusions.

Roberto Soto Antomarchy: Conducted the application of measurements and data collection.