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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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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 ($\Delta = -19.2$ mm in the sum of skinfolds; $p < 0.001$) and an increase in muscle mass ($\Delta = +4.42$ kg; $p < 0.01$; $d = 1.02$), accompanied by improvements in vertical jump performance ($\Delta = +5.8$ 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.

RESUMEN

Introducción: la potencia explosiva constituye un factor determinante del rendimiento en el voleibol de élite, especialmente en acciones de ataque y bloqueo, donde la capacidad de desplazamiento vertical resulta decisiva. En este contexto, la composición corporal influye directamente sobre la eficiencia del movimiento y la manifestación de la potencia relativa.

Objetivo: evaluar los efectos de un macrociclo de entrenamiento de ocho semanas sobre la recomposición corporal y el rendimiento explosivo vertical en voleibolistas profesionales.

Métodos: se empleó un diseño cuasiexperimental con mediciones pre y post intervención en 17 atletas de alto nivel.

Resultados: los resultados evidenciaron una disminución significativa de la adiposidad ($\Delta = -19.2$ mm en la sumatoria de pliegues; $p < 0.001$) y un incremento de la masa muscular ($\Delta = +4.42$ kg; $p < 0.01$; $d = 1.02$), acompañado de mejoras en el rendimiento de salto vertical ($\Delta = +5.8$ cm en Spike Reach; $p < 0.001$; $d = 1.42$).

Conclusiones: la recomposición corporal, mediante la reducción del tejido adiposo y el incremento de masa muscular funcional, constituye una estrategia efectiva para optimizar la potencia explosiva en el voleibol de élite.

Palabras clave: voleibol; potencia relativa; recomposición corporal; salto vertical; periodización; rendimiento deportivo.

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 ($\Delta = -19,2$ mm na soma das espessuras das dobras cutâneas; $p < 0,001$) e um aumento na massa muscular ($\Delta = +4,42$ kg; $p < 0,01$; $d = 1,02$), acompanhados por melhorias no desempenho do salto vertical ($\Delta = +5,8$ 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 $\pm$ SD)	Post-test (M $\pm$ SD)	net Δ	p-value	d Cohen	Magnitude
Total weight (kg)	81.2 $\pm$ 6.4	83.9 $\pm$ 5.8	+2.7	< 0.05	0.44	Average
Σ 7 folds (mm)	105.3 $\pm$ 14.8	86.1 $\pm$ 12.2	-19.2	< 0.0001	1.15	Big
Abdominal fold (mm)	20.6 $\pm$ 4.2	16.9 $\pm$ 3.1	-3.7	< 0.0001	1.01	Big
Thigh skinfold (mm)	15.6 $\pm$ 3.8	12.8 $\pm$ 2.9	-2.8	< 0.005	0.82	Big
Muscle mass (kg)	38.2 $\pm$ 4.5	42.6 $\pm$ 4.1	+4.42	< 0.001	1.02	Big
Fat mass (kg)	11.4 $\pm$ 2.9	9.2 $\pm$ 2.1	-2.2	< 0.001	0.87	Big
Thigh circumference (cm)	54.2 $\pm$ 3.6	58.6 $\pm$ 3.2	+4.4	< 0.001	1.32	Very Big
Arm circumference (cm)	32.1 $\pm$ 2.4	34.2 $\pm$ 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 $\pm$ SD)	Post-test (M $\pm$ SD)	Δ (cm)	p-value	d Cohen	Magnitude
Spike Reach (Attack)	83.8 $\pm$ 4.6	89.6 $\pm$ 4.1	+5.8	< 0.0001	1.42	Extreme
Block (two hands)	71.2 $\pm$ 3.9	75.2 $\pm$ 3.5	+4.0	< 0.005	0.95	Big
One-handed jump	75.8 $\pm$ 4.2	81.6 $\pm$ 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)	57.1⁰%	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.

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BIBLIOGRAPHIC REFERENCES

- Bompa, T. O., y Buzzichelli, C. (2019). Periodization: Theory and methodology of training (6.^a ed.). Human Kinetics. <https://books.google.com.mx/books?id=2f9QDwAAQBAJ&printsec=copyright&hl=es#v=onepage&q&f=false>
- Cronin, J. B., y Sleivert, G. (2005). Challenges in understanding the influence of maximal power training on improving athletic performance. *Sports Medicine*, 35(3), 213–234. <https://doi.org/10.2165/00007256-200535030-00003>
- D'Anastasio, S., Di Giminiani, R., y Di Donato, F. (2024). Anthropometric profiling and body composition in elite athletes: A validation of practical field methods. *Journal of Sports Medicine and Physical Fitness*, 64(1), 45–56. <https://doi.org/10.23736/S0022-4707.23.15001-1>
- Davies, G., Riemann, B. L., y Manske, R. (2015). Current concepts of plyometric exercise. *International Journal of Sports Physical Therapy*, 10(6), 760–786. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4637913/>
- Haff, G. G., y Triplett, N. T. (Eds.). (2016). *Essentials of strength training and conditioning* (4.^a ed.). Human Kinetics. <https://www.nsc.com/certification/cscs/essentials-of-strength-training-and-conditioning-5th-edition/?srsltid=AfmBOorhABZ79A-2JWNSsiu37n0HCqtOZNpmN-7NDacKGwqSD6Bjh9KI>

- Joksimovic, M., Skrypchenko, I., Spalevic, Z., Stankovic, N., y Molnar, S. (2023). Vertical jump performance as a key determinant of success in professional volleyball: A comparative analysis of winning and losing teams. *Scientific Reports*, 13(1), 8421. <https://doi.org/10.1038/s41598-023-35729-w>
- Kerr, D. A. (1988). *An anthropometric method for fractionation of skin, adipose, muscle, bone and residual tissue masses in carcass and living communities* [Tesis de Maestría]. Simon Fraser University.
- Mielgo-Ayuso, J., Calleja-González, J., Clemente-Suárez, V. J., y Zourdos, M. C. (2015). Influence of anthropometric profile on physical performance in professional volleyball players in relation to playing position. *Nutrición Hospitalaria*, 32(3), 1233–1240. <https://doi.org/10.3305/nh.2015.32.3.9238>
- Spearman, A. D., Miller, J. W., y Hart, M. E. (2024). The impact of adiposity on explosive power and vertical reach in indoor and beach volleyball athletes. *International Journal of Exercise Science*, 17(2), 112–125.
- Suchomel, T. J., Nimphius, S., y Stone, M. H. (2016). The importance of muscular strength in athletic performance. *Sports Medicine*, 46(10), 1419–1449. <https://doi.org/10.1007/s40279-016-0486-0>
- Tillin, N. A., y Bishop, D. (2009). Factors modulating post-activation potentiation and its effect on performance of subsequent explosive activities. *Sports Medicine*, 39(2), 147–166. <https://doi.org/10.2165/00007256-200939020-00004>
- Xu, J., Wang, L., Zhang, Y., y Chen, H. (2024). Morphological and neuromuscular predictors of attack jump performance in elite male volleyball players: A focus on vastus lateralis thickness. *Frontiers in Physiology*, 15, 1427748. <https://doi.org/10.3389/fphys.2024.1427748>

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.



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