The Role of Anthropometric Body Proportions and Composition in Olympic Weightlifting Performance: A Narrative Review

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ABSTRACT

This narrative review analyses the influence of anthropometric body dimensions and body composition on performance outcomes in Olympic weightlifting. Evidence suggests that segmental dimensions, such as limb lengths, trunk ratios, and girth measurements, significantly affect leverage, barbell trajectory, and postural control in the snatch and clean and jerk. The distribution of lean mass and the control of body fat influence force output, rate of force development, and lifting efficiency. Biomechanical modelling demonstrates that optimal proportionality improves joint torque production and minimises mechanical work during lifting phases, whereas disproportionate structures may heighten spinal and knee stress, hence increasing the chance of injury. This review highlights the necessity of incorporating anthropometric and compositional profiles into athlete evaluation, skill enhancement, and training development through the synthesis of existing information. It also delineates methodological constraints in current studies and proposes avenues for enhancing the utilisation of anthropometric data in weightlifting research and practice.

Keywords: Olympic weightlifting, body proportion, body composition.

INTRODUCTION

Olympic weightlifting represents a complex sport that tests an athlete's ability to lift maximal loads through two highly technical and explosive movements: the snatch and the clean and jerk. In the snatch, the barbell is lifted from the floor to an overhead position in a single, uninterrupted motion (Garhammer & Taksno, 1992; Jon & Rim, 2023). The clean and jerk, on the other hand, consists of two coordinated phases, the clean, which raises the barbell to the shoulders in one continuous lift, and the jerk, which propels it overhead to full arm extension (Erdağı, 2020).

Performance evaluation in Olympic style weightlifting is grounded in biomechanical and kinematic analyses, focusing on parameters such as barbell trajectory, velocity, and acceleration,

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which serve as indicators of technical efficiency and power generation (Garhammer, 1991, 2001; Gourgoulis et al., 2002; Chiu et al., 2008; Storey & Smith, 2012; Harbili & Alptekin, 2014; Kuruppu et al., 2013; Korkmaz & Harbili, 2015; Daehlin et al., 2017). These analyses are frequently supported by anthropometric modelling, wherein the body is represented as a six-link system comprising the shank, thigh, trunk, upper arm, forearm, and head, to examine mechanical coordination, force distribution, and optimisation of lifting technique (Jon & Rim, 2023). Given that competition occurs within defined weight categories, athletes must manage body composition strategically to maintain or improve relative strength and power output while adhering to weight-class constraints (Stone et al., 1979; Kraemer & Koziris, 1994; Ford et al., 2000). Collectively, these findings emphasise the integrative nature of Olympic weightlifting performance, which depends on the interplay of biomechanical precision and anthropometric proportions to produce efficient and powerful lifting mechanics.

Anthropometry, the scientific assessment of human body dimensions, establishes a critical framework for quantifying morphological attributes that underpin athletic performance (Marfell-Jones et al., 2019). Within sports science, delineating structural characteristics that confer mechanical advantage is integral to understanding sport specific demands and optimising performance potential (Keogh, 1999). In Olympic weightlifting, limb lengths, segment ratios, trunk to limb proportions, and body composition parameters, particularly the distribution of lean soft tissue and fat free mass, exert measurable influence on barbell kinematics, mechanical efficiency, and lift stability (Bayios et al., 2006; Duncan et al., 2006). Empirical studies demonstrate that thigh and lower limb lengths correlate with horizontal barbell displacement during the snatch, illustrating how segmental architecture dictates key components of lift mechanics (Korkmaz & Harbili, 2015). Further evidence indicates that favourable anthropometric proportions, in conjunction with greater muscle and bone mass, are associated with enhanced barbell velocity among both male and female lifters (Harbili & Alptekin, 2014; Vidal Pérez et al., 2021). Large scale comparative analyses across athletic populations additionally highlight the role of proportionality, especially limb to trunk ratios, segment alignment, and optimally distributed lean mass in facilitating mechanical economy and sport specific efficiency (Sedeaud et al., 2012; Mala et al., 2015). Collectively, these findings position anthropometry and body composition not merely as descriptive profiling tools but as fundamental biomechanical determinants that inform athlete selection, individualised training prescription, and the broader understanding of morphological optimisation in Olympic weightlifting.

The present narrative review aims to synthesise current literature on anthropometric and body composition determinants of Olympic weightlifting performance, emphasising how segmental proportions, muscularity, and fat distribution influence biomechanics and lift efficiency. It further seeks to identify methodological gaps and propose future

research directions for integrating anthropometric and compositional insights into athlete profiling, performance assessment, and evidence based training optimisation.

1. Key Body Proportions Determinants of Olympic Weightlifting Performance

Body proportions are fundamental anthropometric determinants of weightlifting performance, influencing leverage, stability, and mechanical efficiency during lifts. Numerous studies have shown that limb lengths, limb to trunk ratios, segmental girths, and bone breadths play decisive roles in technical execution and overall performance outcomes (Erdağı et al., 2020; Vidal Pérez et al., 2021). Longer limb segments and favourable limb to trunk ratios provide mechanical advantages by optimising leverage and force transfer, while greater lower limb girths enhance stability and power generation during pull and recovery phases (Beck et al., 2019; Erdağı et al., 2020). These proportional traits contribute to more efficient bar trajectories, improved balance, and superior lift execution, underscoring the biomechanical importance of structural dimensions in Olympic style weightlifting.

1.1 Height, Breadth, and Girth as Key Determinants of Performance

Height is a significant determinant of Olympic weightlifting performance. While taller lifters often benefit from greater muscle mass potential, which can enhance performance in the snatch, clean and jerk, and squatting movements yet increased height also requires managing longer bar paths and greater technical complexity in Olympic lifts (Siahkouhian & Hedayatneja, 2010; Ferland et al., 2020). Shoulder and chest breadths are strong predictors of performance, contributing to improved leverage, overhead stability, and bar control (Siahkouhian & Hedayatneja, 2010). Similarly, hip breadth and circumference enhance squat and bench press performance by improving stability and force transmission during heavy lifts (Ferland et al., 2020; Ezemagu et al., 2022).

Girth measurements at the chest, shoulders, hips, waist, and thighs show strong positive associations with both absolute and relative strength, reflecting the contribution of muscularity and force producing capacity to overall lifting performance (Ferland et al., 2020; Ezemagu et al., 2022). Elite weightlifters typically present shorter, more compact physiques characterised by moderate stature, broad shoulders, and relatively short limb segments in relation to trunk length, optimising mechanical efficiency and reducing bar path distance during lifts (Musser et al., 2014; Vidal-Pérez et al., 2021). A narrow pelvis to shoulder ratio further enhances vertical force transmission, while larger neck, upper arm, chest, and thigh circumferences are associated with stronger lifting outcomes due to increased muscle size and strength (Ferrari et al., 2022). Collectively, these findings underscore that a combination of height, body breadths, and segmental girths is integral to optimising biomechanical efficiency and maximal performance in Olympic-style weightlifting.

1.2 Limb Length and Torso

Proportions as Determinants of Performance

Anthropometric characteristics fundamentally shape the structural and mechanical factors that determine barbell trajectory, power generation, and technical execution in Olympic weightlifting (Musser et al., 2014; Erdağı et al., 2020; Vidal Pérez et al., 2021). Greater sitting height, reflecting a longer torso, is particularly advantageous for snatch and squat type movements (Siahkouhian & Hedayatneja, 2010; Ferland et al., 2020). Limb proportions further refine these mechanical advantages: thigh and lower leg lengths, for example, directly influence horizontal barbell displacement in the snatch, highlighting the sensitivity of technique efficiency to segmental dimensions (Musser et al., 2014).

Shorter limb segments generally enhance mechanical efficiency by reducing bar path length and enabling higher barbell velocities in both the snatch and clean and jerk (Vidal Pérez et al., 2021). The influence of limb length is nuanced and often sex specific. In males, longer tibial lengths are positively associated with increased snatch velocity, whereas longer thigh segments tend to impede male performance but appear advantageous in females (Vidal Pérez et al., 2021). Upper limb length typically shows a negative association with lifting success, while longer torsos and greater sitting height facilitate more vertical trunk positions, thereby reducing spinal shear forces and improving stability during squat dominant phases of the lifts (Siahkouhian & Hedayatneja, 2010; Vidal Pérez et al., 2021). Favourable segmental ratios, such as shorter femur relative to tibia, further optimise squat mechanics by reducing forward torso lean, while moderate arm lengths aid efficient pulling, though extreme lengths may compromise overhead stability (Erdağı et al., 2020; Vidal-Pérez et al., 2021). Additional structural factors, such as sitting height ratio and foot length, additionally influence barbell displacement, balance, and lift kinematics, as demonstrated in analyses stratified by weight class (Musser et al., 2014; Cunanan et al., 2020).

2. Body Composition as a Key Contributor to Olympic Weightlifting Performance

Body composition is a critical determinant of strength and power performance in Olympic style weightlifting, directly influencing force production, movement efficiency, and weight class optimisation. Higher lean body mass (LBM) and lower body fat percentages are consistently associated with superior lifting outcomes, particularly in the snatch and clean and jerk events (Vidal Pérez et al., 2021; Chaabene et al., 2019). Athletes with greater proportions of lean tissue demonstrate enhanced muscle cross sectional area, rate of force development, and barbell acceleration (Tromaras et al., 2024; Sihanath et al., 2024). Longitudinal studies further reveal that systematic increases in fat free mass and optimized regional muscle distribution, especially in the legs and trunk, are strongly predictive of performance gains across training cycles (Zaras et al., 2020; Chaabene et al., 2019). Collectively, these findings emphasise that maintaining an optimal balance between muscle mass

and fat mass is essential for maximising strength to weight ratio and achieving peak performance in competitive weightlifting.

2.1 Lean Body Mass (LBM) and Its Contribution to Performance

Lean body mass (LBM) is widely recognised as a fundamental determinant of Olympic weightlifting performance, exerting a significant influence on outcomes in both the snatch and the clean and jerk (Tromaras et al., 2024). Higher LBM, particularly in the legs and trunk, contributes to superior lifting performance through enhanced force generation, postural stability, and motor control (Sihanath et al., 2024; Tromaras et al., 2024).

Among regional body compartments, trunk and lower-limb LBM emerge as the strongest predictors of snatch and clean and jerk outcomes, as greater muscularity in these segments enhances explosive power, balance, and technical control by increasing ground reaction forces, accelerating the rate of force development, and improving barbell velocity, all of which are essential for efficient lift execution (Sihanath et al., 2024; Tromaras et al., 2024). Correspondingly, proportional increases in LBM are closely linked with performance gains, highlighting the importance of targeted hypertrophy in key muscle groups (Bagheri et al., 2024). Leg LBM supports explosive phases of the snatch by augmenting ground reaction forces, while trunk LBM stabilises posture and facilitates efficient force transmission (Zaras et al., 2020; Sihanath et al., 2024). Furthermore, both trunk and leg LBM predict lifting outcomes across sexes, though the degree of influence varies. In women, trunk LBM may exert a slightly greater effect due to differences in movement patterns and joint extension, whereas in men, leg LBM is typically the dominant determinant, reflecting the critical role of rapid knee extension during the second pull of the snatch (Sihanath et al., 2024).

2.2 Body Fat Percentage (BF%) and Its Influence on Performance

Body fat percentage (BF%) constitutes a critical anthropometric determinant of performance in Olympic weightlifting, primarily through its influence on the power to weight ratio, mechanical efficiency, and hormonal regulation (Storey & Smith, 2012; Vidal Pérez et al., 2021; Huebner et al., 2023; Tortu et al., 2023; Giovanelli et al., 2024). Maintaining optimal levels of body fat supports adequate energy availability, neuromuscular recovery, and endocrine balance, whereas excessive adiposity negatively impacts relative strength and movement economy (Storey & Smith, 2012). Empirical evidence indicates that elite male weightlifters typically maintain body fat percentage within the range of 8–16%, while female lifters exhibit slightly higher values due to physiological and hormonal distinctions (Erdağı et al., 2020; Tortu et al., 2023; Giovanelli et al., 2024).

BF% plays a nuanced role in Olympic weightlifting performance, with lower BF% being more advantageous in lighter weight categories and moderate levels more prevalent among heavier classes, reflecting the trade-off between

relative and absolute strength (Huebner et al., 2023). Lighter weight class athletes typically exhibit BF% around 8–10%, maximising power output relative to body mass and minimising non-functional tissue that does not contribute to force production (Vidal Pérez et al., 2021). In contrast, heavier lifters often display moderately higher values (≈ 12–15%), as increased total mass can augment absolute strength; however, performance benefits tend to plateau beyond a certain threshold due to reductions in power to weight efficiency (Storey & Smith, 2012).

Recent findings suggest that body composition, particularly the balance between lean and fat mass, strongly influences anaerobic power in both upper and lower limbs, thereby affecting explosive lifting capacity (Tortu et al., 2023). Longitudinal studies further demonstrate that concurrent reductions in BF% and increases in lean body mass yield the most favourable performance outcomes, improving relative strength, technical execution, and metabolic efficiency (Chaabene et al., 2019; Bagheri et al., 2024). Maintaining BF% within an optimal range thus ensures mechanical stability, efficient energy utilisation, and enhanced recovery, underscoring the necessity of achieving equilibrium between muscularity and leanness in elite Olympic weightlifting (Erdağı et al., 2020; Vidal Pérez et al., 2021; Giovanelli et al., 2024).

3.0 Influence of Body Proportions and Body Composition on Biomechanics and Injury Risk in Olympic Weightlifting

Body proportions and body composition fundamentally modulate the biomechanical demands placed on the joints during the Snatch and Clean & Jerk. Segmental ratios such as foot length, tibial length, and upper limb proportions directly influence barbell velocity and the mechanical work required throughout the lift. Evidence shows that longer foot length in females and greater tibial length in males are strongly associated with higher Snatch velocities, whereas relatively longer arms in men negatively affect performance by increasing bar travel distance and joint torque demands (Vidal-Pérez, 2021). Body composition interacts with these structural traits to shape force production and mechanical efficiency: muscle mass percentage demonstrates strong positive associations with both Snatch and Clean & Jerk outcomes, while higher fat mass is consistently linked to reduced performance and less efficient force transmission (Mayhew et al., 1993; Fry et al., 2006; Storey & Smith, 2012). Advanced biomechanical modelling using six-link anthropometric systems further illustrates how joint torques vary across the nine Snatch phases and identifies technical strategies, such as maintaining heel contact in early stages, that reduce total mechanical work (Jon & Rim, 2023). Scaling analyses indicate that excessive stature may diminish strength-to-size ratios due to increases in non-contractile tissue (Alway et al., 1992; Batterham & George, 1997). Together, these findings highlight that both structural proportions and body composition intricately shape biomechanical efficiency and lifting capacity in Olympic weightlifting.

Anthropometric proportions play a

critical role in shaping joint mechanics and influencing injury risk in Olympic weightlifting. Favourable limb-trunk ratios, such as shorter femurs relative to torso length, enable more upright postures during squatting and pulling movements, improving mechanical efficiency and reducing stress on the lumbar spine and knees (Musser et al., 2014; Escamilla et al., 2001). In contrast, less advantageous proportions may necessitate compensatory strategies, including increased lumbar flexion or excessive anterior knee translation, both of which heighten the likelihood of overuse injuries and technical faults (Keogh & Winwood, 2017). Nevertheless, anthropometry functions within a broader performance system that incorporates neuromuscular coordination, technical mastery, training history, and muscle architecture, meaning that structural disadvantages can often be mitigated through targeted hypertrophy, mobility development, and individualised technical adjustments (Nagahi et al., 2020). Comprehensive profiling of body proportions and body composition therefore, provides valuable insight for athlete selection, technique optimisation, and long-term training planning. Segmental and whole-body composition assessments, such as muscle mass distribution obtained from bioimpedance or imaging methods, offer additional information relevant to performance, recovery, and load management (Mazić et al., 2014). By integrating structural characteristics with biomechanical and neuromuscular assessments, coaches can tailor stance width, grip width, pull trajectory, and starting positions to the athlete's morphology, thereby enhancing technical efficiency, reducing injury risk, and supporting sustainable performance progression.

CONCLUSION

Anthropometric body proportions and body composition collectively shape the mechanical and technical demands of Olympic weightlifting. Segmental lengths, limb trunk ratios, and girths influence leverage efficiency, barbell displacement, joint moment distribution, and overall biomechanical economy in both the snatch and clean and jerk. Concurrently, lean body mass, particularly in the trunk and lower limbs emerges as a central predictor of lifting performance due to its direct contributions to force production, stability, and barbell acceleration. Optimal body fat levels further support relative strength, movement efficiency, and energy utilisation, although requirements differ across weight categories. Evidence from biomechanical modelling underscores how favourable proportions minimise mechanical work and joint torques, whereas structural disadvantages may increase injury risk through compensatory movement strategies. Collectively, the literature affirms that anthropometry and body composition function not merely as descriptive indicators but as fundamental determinants of performance capacity, injury susceptibility, and technical optimisation in Olympic weightlifting. Their systematic assessment is therefore crucial for athlete selection, individualised training planning, and evidence based performance enhancement.

FUTURE DIRECTIONS

Future research should employ longitudinal designs and advanced biomechanical tools to further investigate the links between anthropometric characteristics and weightlifting performance. Greater consideration of sex, age and population specific variation is needed to strengthen normative datasets and improve talent identification. Combining imaging techniques with machine-learning approaches may also enhance predictions of optimal body proportions, lean mass distribution, and injury risk. Applied work should prioritise the integration of anthropometric and body-composition profiling into personalised training strategies, weight-class selection, and long-term athlete monitoring.

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