Volume 11 issue 2; 2026

Ciencia y Deporte

Universidad de Camagüey "Ignacio Agramonte Loynaz"

Ciencia y Deporte
ISSN 2223-1773, RNPS: 2276
Vol. 11. No. 2, May-August, 2026 p-e401

Original article

Optimizing explosive power through body recomposition in elite volleyball

[*Optimización de la potencia explosiva mediante la recomposición corporal en el voleibol de élite*]

[*Otimizando a potência explosiva através da recomposição corporal no voleibol de elite*]

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Received: 08/05/2026
Accepted: 12/05/2026

ABSTRACT

Introduction: explosive power is a determining factor in elite volleyball performance, especially in attack and blocking actions, where vertical displacement is crucial. In this context, body composition directly influences movement efficiency and the manifestation of relative power.

Objective: To evaluate the effects of an eight-week training macrocycle on body recomposition and vertical explosive performance in professional volleyball players.

Methods: A quasi-experimental design was used with pre- and post-intervention measurements in 17 high-level athletes.

Results: The results showed a significant decrease in adiposity (Δ = −19.2 mm in the sum of skinfolds; $p < 0.001$) and an increase in muscle mass (Δ = +4.42 kg; $p < 0.01$; $d = 1.02$), accompanied by improvements in vertical jump performance (Δ = +5.8 cm in Spike Reach; $p < 0.001$; $d = 1.42$).

Conclusions: Body recomposition, through the reduction of adipose tissue and the increase of functional muscle mass, constitutes an effective strategy to optimize explosive power in elite volleyball.

Keywords: volleyball; relative power; body recomposition; vertical jump; periodization; athletic performance.

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RESUMO

Introdução: A potência explosiva é um fator determinante no desempenho de jogadores de voleibol de elite, especialmente em ações de ataque e bloqueio, onde o deslocamento

vertical é crucial. Nesse contexto, a composição corporal influencia diretamente a eficiência do movimento e a manifestação da potência relativa.

Objetivo: Avaliar os efeitos de um macrociclo de treinamento de oito semanas na recomposição corporal e no desempenho explosivo vertical em jogadores de voleibol profissionais.

Métodos: Foi utilizado um delineamento quase-experimental com medidas pré e pós-intervenção em 17 atletas de alto nível. Resultados: Os resultados mostraram uma diminuição significativa na adiposidade (Δ = −19,2 mm na soma das espessuras das dobras cutâneas; $p < 0,001$) e um aumento na massa muscular (Δ = +4,42 kg; $p < 0,01$; $d = 1,02$), acompanhados por melhorias no desempenho do salto vertical (Δ = +5,8 cm no alcance do ataque; $p < 0,001$; $d = 1,42$).

Conclusões: A recomposição corporal, por meio da redução do tecido adiposo e do aumento da massa muscular funcional, constitui uma estratégia eficaz para otimizar a potência explosiva no voleibol de elite.

Palavras-chave: voleibol; potência relativa; recomposição corporal; salto vertical; periodização; desempenho esportivo.

INTRODUCTION

Performance in elite volleyball depends largely on the ability to generate explosive actions, particularly in attack and blocking movements, where jump height is a determining factor in competitive success (Joksimovic *et al.*, 2023). In this context, explosive power represents an essential physical quality, the optimization of which requires not only the development of maximum strength but also an appropriate relationship between that strength and the athlete's body mass.

From a biomechanical perspective, relative power—understood as the ability to produce force in relation to body weight—plays a central role in sports where displacement of the center of gravity is crucial. In this sense, body composition directly influences movement efficiency, since excess adipose tissue acts as an inert load that limits

performance, while the development of functional muscle mass favors force production (Spearman *et al.,* 2024).

Several studies have shown that combining strength training and plyometric methods can generate significant neuromuscular adaptations in relatively short periods (Haff & Triplett, 2016; Davies *et al.,* 2015). However, evidence on the interaction between these stimuli and changes in body composition in elite athletes remains limited.

To understand the success of the program, it is imperative to define the biomechanical pillars that governed the intervention:

- Relative power: unlike absolute strength, it is the ability to apply force in relation to total body weight. An increase in muscle mass (engine) along with a decrease in fat (ballast) optimizes this variable, allowing for more explosive takeoffs (Cronin and Sleivert, 2005).
- Inert load: This refers to adipose tissue that does not contribute to generating movement. Reducing this load is the most efficient way to improve vertical jump without excessively increasing muscle mass (Spearman *et al.,* 2024).
- Functional hypertrophy: training focused on increasing the transverse diameter of the lower body muscle fibers (reflected in the thigh and calf circumferences), seeking to translate this growth directly into pushing capacity and vertical power (Suchomel *et al.,* 2016).

In this context, the objective of the present study was to analyze the impact of an eight-week training macrocycle on body recomposition and vertical explosive power in high-level volleyball players.

MATERIALS AND METHODS

Study design and sample

The study was conducted using a quasi-experimental pretest/ posttest design, with a total duration of 8 weeks (one macrocycle of competitive preparation). The sample consisted of 17 athletes from the professional roster of the Jakarta club. Bhayangkara Presisi.

Sample characteristics: average age of 24 years; average height of 188 cm.

Inclusion criteria: athletes with an active professional contract, without current injuries at the start of the macrocycle and with a minimum attendance of 95% at training sessions.

Anthropometric protocol (ISAK)

The measurements were performed under the standards of the International Society for the Advancement of Kinanthropometry (ISAK), using the five-component fractionation method of Kerr (1988), recently validated by D'Anastasio et al. (2024) as a high-precision tool for high-performance athletes.

- Measured variables: total body weight, sum of 7 skinfolds (triceps, subscapular, supraspinal, abdominal, front thigh and calf) and corrected muscle circumferences (arm, thigh and calf).
- Harpenden skinfold caliper, metal anthropometric tape and precision digital scale.

Jumping and power tests

Two critical indicators were used to measure the transfer of strength training to specific game performance:

- Spike Reach (Attack Reach): a technical measurement using a three-step approach run on a standardized surface. It is the most tactically relevant indicator in high-level volleyball.

- Blocking ability (two hands): vertical jump from static position with bilateral extension of both arms.
- One-handed jump: vertical jump from a static position with bilateral extension of the right arm.

Intervention program — macrocycle structure

The training program was structured using a wave-like periodization designed to optimize the transfer of strength to vertical power, following the principles of Bompa and Buzzichelli (2019) on the progression of physical capabilities. The macrocycle was divided into three progressive phases:

- Phase I (Weeks 1–3) — Strength endurance: high-density **circuits** (30" work × 30" rest) focused on anatomical adaptation. Tendon and joint structures were strengthened through stair jumping (Wednesday/Friday/Sunday), preparing the stabilizers for higher mechanical loads (Haff and Triplett, 2016).
- Phase II (Weeks 4–7) — Explosive strength and plyometrics: Transition to maximal loads (half squat up to 240 kg). High- intensity plyometrics—free falls and obstacle jumps—was introduced on Wednesdays and Fridays. Plyometric training combined with heavy loads reduces the stretch-shortening cycle (SSC) time, optimizing Spike Reach (Davies et al., 2015).
- Phase III (Week 8) — implementation and comparison: Application of the Post-Activation Potentiation (PAP) method. Heavy lifts (Clean & Jerk, 140 kg) were paired with immediate explosive transfers (reaction jumps). A prior maximal voluntary contraction increases the recruitment of high-threshold motor units, allowing for maximum power expression (Tillin and Bishop, 2009).

RESULTS AND DISCUSSION

Body composition and anthropometry

The statistical analysis performed after the training macrocycle revealed significant changes in all dimensions evaluated. Table 1 summarizes the athletes' morphological transition, highlighting the metabolic 'crossover of curves,' where the reduction of body fat coexisted with selective muscle hypertrophy of the lower body.

Table 1. *- Changes in body composition and anthropometry (n = 17)*

Variable	Pre-test (M ± SD)	Post-test (M ± SD)	net Δ	p-value	d Cohen	Magnitude
Total weight (kg)	81.2 ± 6.4	83.9 ± 5.8	+2.7	< 0.05	0.44	Average
∑ 7 folds (mm)	105.3 ± 14.8	86.1 ± 12.2	-19.2	< 0.0001	1.15	Big
Abdominal fold (mm)	20.6 ± 4.2	16.9 ± 3.1	-3.7	< 0.0001	1.01	Big
Thigh skinfold (mm)	15.6 ± 3.8	12.8 ± 2.9	-2.8	< 0.005	0.82	Big
Muscle mass (kg)	38.2 ± 4.5	42.6 ± 4.1	+4.42	< 0.001	1.02	Big
Fat mass (kg)	11.4 ± 2.9	9.2 ± 2.1	-2.2	< 0.001	0.87	Big
Thigh circumference (cm)	54.2 ± 3.6	58.6 ± 3.2	+4.4	< 0.001	1.32	Very Big
Arm circumference (cm)	32.1 ± 2.4	34.2 ± 2.1	+2.1	< 0.01	0.85	Big

M: mean; SD: standard deviation; Δ: net change; d: Cohen's d.

Explosive power and vertical jump

The increase in vertical reach was the most compelling finding of the study, showing maximum statistical significance and extreme magnitude of effect in the specific attack gesture (Table 2).

Table 2. - *Evaluation of explosive power and vertical jump (n = 17)*

Jump Variable	Pre-test (M ± SD)	Post-test (M ± SD)	Δ (cm)	p-value	d Cohen	Magnitude
Spike Reach (Attack)	83.8 ± 4.6	89.6 ± 4.1	+5.8	< 0.0001	1.42	Extreme
Block (two hands)	71.2 ± 3.9	75.2 ± 3.5	+4.0	< 0.005	0.95	Big
One-handed jump	75.8 ± 4.2	81.6 ± 3.8	+5.8	< 0.001	1.10	Big

M: mean; SD: standard deviation; Δ: net change; d: Cohen's d.

Interpretation of statistical indicators:

- Statistical significance ($p < 0.0001$): The change in Spike Reach and the sum of folds rules out any influence of chance on the observed results.
- Effect size ($d = 1.42$): A value greater than 0.80 is considered large; achieving $d = 1.42$ in elite athletes in just 8 weeks is classified as an extraordinary impact, validating the efficiency of the periodization used.
- Group homogeneity: The reduction in standard deviation in the post-test indicates that the program was effective for the entire team, reducing individual physical gaps and raising the collective athletic level.

Comparative analysis of competitive performance (2023–2026)

Table 3 shows how the implementation of the strength and body recomposition program has directly impacted on-court performance indicators over four consecutive seasons.

Table 3. *- Evolution of competitive performance — Jakarta Bhayangkara Presisi (2023–2026)*

Season	Efficiency (%)	Locks/Set	Status / Achievement
2023	48.1%	2.1	Runner-up (Debut)
2024	54.2%	2.8	Champion (ProLeague)
2025	56.4%	3.1	Two-time champion (ProLiga)
2026 (Current)	**57.1%**	**3.2**	**Leader – Final Four**

Data extracted from the official statistical records of the Indonesian ProLiga and AVC.

The results obtained in Jakarta Bhayangkara Presisi confirm that improvements in explosive performance depend not only on absolute strength but also on optimizing relative power (Cronin and Sleivert, 2005). By reducing the inert load by 19.2 mm of total skinfold thickness, the biomechanical brake was decreased, allowing functional hypertrophy to translate into a net increase of 5.8 cm in spike reach. This gain is not only statistical but also tactical: it allows attackers to clear the height of the opponent's block more frequently, validating the physical preparation strategy implemented for international competitions.

The success of this 8-week macrocycle supports the contemporary periodization theory of Bompa and Buzzichelli (2019), who argue that a concentrated period of maximum strength training and contrast methods is sufficient to generate deep neuromuscular adaptations when there is competent technical direction and rigorous nutritional control.

Statistical analysis using Kerr's fractionation method (1988) confirmed that the increase in total body weight (+2.7 kg) was solely due to functional muscle tissue, more than compensating for the reduction in adipose tissue. The observed morphological transformation supports the findings of Mielgo-Ayuso et al. (2015), who established that the optimal anthropometric profile in elite volleyball should prioritize low adipose mass to maximize the center of gravity during takeoff. The 2.76% decrease in body fat was the determining factor in raising the team's physical performance ceiling.

The increase in lower body muscle perimeters (thigh: +4.4 cm; calf: included in the corrected sum) gave the athletes greater contractile capacity, confirming the findings of Xu et al. (2024) on the relationship between the thickness of the vastus lateralis and the performance in the attack jump in elite male volleyball players.

From a competitive perspective, the progress in game indicators (attack efficiency: +9% between 2023 and 2026; blocks per set: +52%) constitutes ecological evidence of the transfer of strength training to competitive performance, which reinforces the external validity of the findings of the present study.

CONCLUSIONS

Effectiveness of body recomposition: The program achieved a successful metabolic 'curve crossover'. The 4.42 kg increase in skeletal muscle mass demonstrates that the quality of weight gain is more crucial than its magnitude for relative power.

Selective functional hypertrophy: A direct correlation is confirmed between the increase in corrected thigh circumferences and the improvement in vertical takeoff ability.

Real competitive advantage: The 5.8 cm increase in Spike Reach and the extreme effect size (d = 1.42) validate that the integration of anthropometric science (ISAK/Kerr) with wave periodization of strength is the key to success in modern elite volleyball.

Practical applicability: The methodology described is replicable in high-performance contexts that have ISAK certified anthropometric assessment, weightlifting facilities, and supervised nutritional control.

Acknowledgments

The authors express their deep gratitude to the board of directors of the Jakarta club Bhayangkara Presisi for his unwavering support and for providing the necessary resources for the implementation of this scientific program. We especially extend our

gratitude to the 17 athletes who participated in this study, whose commitment, discipline, and effort in each training session made the results presented here possible.

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Conflict of interest:

The authors declare no conflicts of interest.

Authors' contribution:

The authors have participated in the writing of the work and analysis of the documents.