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Prediction of Skeletal Muscle Mass using Anthropometric Measurements in Athletes

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Resumen

Introducción: El objetivo principal del estudio fue estimar la masa del músculo esquelético en deportistas mediante la utilización de medidas antropométricas. **Métodos:** El estudio se realizó en 100 deportistas masculinos. Se utilizó el analizador de impedancia bioeléctrica para medir la altura, el peso, el% de grasa, la masa libre de grasa (FFM) y la masa del músculo esquelético. **Resultados:** El análisis estadístico reveló una correlación significativa ($p \leq 0,05$) entre la masa muscular, la altura, el peso, el % de grasa y la masa libre de grasa (FFM). **Conclusion:** El estudio reveló la importancia de las medidas antropométricas y de la masa muscular esquelética entre los deportistas para un mejor rendimiento.

Palabras Clave: Altura, Peso, Porcentaje de grasa, MLG, Masa muscular.

Abstract

Introduction: The primary aim of the study was to estimate the skeletal muscle mass in athletes through the utilization of anthropometric measurements. **Methods:** The study was conducted on 100 male athletes. Bioelectrical Impedance Analyser was used to measure Height, Weight, Fat%, Fat-Free mass (FFM), and Skeletal muscle mass. **Result:** Statistical analysis revealed a significant correlation ($p \leq 0.05$) between Muscle mass, height, weight, Fat% and Fat-Free Mass (FFM). **Conclusion:** The study revealed the importance of anthropometric measurements and skeletal muscle mass among athletes for better performance.

Keywords: Height, Weight, Fat %, FFM, Muscles Mass

Introduction

Achieving optimal muscle mass is pivotal for enhancing sports performance and cultivating a positive body image. Beyond its role in movement and posture, muscle is increasingly recognized for maintaining overall health and regulating inter-organ interactions crucial for protein and energy metabolism. The preservation and enhancement of lean body mass are essential to prevent muscle loss and promote overall well-being (Oshima *et al.,* 2011; Argilés *et al.,* 2016 ; Ohta *et al.,* 2017;

Within the context of body composition, sports science places particular emphasis on whole-body fat-free mass (FFM), a key component linked to talent identification, athletic performance, and body mass management. FFM not only serves as a potential statistic for force generation but is also widely employed in determining resting energy expenditure. Investigating FFM from a physical resources perspective provides valuable insights for sports scientists and coaches, aiding in the development of training schedules and effective body mass control.

In Bioimpedance Analysis (BIA) , anthropometric measurements are not required to determine the composition of the limbs. The limb can be conceptualized as consisting of three electrical conductors: low-resistance skeletal muscle, high-resistance adipose tissue, and bone (Chumlea & Baumgartner, 1990 ; Kanehisa *et al.,* 1998 ; Abe *et al.,* 2014; Takai *et al.,* 2017). It's likely that as patients age, the composition of their skeletal muscles changes.

The aim of present study was to predict skeletal muscle mass using anthropometric factors such as height, weight, percentage of fat mass, and percentage of fat-free mass.

Material and Methods

The primary objective of this study was to assess skeletal muscle mass in athletes through the application of anthropometric measurements. The participants, numbering 100, were male athletes affiliated with the Sports Authority of India's Lakshmibai National College of Physical Education in Kerala, India. The inclusion criteria encompassed individuals aged between 18 and 25 years. Essential anthropometric measurements included height, weight, percentage of fat mass, percentage of fat-free mass, and percentage of skeletal muscle mass. Height measurements were obtained using an electronic scale from Seca Instruments Ltd. (Hamburg, Germany), with a precision of up to .001 m. The assessment of the percentage of fat mass, percentage of fat-free mass, and skeletal muscle mass was facilitated by Seca Bioelectrical Impedance Analysis (BIA). To ensure familiarity with the prescribed examination, all participants were allowed to acquaint themselves with the process. The data analysis involved the utilization of SPSS software, employing a regression equation to estimate skeletal muscle mass based on the anthropometric factors of athletes. Additionally, the Pearson product-moment correlation was employed to ascertain the relationship between skeletal muscle mass and the anthropometric variables of athletes. The chosen significance threshold for statistical analysis was set at the .05 level. This meticulously designed methodology ensured a comprehensive assessment of skeletal muscle mass among the selected cohort of male athletes. The integration of precise measurements and statistical analyses contributes to the robustness and reliability of the study's outcomes, shedding light on the intricate relationship between anthropometric variables and skeletal muscle mass in this specific demographic.

Results

Table 1. Descriptive Analysis of Selected Anthropometric Variables of Athletes (N=100)

Variables	Mean	S.D	Variance	Skew.	Kurt.	Range	Min.	Max.	SE
Height	1.68	.09	.00	-.01	-.02	.47	1.47	1.94	.00
Weight	61.91	9.34	87.24	-.00	-.66	38	42.35	80.35	.93
Percentage of Fat Mass	16.35	7.17	51.53	.14	-.88	30.38	3.67	34.05	.71
Percentage of Fat-Free Mass	83.64	7.17	51.53	-.14	-.88	30.38	65.95	96.33	.71
Skeletal Muscles Mass	23.33	5.14	26.42	.38	-.92	20.81	14.92	35.73	.51

Table 1 provides insights into the average values of anthropometric variables among junior hockey players: Height (1.68 ± 0.09), Weight (61.91 ± 9.34), Percentage of Fat Mass (16.35 ± 7.17), Percentage of Fat-Free Mass (83.64 ± 7.17), and Skeletal Muscle Mass (23.33 ± 5.14). Correspondingly, the minimum and maximum values for these variables were as follows: Height (1.47; 1.94), Weight (42.35; 80.35), Percentage of Fat Mass (3.67; 34.05), Percentage of Fat-Free Mass (65.95; 96.33), and Skeletal Muscle Mass (14.92; 35.73).

Examining the distribution of these variables, it was observed that Height, Weight, and Percentage of Fat-Free Mass exhibited negatively skewed patterns, while Percentage of Fat Mass and Skeletal Muscle Mass showed positive skewness. The negative skewness indicates that a majority of the data falls on the higher side for these variables, whereas the positive skewness suggests that most of the data is concentrated on the lower side.

Furthermore, the kurtosis values for Height, Weight, Percentage of Fat Mass, Percentage of Fat-Free Mass, and Skeletal Muscle Mass were all negative. Negative kurtosis signifies that the data for these variables exhibits greater variability than that of a normal distribution. This information enhances our understanding of the distributional characteristics of anthropometric variables among junior hockey players, providing valuable insights into the diversity and trends within these measurements.

Table 2 illustrates a significant correlation between Skeletal Muscle Mass and anthropometric variables such as Height, Weight, Percentage of Fat Mass, and Percentage of Fat-Free Mass. The correlation coefficients for these relationships demonstrated statistical significance with values of (.000, .000, .006, .006), all of which were less than the predetermined p-value threshold ($p < .05$). This signifies a meaningful association between Skeletal Muscle Mass and the specified anthropometric factors, providing empirical support for their interdependence.

Table 2. Relationship between Dependent Variable (Skeletal muscle mass) and Independent Variables (Selected Anthropometric variables) of Athletes.

Independent Variables	Correlation coefficient	Sig.
Height	.645	.000
Weight	.770	.000
Percentage of Fat Mass	-.253	.006
Percentage of Fat-Free Mass	.253	.006

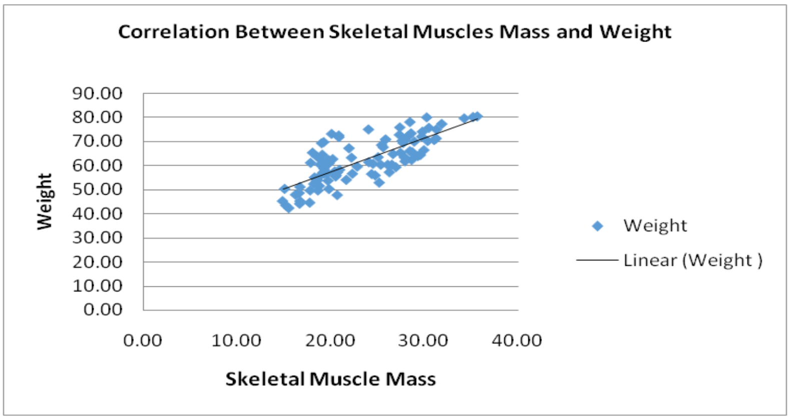

Figure 1. Relationship between Skeletal Muscles Mass and Body Weight of Athletes

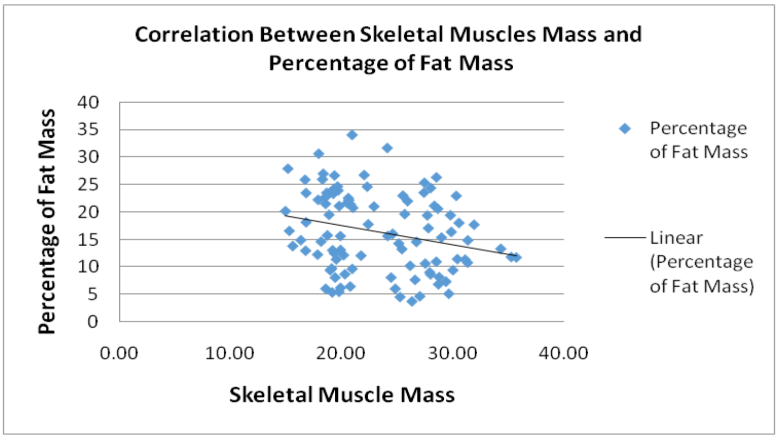

Figure 2. Relationship between Skeletal Muscles Mass and Percentage of Fat Mass of Athletes

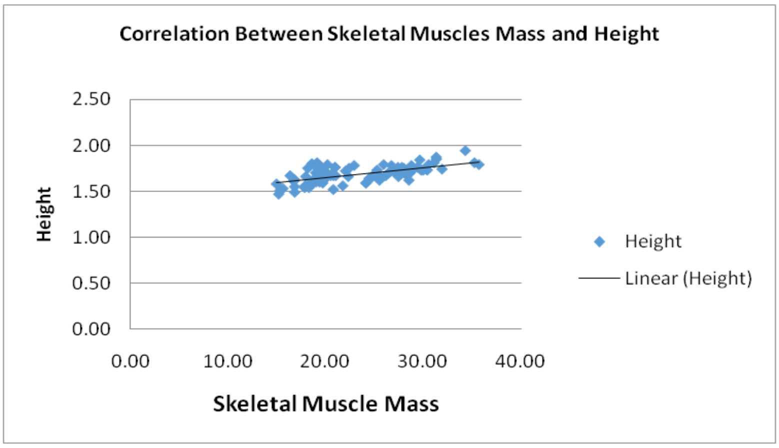

Figure 3. Relationship between Skeletal Muscles Mass and Height of Athletes

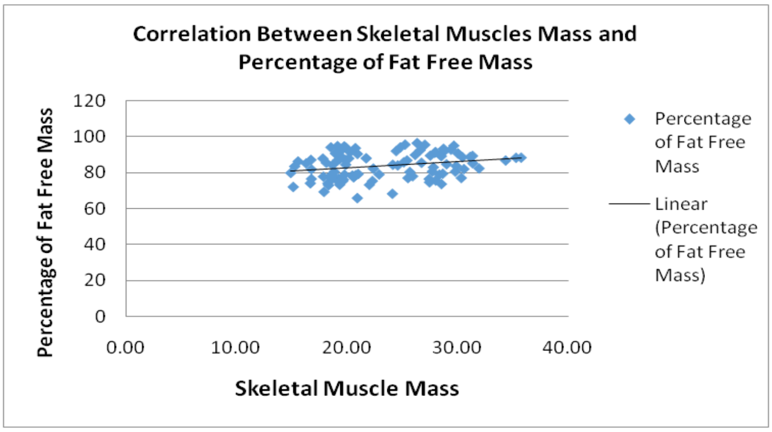

Figure 4. Relationship between Skeletal Muscles Mass and Percentage of Fat Free Mass of Athletes

Table 3. Joint Contribution of Independent Variables (Selected Anthropometric Variables) in Predicting Dependent Variable (Skeletal Muscles Mass) of Athletes

Criterion Variables	Independent variables	Coefficient of multiple correlations	Sig.
Skeletal Muscles Mass	Height	.811*	.000
	Weight		
	Percentage of Fat Mass		
	Percentage of Fat-Free Mass		

* Significant at 0.05 level.

Table 3 demonstrates a noteworthy association between the criterion variable (Skeletal Muscle Mass) and the independent variables (Selected Anthropometric Characteristics). The significance of this relationship is underscored by a multiple correlation value of .000, which is less than the predetermined threshold of .05 ($p < .05$). This finding affirms a statistically significant connection between Skeletal Muscle Mass and the specified set of anthropometric characteristics, reinforcing the relevance of these variables in understanding and predicting variations in Skeletal Muscle Mass.

Table 4. Model Summary

R Square	Adjusted R Square	Standard Error
.657	.646	3.05

In Table 4 above, it is evident that the inclusion of the Adjusted R Square (.646) as a predictor indicates that 64.6% of the variance in Skeletal Muscle Mass is attributed to changes in the Anthropometric variable. This underscores the predictive utility of the selected anthropometric characteristics in explaining a substantial proportion of the variability observed in Skeletal Muscle Mass.

Table 5. Analysis of Variance for the Regression

	Sum of Square	df	Mean Square	F	Sig.
Regression	1718.85	3	572.94	61.29*	.000
Residual	897.40	96	9.34		
Total	2616.24	99			

* Significant at .05 level

The results presented in Table 5 indicate that the established regression model holds significance for predicting criterion variables. The model's applicability for further predictions is supported by the observed significance of the 'F' value (61.29) at the 0.05 level of significance. This underscores the reliability and validity of the regression model in forecasting criterion variables, offering a basis for its utilization in subsequent predictions.

Table 6. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-18.611	6.589		-2.825	.006
Weight	.420	.051	.763	8.200	.000
Height	.587	5.839	.010	.101	.920
Percentage of Fat-Free Mass	.179	.051	.250	3.531	.001

Dependent Variables

Skeletal Muscles Mass

Table 6 illustrates the coefficients in the regression equation, offering insights into the likelihood of a linear relationship between anthropometric variables and Skeletal Muscle Mass. In this context, 'B' represents the slope, 'SE' stands for the standard error of 'B,' and 'Beta' denotes the standardized regression coefficient. The 'Sig' value indicates the level of significance for testing the null hypothesis that the coefficient value is zero in the population.

The estimation of Skeletal Muscle Mass based on selected anthropometric variables of athletes involved a multiple regression analysis. The resulting multiple regression equation, reflecting the relative contributions of three anthropometric variables, is as follows:

Equation

$$Y= -18.611+0.420\ (X1)\ -0.587\ (X2)\ -.179\ (X3)$$

Y=Skeletal Muscles Mass

X1=Weight

X2= Height

X3= Percentage of Fat-Free Mass

The regression equation mentioned above indicates that Skeletal Muscle Mass is contingent on Height, Weight, and Percentage of Fat-Free Mass.

Discussion

The outcomes of this statistical investigation underscore the pivotal role played by specific anthropometric variables in predicting skeletal muscle mass among athletes. Notably, weight, height, percentage of fat mass, and percentage of fat-free mass emerged as influential factors significantly associated with skeletal muscle mass. The presence of substantial multiple correlation coefficients among weight, height, percentage of fat mass, percentage of fat-free mass, and skeletal muscle mass further accentuates the interrelated nature of these variables.

The examination of regression equations yielded valuable insights into the primary anthropometric determinants of variable skeletal muscle mass in athletes. Among these determinants, height, weight, and the percentage of fat-free mass emerged as key contributors. The statistical significance of these findings reinforces the notion that these specific anthropometric characteristics hold significant predictive value for variations in skeletal muscle mass among athletes.

The observed influence of weight, height, and percentage of fat-free mass on skeletal muscle mass aligns with existing literature on the subject, emphasizing the importance of comprehensive anthropometric assessments in understanding and predicting muscular development in athletes. These findings contribute not only to our understanding of the nuanced relationship between anthropometric variables and skeletal muscle mass but also hold practical implications for athletes, trainers, and sports scientists involved in optimizing training regimens and performance outcomes. Overall, the study underscores the significance of weight, height, and the percentage of fat-free mass as key determinants in predicting skeletal muscle mass in athletes, providing valuable insights for tailored training and performance enhancement strategies in the realm of sports science.

Conclusions

This study underscores the significance of anthropometric factors, including weight, height, percentage of fat mass, and percentage of fat-free mass, in influencing the muscle mass of athletes. The presence of a substantial multiple correlation coefficient of 0.811 emphasizes the collective impact of these variables on muscle mass. Given the importance of muscle mass for overall physical health and body composition, the relevance of weight, height, and the percentage of fat-free mass in this context is notable.

Interestingly, the exclusion of the percentage of fat mass in the calculation may suggest its non-essential role in predicting muscle mass. The positive outcomes of these associations imply that these anthropometric factors contribute effectively to the prediction of muscle mass, potentially guiding athletes in achieving optimal muscular development. As maintaining proper muscle mass is crucial for athletes, this study provides valuable insights that may aid them in structuring effective training regimens to attain the necessary muscular mass for optimal performance.

References

Abe, T., Nahar, V.K., Young, K.C., Patterson, K.M., Stover, C.D., Lajza, D.G., Tribby, A.C., Geddam, D.A., Ford, M.A., Bass, M.A., Loftin, M. (2014). Skeletal muscle mass, bone mineral density, and walking performance in masters cyclists. *Rejuvenation research*, 17(3): 291-296. https://doi.org/10.1089/rej.2013.1538

Argilés, J. M., Campos, N., Lopez-Pedrosa, J. M., Rueda, R., Rodriguez-Mañas, L. (2016). Skeletal muscle regulates metabolism via interorgan crosstalk: roles in health and disease. *Journal of the American Medical Directors Association*, 17(9): 789-796. https://doi.org/10.1016/j.jamda.2016.04.019

Baumgartner, R. N., Chumlea, C., Roche, A. F. (1990). Bioelectric impedance for body composition. *Exercise and sport sciences reviews*, 18(1): 193-224.

Kanehisa, H., Ikegawa, S., Fukunaga, T. (1998). Body composition and cross-sectional areas of limb lean tissues in Olympic weight lifters. *Scandinavian journal of medicine & science in sports*, 8(5): 271-278. https://doi.org/10.1111/j.1600-0838.1998.tb00482.x

Ohta, M., Midorikawa, T., Hikihara, Y., Sakamoto, S., Kawakami, Y., Fukunaga, T., Kanehisa, H. (2017). Body mass-to-waist ratio strongly correlates with skeletal muscle volume in children. *PloS one*, 12(5): e0177155. https://doi.org/10.1371/journal.pone.0177155

Oshima, S., Miyauchi, S., Kawano, H., Ishijima, T., Asaka, M., Taguchi, M., Torii, S., Higuchi, M. (2011). Fat-free mass can be utilized to assess resting energy expenditure for male athletes of different body sizes. *Journal of nutritional science and baraminology*, 57(6): 394-400. https://doi.org/10.3177/jnsv.57.394

Takai, Y., Kai, T., Horio, K., Nakatani, M., Haramura, M., Aoki, T., Kanehisa, H. (2017). Lean body mass index is an indicator of body composition for screening prospective young adult soccer players. *Football Science*, 14: 8-14. https://doi.org/10.57547/jssfenfs.14.1_8

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Conflicts of Interest
The authors have no conflicts of interest to declare that they are relevant to the content of this article.