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Relative anthropometric parameters as predictors of strength abilities of Olympic weightlifters

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Abstract

Background: Body proportions and muscular development are closely linked to force production capacity, yet their application as predictive tools in Olympic weightlifting training and athlete selection remains insufficiently explored.
Aims: The study aimed to quantify the relationships between specific relative indexes of body muscularity and maximal force generated during two classic multi-joint resistance exercises – the back squat and the clean and jerk deadlift.
Methods: 17 athletes participated in the study, all of whom were national-level competitors. Linear regression equations were estimated between four relative body muscularity parameters (Height/Body mass^3 (BMH), Height/Shin circumference (HS), Height/Thigh circumference (HT), Height/Arm circumference (HA), and Height/Chest circumference (HC)) and maximal strength in back squat and clean and jerk deadlift.
Results: We calculated statistically significant Pearson correlation coefficients and linear regression coefficients between the studied relative body muscularity parameters and maximal muscle strength in the back squat and deadlift. The adjusted R-squared values ranged from 0.082 to 0.768 across the regression equations.
Conclusion: All studied relative parameters were statistically significant predictors of maximal strength in the deadlift and squat, with only 3 exceptions (BMH for the deadlift and BMH and HS for the squat). These results (in conjunction with the high adjusted R-squared values of the regressions) indicate that the constructed statistical models explain a relatively high proportion of the variation in the results. These findings can be used in training practice as guidelines for anthropometric changes to improve sports performance.

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INTRODUCTION

Resistance training has been a mainstay in athletic preparation since ancient times, with structured weight training documented as far back as the Ancient Olympics (Panayotov, 2020). Olympic weightlifting has been an individual sport since 1920, with two official competitive movements: the snatch and the clean and jerk. These exercises are technically complex, highly dynamic, and require the simultaneous expression of maximum strength and high movement speed, a quality often referred to as power-speed ability (Siff, 2000; Zatsiorsky, 2000). Weightlifting routinely uses additional resistance exercises, primarily the back squat and clean and jerk deadlift, which are considered the cornerstones of the Bulgarian training system and other leading training systems (Simmons, 2007; Issurin, 2010; Thompson et al., 2020). Maximal strength in these exercises is defined as the ability to generate peak force against external resistance through maximal voluntary contraction, widely recognized as a critical determinant of performance in competitive lifting.

Regression-based relevance in Olympic weightlifting has gained increased attention in the last decade (Chen et al., 2026). Recent studies show that performance in supporting

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exercises, such as the back squat and pull variations, is a strong predictor of competitive lifting results. Regression modeling based on supporting exercises has high predictive accuracy in the context of Olympic weightlifting, extending similar approaches beyond performance variables to morphological variables that influence strength capacity itself (Sandau & Kipp 2025). Supporting exercises can predict competition results, so the anthropometric characteristics that determine strength in these exercises serve as the missing link in this predictive chain.

Maximal muscle strength is positively correlated with muscle size and cross-sectional area (Reggiani & Schiaffino, 2020; Schoenfeld, 2010), and anthropometric characteristics, including body segment length and circumference, are morphological determinants of force production in composite resistance exercises (Zatsiorsky & Kraemer, 2006). Body proportions influence joint mechanics, lever arms, and the contribution of individual muscle groups throughout the range of motion, thereby affecting performance in exercises such as squats and deadlifts specifically for athletes (Ratamess, 2012; Verkhoshansky & Siff, 2010). Anthropometric characteristics identify talent across various sports, and simple, measurable, and replicable screening tools in the field are practical prerequisites for the effectiveness of such programs (Han et al., 2023; Mijaica et al., 2025). In particular, the ability of coaches to identify the morphological potential of young athletes before long-term investment in technical training is made has direct consequences for the efficiency of coaching and resource allocation (Ratamess, 2012). In Olympic weightlifting, there are no standardized, evidence-based morphological screening instruments available for this purpose. While other sports have developed anthropometric profiles that can be used as selection criteria, Olympic weightlifting still relies on subjective assessments by coaches or on absolute measurements that do not account for individual body proportions, a gap that, if left unaddressed, could lead to both under-selection and under-development of talented athletes.

Most published studies on this topic have been conducted on powerlifting populations. Keogh et al. (2007, 2009) examined anthropometric profiles and their relationship to competitive performance in powerlifters, finding greater differences between weight classes than between stronger and weaker athletes within the same class. Ferland et al. (2020) used stepwise regression analysis to develop predictive equations for 1RM squat, bench press, and deadlift based on anthropometric and body composition variables in junior powerlifters and American football players, showing that the relative muscle stiffness index is a meaningful predictor of performance in these populations. Ferrari et al. (2022) also studied powerlifters and reported that upper-arm length relative to height was the only anthropometric predictor that was statistically significant for competitive performance. In Olympic weightlifting specifically, Ebada (2011) examined the relationship between body mass, height, and BMI with competition results, while Vidal Pérez et al. (2021) analyzed limb length, body composition, and barbell kinematics, finding a positive correlation between muscle mass percentage and performance in the snatch and clean and jerk. Vigotsky et al. (2019) examined relative anthropometric predictors of back squat strength and identified relative fat-free mass as the main significant variable in the multiple regression model.

Most previous studies have focused on powerlifters, whose training methods, strength-speed profiles, and biomechanical demands differ significantly from those of Olympic weightlifters (Zatsiorsky & Kraemer, 2006; Alcazar et al., 2019; Ratamess, 2012). Absolute anthropometric measurements or complex body composition assessments such as DXA or fat-free mass calculated from skinfold measurements require laboratory equipment that is not available in most field training environments (Vigotsky et al., 2019; Ferland, Pollock, et al., 2020). While the Bulgarian weightlifting system has long applied a regression-based approach to link additional training performance with competition results (Boyanov, 2014), similar models linking body proportions directly to strength capacity remain underdeveloped. A linear regression model linking relative muscle tightness indices based on body circumference to 1RM performance in support exercises that form the core of Olympic weightlifting training. However, this absence limits coaches' ability to use readily accessible anthropometric data for athlete profiling, performance prediction, and identification of specific morphological targets for training interventions. This study addresses this gap by investigating the relationship between five relative muscle tightness indices derived solely from standard anthropometric measurements and maximum strength in the back squat, clean and jerk, and deadlift in national-level Olympic weightlifters.

This research aims to quantify these relationships through linear regression modeling to provide practical, field-applicable screening tools for coaches and sports scientists in athlete profiling, exercise prescription, and sports selection in Olympic weightlifting. By operationalizing muscularity as height-normalized indices rather than absolute measurements or laboratory-dependent body composition assessments such as DXA or skinfold-derived fat-free mass, the study advances a low-cost, replicable screening model directly applicable to field training environments without specialized equipment.

METHOD

Research Design

This study used a cross-sectional correlational design to examine the relationship between relative anthropometric indices and maximum strength performance in Olympic weightlifters. Stepwise linear regression was applied to determine the predictive value of selected anthropometric indices on one-rep maximum (1RM) performance in two specific Olympic weightlifting exercises (Papoulis, 1991). This design was chosen to simultaneously examine several predictor variables while controlling for multicollinearity, given the correlated nature of anthropometric measurements.

Participants

17 male Olympic weightlifters with competitive experience at the national level participated in this study (age: 21.29 ± 2.97 years; athletic age: 6.56 ± 3.92 years). All participants were actively competing at the national level at the time of data collection, ensuring their familiarity with the test exercises and loading protocols used. Inclusion criteria required a minimum of three years of structured Olympic weightlifting training and active competitive status at the national level. Participants who had experienced musculoskeletal injuries within 3 months of data collection were excluded from the study. All participants provided written informed consent before participation, and all procedures were conducted in accordance with the Declaration of Helsinki.

Research Instruments

Anthropometric Measurements

Six anthropometric parameters were assessed: body mass, height, and four body circumferences (chest, thigh, upper arm, and calf). All measurements were performed following the standard procedures established by Preedy (2012). Height was defined as the distance from the floor to the vertex of the highest point on the sagittal line of the skull, measured while the participant stood upright without shoes. Measurements were taken using a Martin-type anthropometer by Cameron (2022) with an accuracy of 0.1 cm. Body mass was recorded using a Tanita digital scale with an accuracy of 0.5 kg. Chest circumference was measured at the level below the mammary areola on the anterior side and the inferior angle of the scapula on the posterior side. Thigh circumference was measured at the level of the right gluteal fold, with the participant standing in a shoulder-width position. Upper arm circumference was recorded as the largest circumference of the right upper arm in a relaxed state. Calf circumference was defined as the largest circumference of the right calf, measured while the participant stood with feet shoulder-width apart. All body circumferences were recorded in centimeters using a standard anthropometric tape with an accuracy of 0.1 cm. All measurements were performed by a single trained investigator, with standard instructions verbally communicated consistently to each participant to minimize inter-measurement variability.

Anthropometric Indices

Given that absolute circumference values are inherently correlated with body mass and, indirectly, with maximum strength, all variables were expressed as indices relative to height, thereby isolating morphological proportionality from overall body size.

Five indices were derived: (1) Body Mass-Height Index (BMI): Body mass (kg) divided by height^3 (m^3). This index, also known as the *Ponderal Index* or *Corpulence Index*, was chosen in place of the standard Body Mass Index (BMI) because of its greater validity in individuals with extreme stature (Taylor, 2010; V Roth, 2018). BMH is used as an indicator of overall muscularity. (2) Height-Calf Circumference Index (HS): Height divided by calf circumference. This index operationalizes lower limb muscularity relatively. (3) Height-Upper Arm Circumference Index (HA): Height divided by upper arm circumference. This index operationalizes upper extremity muscularity relatively. (4) Height-Thigh Circumference Index (HT): Height divided by thigh circumference. This index operationalizes thigh muscularity relatively. (5) Height-Chest Circumference Index (HC): Height divided by chest circumference. This index operationalizes relative torso muscularity.

Strength Assessment

Maximal strength is operationalized as the ability to exert maximal voluntary contraction force against external resistance, expressed as 1RM (Thompson et al., 2020). Two exercises were selected for the test protocol: Barbell Back Squat and Barbell Clean and Jerk Deadlift. Barbell Back Squat is positioned on the upper trapezius, posterior to the neck. Participants begin the movement from a standing position with a standardized shoulder-width stance, descending to full depth while maintaining natural lumbar lordosis. The Barbell Clean and Jerk Deadlift is performed slightly wider than shoulder-width, with the hands lateral to the thighs. Participants perform a dynamic pull-to-full-body extension, ending with a rise on the balls of the feet in accordance with the second pull phase of the clean movement. Both exercises were selected based on their central role in Olympic weightlifting training programs, so all participants had established technical proficiency in their execution (Issurin, 2010). Foot position width was standardized across all participants: shoulder-width for the back squat and hip-width for the deadlift.

Procedure

The 1RM estimate followed the modified protocol described by Comfort & McMahon (2015), which has demonstrated high test-retest reliability and practical suitability for trained athletes. Participants performed a standardized warm-up using submaximal loads derived from their daily training routine. A maximum of six progressively increasing load trials were allowed per exercise, although all participants reached their maximum within four to five trials. Load increments started at 15–20 kg and were progressively reduced as the maximum estimate was approached, with a final increment of 5 kg. Rest intervals between attempts were standardized at three to five minutes to ensure adequate neuromuscular recovery.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Mac (Version 26). A forward stepwise approach was applied to identify the anthropometric indices with the greatest independent predictive value for each 1RM test outcome. This approach was chosen for its ability to handle mutually correlated predictors and produce a parsimonious model — maximizing explanatory power while minimizing overfitting (Papoulis, 1991; Freund, 1992).

Scope and Limitations of the Methodology

The test exercises and 1RM protocols used in this study are highly technical and require a well-established level of motor skill. Therefore, this methodology can only be applied to trained athletes with established technical competence in Olympic weightlifting movements and cannot be generalized to recreational or beginner populations.

RESULTS AND DISCUSSION

Results

A total of 17 national-level Olympic weightlifters completed all required procedures for the study. Descriptive statistics for all anthropometric indices and maximal strength performance variables, including mean values and standard deviations, are presented in Table 1. Pearson correlation coefficients examining the relationships between anthropometric indices and 1RM performance in the back squat, clean and jerk, and deadlift are presented in Table 2.

Table 1. *Variation Analysis of the Obtained Data*

Variable	Minimum	Maximum	Mean	Std. Deviation	Variance
BMH	12.94	21.43	16.50	2.24	5.040
HS	4.01	5.24	4.53	0.36	0.132
HA	4.20	6.17	5.09	0.56	0.318
HT	1.56	1.94	1.78	0.12	0.015
HC	2.28	3.14	2.69	0.21	0.046
Deadlift	170	280	216.76	27.44	752.94
Squat	170	300	208.82	28.80	829.77

Note: The following abbreviations were used: BMH – body mass/height^3; HS – height/shin circumference; HA – height/arm circumference; HT – height/thigh circumference; HC – height/chest circumference.

As shown in Table 1, the BMH index ranged from 12.94 to 21.43 (mean: 16.50 ± 2.24), reflecting substantial inter-individual variability in overall muscularity despite the homogeneous competitive level of the sample. The remaining circumference-based indices, HS, HA, HT, and HC, demonstrated comparatively narrower distributions, suggesting greater morphological uniformity in segmental proportions among national-level competitors. Table 2 explains the correlation matrix of the study variables.

Table 2. *Correlation Matrix of Studied Variables*

Variable	BMH	HS	HA	HT	HC	Deadlift	Squat
BMH	1						
HS	-0.737*	1					
HA	-0.884*	0.702*	1				
HT	-0.853*	0.751*	0.946*	1			
HC	-0.853*	0.678*	0.848*	0.839*	1		

Variable	BMH	HS	HA	HT	HC	Deadlift	Squat
Deadlift	0.805*	-0.540*	-0.843*	-0.884*	-0.822*	1	
Squat	0.624*	-0.373	-0.520*	-0.610*	-0.520*	0.817*	1

Note: The following abbreviations were used: BMH – body mass/height^3; HS – height/shin circumference; HA – height/arm circumference; HT – height/thigh circumference; HC – height/chest circumference * $p<0.05$.

The parameter estimates for the linear regression models for the studied strength tests are presented in Tables 3 and 4. All variables in the models are statistically significant, with only a few exceptions: the intercept in the regression between Deadlift and BMH, the intercept in the regression between Squat and BMH, and the regression coefficient between Squat and HS. However, for the first two models, the values of the adjusted R-squared show that a large proportion of the variance is explained – 62.4% and 34.8%, respectively. The linear regression between HS and Squat does not accurately model the relationship between these two variables: the coefficient is not statistically significant, and R R-squared is low. All other linear regression models explain between 22.2% (for HA, HC, and Squat) and 76.8% (for HT and Deadlift) of the variance in results. The accuracy of the models for the two studied exercises is presented in Table 3 and Figure 1.

Table 3. *Coefficients of Determination of Estimated Linear Regression Models*

Model Summary Deadlift			
Model	**R**	**R^2**	**Adjusted R^2**
BMH	0.805	0.647	0.624
HS	0.54	0.292	0.245
HA	0.843	0.711	0.692
HT	0.884	0.782	0.768
HC	0.822	0.676	0.654
Squat			
BMH	0.624	0.389	0.348
HS	0.373	0.139	0.082
HA	0.52	0.27	0.222
HT	0.61	0.373	0.331
HC	0.52	0.27	0.222

Note: The following abbreviations were used: BMH – body mass/height^3; HS – height/shin circumference; HA – height/arm circumference; HT – height/thigh circumference; HC – height/chest circumference.

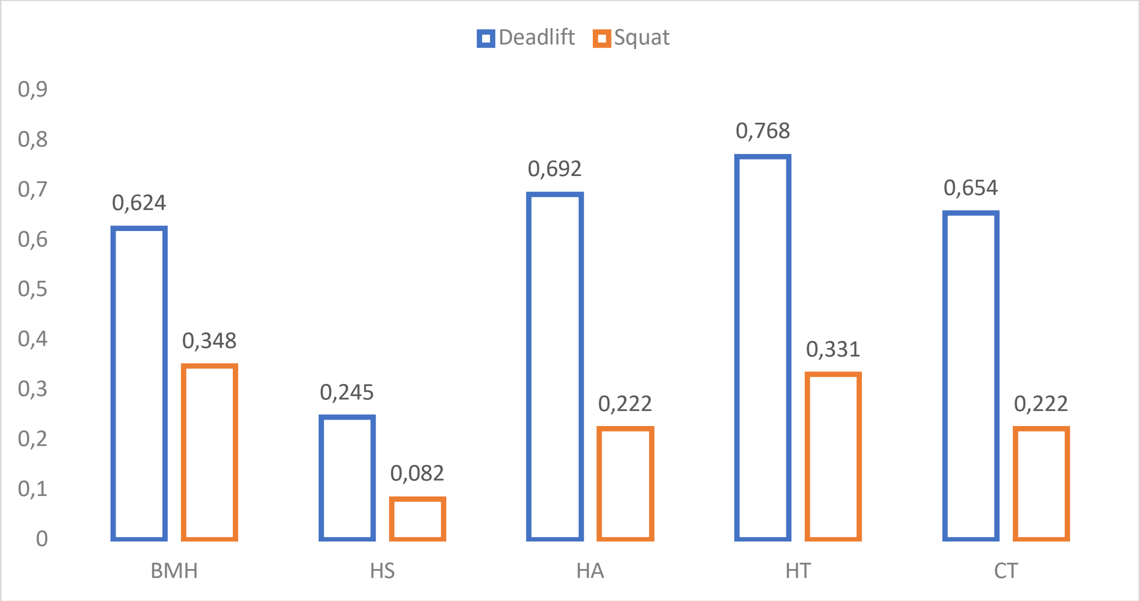

Figure 1. *Comparison of model accuracy (measured by Adjusted R² values) by studied parameters: Deadlift vs. Squat*

Note: The following abbreviations were used: BMH – body mass/height^3; HS – height/shin circumference; HA – height/arm circumference; HT – height/thigh circumference; HC – height/chest circumference.

Table 4. *Linear Regression Models of the Studied Variables*

Model	Unstandardized	Standard Error	Standardized	t	P
		Deadlift			
(Intercept)	54.493	31.201		1.747	0.101
BMH	9.833	1.874	0.805	5.246	< .001
(Intercept)	401.946	74.651		5.384	< .001
HS	-40.801	16.399	-0.54	-2.488	0.025
(Intercept)	426.061	34.636		12.301	< .001
HA	-41.047	6.754	-0.843	-6.077	< .001
(Intercept)	520.335	41.501		12.538	< .001
HT	-112.693	15.36	-0.884	-7.337	< .001
(Intercept)	549.269	59.563		9.222	< .001
HC	-186.433	33.325	-0.822	-5.594	< .001
		Squat			
(Intercept)	76.761	43.107		1.781	0.095
BMH	8.003	2.59	0.624	3.09	0.007
(Intercept)	343.135	86.408		3.971	0.001
HS	-29.593	18.981	-0.373	-1.559	0.14
(Intercept)	344.27	57.795		5.957	< .001
HA	-26.564	11.27	-0.52	-2.357	0.032
(Intercept)	428.805	73.918		5.801	< .001

Model	Unstandardized	Standard Error	Standardized	t	P
			Deadlift		
HT	-81.663	27.358	-0.61	-2.985	0.009
(Intercept)	429.551	93.839		4.578	< .001
HC	-123.76	52.501	-0.52	-2.357	0.032

Note: The following abbreviations were used: BMH – body mass/height^3; HS – height/shin circumference; HA – height/arm circumference; HT – height/thigh circumference; HC – height/chest circumference.

The parameters of the simple linear regression models for each anthropometric index as a predictor of 1RM deadlift and squat performance are presented in Table 4. For the deadlift, all regression coefficients were statistically significant ($p < 0.05$), except for the intercept in the BMH model ($p = 0.101$). The strongest predictor was HT ($\beta = -0.884$; $p < .001$), followed by HA ($\beta = -0.843$; $p < .001$), HC ($\beta = -0.822$; $p < .001$), BMH ($\beta = 0.805$; $p < .001$), and HS ($\beta = -0.540$; $p = 0.025$). For the squat, the pattern of significance was less consistent: BMH ($\beta = 0.624$; $p = 0.007$), HA ($\beta = -0.520$; $p = 0.032$), HT ($\beta = -0.610$; $p = 0.009$), and HC ($\beta = -0.520$; $p = 0.032$) all reached significance, whereas the HS model failed to produce a statistically significant regression coefficient ($\beta = -0.373$; $p = 0.14$), indicating that lower leg muscularity does not independently predict squat performance in this sample.

Discussion

Implications

Olympic weightlifters train to increase their maximum strength without gaining excessive body weight (Everett, 2009). On the other hand, in general, muscle strength increases with muscle size (Reggiani & Schiaffino, 2020). According to the general view of strength coaches, certain body proportions confer advantages in basic resistance training (e.g., front and back squats or deadlifts). They are therefore useful for developing strength in competitive weightlifting. For example, relatively long arms are considered advantageous for conventional or sumo deadlifts, whereas short lower extremities are advantageous for squats (Simmons, 2007). The relationship between anthropometric size and performance in strength sports is unclear, and, logically, there are no systematic, consistent opinions or conclusions on this topic within the scientific community.

Meanwhile, the findings of this study provide empirical support for the premise that relative anthropometric indices derived from simple body circumference measurements show significant predictive validity for 1RM performance on two specific Olympic weightlifting support exercises, with HT emerging as the single strongest predictor of deadlift performance (adjusted $R^2 = 76.8\%$). A systematic gap in the literature regarding the anthropometry-strength relationship, specifically in Olympic weightlifters, distinct from powerlifters, has been previously identified but largely unaddressed. Keogh et al. (2007, 2009) examined the anthropometric profiles and somatotypes of competitive powerlifters across weight categories, finding that body segment length differentiated weight classes but did not differentiate stronger from weaker athletes within the same class. The analytical focus on body proportion discrimination rather than strength prediction and the exclusive use of the powerlifting population limited the applicability of these findings to Olympic weightlifting, which demands fundamentally different biomotor qualities, namely strength-speed rather than maximal isometric force production (Siff, 2000; Zatsiorsky & Kraemer, 2006). Guevara-Pérez et al. (2022) also reported a positive association between fat-free mass percentage and barbell speed in Olympic weightlifters. However, the small sample size limited statistical power, and most coefficients did not reach significance. The findings of this study confirm the consistency of the relationship's direction while extending it through a more accessible measurement framework.

This study reinforces several conclusions from a previous experiment that tested experienced weightlifters (Ferland, Laurier, et al., 2020). Although weightlifting and Olympic weightlifting have similar goals, their training methodologies differ in many aspects. Weightlifting involves muscular effort positioned at the top of the force-velocity curve (Zatsiorsky & Kraemer, 2006, Alcazar et al., 2019), close to the isometric contraction region. On the other hand, competitive Olympic weightlifting exercises are technically complex and dynamic, requiring the development of a skill called power-speed (Zatsiorsky, 2000). Because the training methodologies of strength sports differ, the strength abilities and physical development of strength athletes also differ (Ratamess, 2012; Verkhoshansky & Siff, 2010). The authors mentioned above, Ferland et al. (2020), used stepwise multinomial regression to obtain predictive equations for maximum strength in the squat, bench press, and deadlift based on anthropometric data. Although they used not only circumference but also body segment length, their results showed that higher relative muscle mass (measured with an index similar to the one we used in this study) is an important factor in powerlifting performance. Following a similar protocol, Ferland et al. (2020) studied junior powerlifters and compared their maximum strength capabilities with those of American football players. They obtained a multiple regression equation similar to the one mentioned above. Unfortunately, we cannot compare their results with ours because they reported data from a group that combined powerlifters and American football players.

Ferrari et al. (2022) reported that only the upper limb length-to-height ratio reached statistical significance as a predictor of powerlifting performance, while body composition parameters failed to produce significant regression coefficients. This differs from the findings of this study, likely reflecting differences between absolute somatometric parameters and relative muscularity indices, as well as the use of competition results subject to strategic loading decisions versus laboratory-controlled 1RM estimates. Külkamp et al. (2020) demonstrated that absolute body mass-based allometric models failed to predict strength performance independently of athletes' body size, both in powerlifting and Olympic weightlifting, a finding that substantiates the methodological rationale for using height-normalized relative indices, as applied in this study. Conversely, the findings in this study indicate that the relative measure of muscle strength can be a reliable predictor of maximum strength in Olympic weightlifting. A consistent, mechanistically informative pattern emerged across regression models, with substantially higher predictive validity for *deadlift* performance than for *squat* across all five anthropometric indices. This systematic difference requires a biomechanical interpretation that goes beyond mere statistical observation. In the deadlift, the ankle joint undergoes a greater range of extension than in the squat, resulting in a proportionally greater contribution from the plantar flexor musculature, particularly the gastrocnemius and soleus, to total force production (Schoenfeld, 2010; Vigotsky et al., 2019).

This mechanistic relationship explains why the HS index, which operationalizes lower-limb muscularity, achieves statistical significance only in the deadlift model, not in the squat model. In the squat, the ankle's smaller range of motion limits the relative contribution of the calf muscles, thereby weakening the association between calf circumference and performance outcomes.

The non-significance of HT in the squat model is equally informative, and appears counterintuitive given the common coaching assumption that the squat is a quadriceps-dominant exercise. However, biomechanical analysis shows that individual technical strategies substantially moderate quadriceps involvement during the squat: athletes who actively shift their knees posteriorly during the ascent phase effectively increase the knee joint angle, redistributing the load from the quadriceps to the hamstrings, gluteal muscles, and erector spinae (Schoenfeld, 2010; Kubo et al., 2019).

Inter-individual variability in these muscle recruitment strategies, which is not captured by any static morphological index, is a major source of unexplained variance in the squat model. The contribution of the stretch reflex at the deepest position of the squat Thomas, 1988) presents an additional neuromuscular variable that body circumference-based indices cannot operationalize. Overall, these observations indicate that the squat performance of trained Olympic weightlifters is influenced by more complex interactions of morphological, neuromuscular, and technical factors than the deadlift performance findings, with direct implications for the selection of field-based monitoring tools and the interpretation of athlete profiling data.

Research Contributions

This study makes a meaningful contribution to the strength and conditioning literature by advancing an accessible, sport-specific anthropometric framework for predicting maximal strength in Olympic weightlifters, a population that remains underrepresented in previous morphology–performance research compared with powerlifters. By demonstrating that five relative muscularity indices derived from simple field-based circumference measurements are significantly associated with 1RM performance—particularly with thigh-related proportionality (HT) emerging as the strongest predictor of deadlift performance (adjusted $R^2 = 0.768$)—the study extends existing regression-based approaches beyond laboratory-dependent body composition assessments toward a more practical and scalable screening model for athlete profiling, exercise prescription, and talent identification. Importantly, the findings also show that predictive strength differs between exercises, with deadlift performance being more strongly explained by relative anthropometric structure than squat performance, thereby offering a biomechanically informed perspective on why static morphology may better capture some lifting tasks than others. Taken together, this study contributes both conceptually and practically by bridging the gap between morphological assessment and performance prediction in Olympic weightlifting and by providing an evidence-based foundation for low-cost field monitoring in high-performance training environments.

Limitations

The authors acknowledge several limitations of the study. Most importantly, due to the specifics of the studied sample (highly qualified strength athletes), the results are most likely not directly applicable to competitors in other sports or to the general population. The same holds for female and youth athletes in strength sports. It is also important to note that the exercises we used for testing (back squat and deadlift) are technically complex and require sufficient time for technique refinement. The sample size ($n = 17$), although appropriate for a homogeneous population of national-level competitive athletes, limits the statistical power and generalizability of the resulting regression equations. Replication in larger and more diverse samples is necessary before these models can be applied with confidence outside the specific population studied.

Suggestions

The regression model generated in this study offers concrete practical utility for coaches and practitioners working in the context of Olympic weightlifting, precisely because the underlying measurements require only standard anthropometric tape measures and can be completed in the field in a matter of minutes without access to laboratory equipment or specialized personnel. Further research is recommended to prioritize replication on larger samples in various national contexts and competitive levels to establish normative ranges and validate the generalizability of the generated equations, expansion to female and youth athlete populations, which will likely require their own normative frameworks, and the integration of dynamic biomechanical parameters including joint angles, barbell velocity profiles, and ground reaction forces to improve the explanatory power of predictive models, particularly for *squat* performance where morphological indices alone show limited explanatory capacity.

CONCLUSION

This study demonstrates that five relative muscularity indices based on body circumference have significant predictive validity for maximum strength performance in national-level Olympic weightlifters. For the *deadlift*, all indices produced statistically significant models, with HT proving to be the strongest predictor ($\beta = -0.884$; adjusted R^2 = 76.8%), followed by HA (adjusted R^2 = 69.2%), HC (adjusted R^2 = 65.4%), BMH (adjusted R^2 = 62.4%), and HS (adjusted R^2 = 24.5%). For the *squat*, the pattern of significance was more limited, with BMH, HA, HT, and HC reaching statistical significance. In contrast, HS failed to yield a significant regression coefficient, with consistently lower explanatory power across models (adjusted R^2 ranged from 22.2% to 34.8%). The systematic difference in predictive power between these two exercises reflects the greater biomechanical complexity of the squat, where inter-individual variability in muscle recruitment strategies and the contribution of stretch reflexes generate performance variance that static morphological indices cannot capture. This study contributes to the empirical validation of relative indices as an alternative to absolute or laboratory-based body composition measurements, offering an accessible yet substantially predictive measurement framework for Olympic weightlifting populations. This population has been underrepresented in the strength anthropometry literature, which is dominated by powerlifting studies. However, the generalizability of these findings is limited by the sample's homogeneity and the cross-sectional design. Further investigation is needed to replicate the model in larger, more diverse cohorts, including female athletes, young athletes, and other strength-sport populations, as well as to examine the longitudinal stability of the identified relationships and the direct predictive validity of these indices for competitive performance in the snatch and clean and jerk.

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AUTHOR CONTRIBUTION STATEMENT

VP wrote the original draft, the methodology, the investigation, data processing, data analysis, and project administration. KP is writing a review and editing. RM wrote the revision, edited, and curated the data.

AI DISCLOSURE STATEMENT

The authors declare that artificial intelligence (AI) tools were used in a limited manner to support language refinement, clarity of expression, and editorial consistency during the manuscript preparation process. The use of AI did not involve the generation of research data, the analysis or interpretation of findings, or substantive scholarly arguments. All intellectual content, research design, data collection, analysis, and conclusions remain the full responsibility of the authors.

CONFLICTS OF INTEREST

There is no conflict of interest.

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