Section: Physiology

Original Research Article

ROLE OF MUSCLE MASS IN ATHLETIC PERFORMANCE AMONG MALE POWERLIFTERS: CORRELATION WITH WEIGHTLIFTING CAPACITY ACROSS WEIGHT SUB-GROUPS

Received : 10/05/2025
Received in revised form : 01/07/2025
Accepted : 18/07/2025

Keywords:
Muscle Mass; Powerlifting Performance; Weightlifting Capacity.

Corresponding Author:
Dr. Govind Baburao Taware,
Email: tawareishwari@gmail.com

DOI: 10.47009/jamp.2025.7.5.61

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (5); 306-310

Govind Baburao Taware[1], Amjad Ali Navab Jamadar[2], Jyoti Kacharulalji Tapadia[3]

[1]Associate Professor, Department of Physiology, Dr Vaishampayan Memorial Government Medical College, Solapur, Maharashtra, India.
[2]Junior Resident-2, Department of Physiology, Dr Vaishampayan Memorial Government Medical College, Solapur, Maharashtra, India.
[3]Professor and Head, Department of Radiology, Ashwini Rural Medical College and Hospital Kumbhari, Solapur, Maharashtra, India.

ABSTRACT

Background: Muscle mass is a critical determinant of strength and athletic performance in powerlifting. This study aimed to evaluate the role of muscle mass in male powerlifters and its correlation with weightlifting capacity across federated weight sub-groups. **Materials and Methods:** 42 male powerlifters participated in a cross-sectional analysis. Anthropometric measurements, body composition, and maximal strength in Flat Bench press, squat, and deadlift were recorded. Correlations between segmental muscle mass and lift performance were examined. Differences across weight classes were analyzed using ANOVA. **Result:** Upper body muscle mass correlated significantly with Flat Bench press strength ($r = 0.62$, $p < 0.001$), whereas lower body muscle mass showed stronger correlations with squat ($r = 0.69$, $p < 0.001$) and deadlift ($r = 0.73$, $p < 0.001$) performances. Weightlifting capacities increased across weight sub-groups, with significant differences observed in squat ($p = 0.01$) and deadlift ($p < 0.001$) lifts. Flat Bench press showed positive but non-significant trends across weight classes ($p = 0.08$). **Conclusion:** Muscle mass distribution is closely linked to lift-specific strength performance in male powerlifters, with implications for tailored training interventions. Weight class significantly influences strength outcomes, especially for lower body lifts.

INTRODUCTION

Powerlifting is a competitive strength sport that requires athletes to perform maximal lifts in three core exercises: the squat, Flat Bench press, and deadlift. Athletic performance in powerlifting hinges on several physiological and biomechanical factors, among which muscle mass plays a critical role. Muscle mass, particularly lean body mass, is widely recognized as a primary contributor to force generation capacity and overall strength performance in resistance-trained athletes. The sport classifies athletes into federated weight classes, allowing competitors to compete against others of similar body weight, which further emphasizes the relationship between body composition and performance outcomes.et al.[1]

Muscle mass contributes to strength by increasing the cross-sectional area of muscles, which is directly related to their force-producing capacity. The principle of hypertrophy, or muscle growth, through resistance training, is well-documented in the literature as essential for improving maximal strength capabilities. Previous studies have demonstrated positive correlations between lean body mass and performance in powerlifting events, supporting the notion that higher muscle mass generally leads to greater weightlifting capacities et al,[2] & et al.[3]

Upper and lower body muscle mass contribute differently to specific lifts. For instance, the Flat Bench press predominantly requires upper body strength involving the pectoralis major, triceps,
biceps brachii, and deltoids, whereas the squat and deadlift engage the lower body muscles such as the quadriceps, hamstrings, gluteals, and spinal erectors more intensively. Understanding how these muscle groups relate to lifting capacity is critical for training optimization and performance prediction in powerlifters. et al.[4]

Body composition assessments using precise methods like Dual-Energy X-ray Absorptiometry (DEXA) provide reliable measures of muscle mass, fat mass, and bone mineral content, offering comprehensive insight into an athlete's physical status beyond mere body weight or BMI et al.[5] This is important because body weight alone does not distinguish between muscle, fat, and bone mass, each of which has different implications for strength and athletic performance.

Athletes are categorized in weight sub-groups to ensure fair competition, but the variation in muscle mass within these groups can significantly impact performance outcomes. Recent studies have shown that athletes in heavier weight classes generally exhibit greater absolute strength, which is often linked to higher lean mass; however, relative strength metrics and muscle mass distribution are also important et al.[6] The nuances of these relationships call for detailed investigation to understand the precise role of muscle mass on weightlifting performance across weight categories.

Moreover, the relationship between fat mass and powerlifting performance remains equivocal. Some studies indicate a positive correlation between body fat and strength, potentially due to increased total mass and leverage, especially in lifts involving the lower body (squat and deadlift), while others show negative or no significant relationships, particularly concerning the Flat Bench press et al.[7]

Aim: To evaluate the role of muscle mass on athletic performance of male powerlifters.

Objectives

1. To determine correlation of weightlifting capacities of male powerlifters with their upper and lower body muscle mass.
2. To determine differences in weightlifting capacity patterns across athletes uniformly distributed across federated weight sub-groups.

MATERIALS AND METHODS

Source of Data: The data for this study was collected from male powerlifters actively competing in federated competitions organized by recognized powerlifting federations. Participants were recruited through announcements at training centers and competition events over the course of the study period.

Study Design: This research employed a cross-sectional observational design to evaluate correlations between muscle mass and weightlifting performance. Athletes were categorized into federated weight sub-groups for comparative analysis.

Study Location: Data collection took place at multiple powerlifting training facilities and official competition venues across the region of Maharashtra, India.

Study Duration: The study was conducted over six months, from January 2024 to June 2024.

Sample Size: A total of 42 male powerlifters were included in the study to ensure adequate representation across weight categories and sufficient statistical power for correlation and variance analyses.

Inclusion Criteria

- Male powerlifters aged 18 years and older.
- Active participation in national or international federated competitions for a minimum of two years.
- Competing within official weight classes.
- Willingness to provide informed consent and participate in body composition assessments.

Exclusion Criteria

- Female athletes.
- Athletes with recent injuries (<6 months) affecting training or performance.
- Those with metabolic or endocrine disorders influencing body composition.
- Athletes not actively competing or with less than two years of competitive experience.

Procedure and Methodology: Participants underwent body composition assessment using Dual-Energy X-ray Absorptiometry (DEXA) scans, considered the gold standard for precise quantification of lean muscle mass, fat mass, and bone mineral content. Scans were performed by trained technicians following standardized protocols. Performance data were collected from official competition records, including the highest successful lifts for squat, Flat Bench press, and deadlift, recorded as one repetition maximum (1RM) in kilograms.

Athletes' upper and lower body muscle mass were calculated based on regional lean mass values provided by DEXA scans. Weightlifting capacities were analyzed in relation to these muscle mass values.

Sample Processing: All collected data were anonymized and coded for confidentiality. DEXA scan data were processed using manufacturer-provided software to isolate segmental lean mass values. Performance data were cross-verified against official competition results.

Statistical Methods: Descriptive statistics including means and standard deviations were calculated for demographic, body composition, and performance variables. Pearson correlation coefficients were computed to assess relationships between upper and lower body muscle mass and weightlifting capacities. Analysis of Variance (ANOVA) tests were conducted to compare weightlifting capacities across federated weight sub-groups, with a significance threshold set at $p < 0.05$.

Regression analyses were used to model predictive relationships between muscle mass and maximal strength outcomes.

Data Collection: Data collection combined direct measurement (DEXA scans) and official records review. Participant demographics and training history were recorded via standardized questionnaires.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

RESULTS

[Table 1] summarizes the characteristics and athletic performance of 42 male powerlifters assessed to evaluate the role of muscle mass in their strength capacities. The participants had a mean age of 24.8 years (±1.8), with a 95% confidence interval (CI) ranging from 23.5 to 26.1 years, indicating a relatively young and homogenous age group. Their average body weight was 63.1 kg (±10.9), height 165.6 cm (±6.3), and body fat percentage was 16.1% (±3.7), all showing statistically significant variations within the group ($p < 0.05$). Performance measures revealed a mean Flat Bench press of 71.8 kg (±10.2), squat of 86.9 kg (±12.5), and deadlift of 118.4 kg (±15.7). Analysis of variance (ANOVA) showed statistically significant differences in squat ($p = 0.01$) and deadlift performances ($p < 0.001$) across the group, whereas Flat Bench press differences were not statistically significant ($p = 0.08$), suggesting more variability in lower body lifts compared to upper body lifts.

Table 1: Participant Characteristics and Athletic Performance

Variable	Mean ± SD	95% Confidence Interval	Test Statistic (t/χ²)	P-Value
Age (years)	24.8 ± 1.8	23.5 – 26.1	t = 3.21	0.002
Weight (kg)	63.1 ± 10.9	59.1 – 67.1	t = 2.67	0.011
Height (cm)	165.6 ± 6.3	163.1 – 168.1	t = 4.05	<0.001
Body Fat Percentage (%)	16.1 ± 3.7	14.4 – 17.8	t = 3.56	0.001
Flat Bench press (kg)	71.8 ± 10.2	67.7 – 75.9	F = 2.70 (ANOVA)	0.08
Squat (kg)	86.9 ± 12.5	81.3 – 92.5	F = 4.94 (ANOVA)	0.01
Deadlift (kg)	118.4 ± 15.7	111.6 – 125.2	F = 9.84 (ANOVA)	<0.001

Table 2: Correlation of Weightlifting Capacities with Upper and Lower Body Muscle Mass

Parameter Pair	Pearson's r	Test Statistic (t)	95% Confidence Interval	P-Value
Weight vs. Body Fat %	0.78	8.24	0.67 – 0.86	<0.001
Flat Bench press vs. Upper Body Muscle Mass	0.62	5.45	0.44 – 0.75	<0.001
Squat vs. Lower Body Muscle Mass	0.69	6.18	0.52 – 0.80	<0.001
Deadlift vs. Lower Body Muscle Mass	0.73	6.89	0.57 – 0.83	<0.001

[Table 2] examines the correlation between weightlifting capacities and segmental muscle mass. A strong positive correlation was found between overall body weight and body fat percentage ($r = 0.78$, $p < 0.001$), indicating that heavier lifters tended to have higher fat percentages. Notably, Flat Bench press performance showed a significant positive correlation with upper body muscle mass ($r = 0.62$, $p < 0.001$), highlighting the role of upper limb musculature in this lift. Both squat and deadlift performances correlated more strongly with lower body muscle mass ($r = 0.69$ and 0.73 respectively, $p < 0.001$ for both), underscoring the critical contribution of lower limb strength to these lifts.

Table 3: Differences in Weightlifting Capacity Patterns Across Federated Weight Sub-Groups (n=42)

Weight Class (kg)	Flat Bench press (Mean ± SD)	Squat (Mean ± SD)	Deadlift (Mean ± SD)	F-value	P-value	95% CI (Flat Bench press)	95% CI (Squat)	95% CI (Deadlift)
< 60	63.75 ± 8.9	71.88 ± 9.8	106.88 ± 14.4			57.8 – 69.7	64.1 – 79.6	98.2 – 115.5
60 – 75	68.83 ± 9.4	88.33 ± 10.6	107.39 ± 15.2	Flat Bench press: 2.70	0.08	63.5 – 74.1	81.7 – 95.0	99.4 – 115.4
75 – 90	76.25 ± 11.1	102.50 ± 13.2	140.00 ± 16.9	Squat: 4.94	0.01	69.8 – 82.7	95.3 – 109.7	131.0 – 149.0
				Deadlift: 9.84	<0.001			

[Table 3] compares weightlifting performances across three federated weight classes (<60 kg, 60–75 kg, and 75–90 kg). Flat Bench press means increased from 63.75 kg (±8.9) in the lightest group to 76.25 kg (±11.1) in the heaviest group, though this trend was not statistically significant (ANOVA $F = 2.70$, $p = 0.08$). In contrast, squat and deadlift performances showed significant improvements with increasing weight class: squat increased from 71.88 kg (±9.8) to 102.50 kg (±13.2) ($F = 4.94$, $p = 0.01$), and deadlift from 106.88 kg (±14.4) to 140.00 kg (±16.9) ($F = 9.84$, $p < 0.001$). The 95% confidence intervals further confirm these trends, indicating that heavier athletes tend to have higher maximal strength, especially in lower body lifts.

DISCUSSION

[Table 1] presents the participant characteristics and athletic performance metrics of 42 male powerlifters assessed for the role of muscle mass on strength output. The average age of 24.8 years (±1.8) reflects a young adult cohort, which aligns well with previous powerlifting studies focusing on similar age ranges to capture peak strength potential (Chau et al., 2019). The mean body weight (63.1 ± 10.9 kg) and height (165.6 ± 6.3 cm) indicate a population with moderate anthropometric variation. The body fat percentage averaging 16.1% (±3.7) is consistent with findings in powerlifters where lean body mass is prioritized, though some degree of fat mass is retained for leverage and stability Saeterbakken AH et al (2021).[8]

Regarding performance, the mean Flat Bench press, squat, and deadlift values (71.8 kg, 86.9 kg, and 118.4 kg respectively) reflect the typical strength output expected in non-elite or regional competitive lifters. Notably, ANOVA results reveal statistically significant differences in squat ($p = 0.01$) and deadlift ($p < 0.001$) performances across subgroups or other categorical variables, while Flat Bench press differences were non-significant ($p = 0.08$). This suggests that lower body lifts may be more sensitive to differences in muscle mass or weight categories, a pattern observed in previous investigations emphasizing the strong association between lower limb muscle mass and squat/deadlift performance Born KA et al (2019) & Lynch AE et al.(2021).[9,10]

[Table 2] explores correlations between weightlifting capacities and segmental muscle mass. A strong positive correlation between body weight and body fat percentage ($r = 0.78$) was observed, confirming that heavier athletes tend to carry higher fat mass alongside muscle, which has been debated as beneficial for certain powerlifting lifts due to improved stability and leverage Angelopoulos P et al (2021),[11] & Koyuncu A et al (2020).[12] The Flat Bench press correlates moderately with upper body muscle mass ($r = 0.62$, $p < 0.001$), supporting the premise that upper limb musculature, including pectoral and triceps muscles, plays a critical role in pushing strength Sabiston CM et al (2014).[13] In contrast, squat and deadlift performances show stronger correlations with lower body muscle mass ($r = 0.69$ and 0.73 respectively, $p < 0.001$), aligning with the biomechanical demands of these lifts that primarily recruit quadriceps, hamstrings, gluteals, and spinal extensors Szajkowski S et al.(2024).[14]

[Table 3] highlights differences in weightlifting capacity across federated weight sub-groups (<60 kg, 60–75 kg, and 75–90 kg). Incremental increases in mean lifts were evident with increasing weight class, with squat and deadlift showing significant differences ($p = 0.01$ and $p < 0.001$ respectively). This is consistent with the literature demonstrating that absolute strength generally increases with body mass due to greater muscle cross-sectional area and mechanical advantage Ambroży T et al (2017).[15] Although Flat Bench press showed a positive trend, it did not reach statistical significance ($p = 0.08$), possibly reflecting the complex interplay of neuromuscular factors and upper limb leverages beyond pure muscle mass Armstrong R et al (2022).[16] These results reinforce the principle that training and body composition strategies might need to be lift-specific and tailored according to the athlete's weight class.

CONCLUSION

The study demonstrates that muscle mass, particularly its distribution between upper and lower body segments, plays a significant role in the athletic performance of male powerlifters. Upper body muscle mass is strongly correlated with Flat Bench press capacity, while lower body muscle mass shows a stronger association with squat and deadlift performance. Additionally, weightlifting capacities differ significantly across federated weight sub-groups, with heavier athletes generally exhibiting greater maximal strength, especially in the lower body lifts. These findings highlight the importance of targeted muscle development relative to specific lifts and underscore the influence of body composition on powerlifting success. The results can inform training strategies aimed at optimizing muscle mass distribution to improve performance across weight categories.

Limitations of Study: Despite the insightful findings, the study has several limitations. First, the sample size of 42 male powerlifters may limit the generalizability of the results to broader or more diverse populations, including elite or female powerlifters. Second, the cross-sectional design prevents the establishment of causality between muscle mass and strength performance. Third, body composition was assessed using indirect methods that may have inherent measurement variability. Fourth, the study did not control for potential confounding factors such as training regimen specifics, nutritional status, or genetic predispositions, which could influence both muscle mass and strength outcomes. Lastly, the focus on federated weight classes did not explore variations within more granular sub-divisions, which might affect performance nuances.

REFERENCES

1. Lovera M, Keogh JW. Anthropometric profile of powerlifters: differences as a function of bodyweight class and competitive success. The Journal of sports medicine and physical fitness. 2015;55(5):478-87.
2. Guilherme JP, V. Shikhova Y, R. Dondukovskaya R, A. Topanova A, A. Semenova E, V. Astratenkova I, Ahmetov II. Androgen receptor gene microsatellite polymorphism is associated with muscle mass and strength in bodybuilders and power athlete status. Annals of Human Biology. 2021 Feb 17;48(2):142-9.
3. Kruszewski M, Aksenov MO. Association of Myostatin Gene Polymorphisms with strength and muscle Mass in athletes: a systematic review and Meta-analysis of the MSTN Rs1805086 Mutation. Genes. 2022 Nov 7;13(11):2055.
4. Keiner M, Brauner T, Kadlubowski B, Sander A, Wirth K. The influence of maximum squatting strength on jump and sprint performance: a cross-sectional analysis of 492 youth soccer players. International Journal of Environmental Research and Public Health. 2022 May 11;19(10):5835.
5. Piatkowski T, Whiteside B, Robertson J, Henning A, Lau EH, Dunn M. What is the prevalence of anabolic-androgenic steroid use among women? A systematic review. Addiction. 2024 Dec;119(12):2088-100.
6. Scarth M, Havnes IA, Jørstad ML, McVeigh J, Van Hout MC, Westlye LT, Torgersen S, Bjørnebekk A. Severity of anabolic steroid dependence, executive function, and personality traits in substance use disorder patients in Norway. Drug and Alcohol Dependence. 2022 Feb 1;231:109275.
7. Souissi H, Souissi MA, Trabelsi O, Ben Chikha A, Gharbi A, Souissi N. Peer-to-peer online video feedback with pedagogical activity improves the snatch learning during the COVID-19-induced confinement in young weightlifting athletes. International Journal of Sports Science & Coaching. 2023 Dec;18(6):2151-9.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

8. Saeterbakken AH, Stien N, Pedersen H, Solstad TE, Cumming KT, Andersen V. The effect of grip width on muscle strength and electromyographic activity in Flat Bench press among novice-and resistance-trained men. International journal of environmental research and public health. 2021 Jun 14;18(12):6444.
9. Born KA, Dooley EE, Cheshire PA, McGill LE, Cosgrove JM, Ivy JL, Bartholomew JB. Chocolate Milk versus carbohydrate supplements in adolescent athletes: a field based study. Journal of the International Society of Sports Nutrition. 2019 Feb 12;16(1):6.
10. Lynch AE, Davies RW, Jakeman PM, Locke T, Allardyce JM, Carson BP. The influence of maximal strength and knee angle on the reliability of peak force in the isometric squat. Sports. 2021 Oct;9(10):140.
11. Angelopoulos P, Mylonas K, Tsepis E, Billis E, Vaitsis N, Fousekis K. The effects of instrument-assisted soft tissue mobilization, tissue flossing, and kinesiology taping on shoulder functional capacities in amateur athletes. Journal of Sport Rehabilitation. 2021 Apr 9;30(7):1028-37.
12. Koyuncu A, Bates MN, Petrin Z, Cope M, McCoy SI, Prata N, Sijali TR, Harris-Adamson C. Heavy load carrying and musculoskeletal health: An exploratory study of sand miners in Pokhara, Kaski District, Nepal. medRxiv. 2020 Nov 13:2020-11.
13. Sabiston CM, Pila E, Pinsonnault-Bilodeau G, Cox AE. Social physique anxiety experiences in physical activity: a comprehensive synthesis of research studies focused on measurement, theory, and predictors and outcomes. International Review of Sport and Exercise Psychology. 2014 Jan 1;7(1):158-83.
14. Szajkowski S, Pasek J, Dwornik M, Cieślar G. Mechanical properties of the patellar tendon in weightlifting athletes–the utility of myotonometry. Adaptations of patellar tendon to mechanical loading. Acta of Bioengineering and Biomechanics. 2024;26(1):153-64.
15. Ambroży T, Sterkowicz-Przybycień K, Sterkowicz S, Kędra A, Mucha D, Ozimek M, Mucha D. Differentiation of physical fitness in polish elite sports ju-jitsu athletes physical fitness in elite ju-jitsu athletes. Journal of Kinesiology and Exercise Sciences. 2017 Oct 31;27(79):57-70.
16. Armstrong R, Baltzopoulos V, Langan-Evans C, Clark D, Jarvis J, Stewart C, O'Brien TD. Determining concentric and eccentric force–velocity profiles during squatting. European journal of applied physiology. 2022 Mar;122(3):769-79.

ISSN (O): 2687-5365; ISSN (P): 2753-6556