Analysis of Body Composition of Indian National Level Boxers and Weightlifters: A Comparative Approach

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DOI: 10.31838/ecb/2023.12.si7.508

Abstract

Purpose: Body composition is a crucial factor in determining sports performance & athletic success. Athletes need to maintain an appropriate balance between fat & muscle mass to optimize their performance & prevent injuries. Body composition can vary depending on the specific demands of sport, & optimal body composition can be achieved through a combination of proper nutrition & exercise. The current study reports the body composition of Indian boxers & weightlifters of national level & serves as a reference database for Indian athletes.
Method: A cross sectional descriptive study design was used with total 72 boxers (age 23.5±2.27 Yrs, Ht 169.33±7.81 cms & Wt 60.93±9.9 Kg) & 72 weightlifters, (age 23.97±3.01 Yrs, Ht 161.05±6.46 cms & Wt 74.75±16.8 Kg). Anthropometric variables were also recorded as per standard procedures, % Body Fat & % Lean Body Mass was calculated using Siri equation.
Results: Independent t-test was used to compare anthropometric variables and body composition in national level boxers & weightlifters. Result shows statistically significant differences exist between in boxers & weightlifters.
Conclusion: Boxers usually have a higher fat free mass and lower body fat percentage due to the demands of their sport. Whereas, weightlifters may have a higher body fat percentage for stability and lower center of gravity. This study establishes normative values for anthropometric variables & body composition among male & female boxers & weightlifters at national levels. This information could be used in future for training purpose &to identify & select talented boxers & weightlifters.

Keywords: *Body composition, Percent body fat, Percent lean body mass, Skin fold, Boxing, Weightlifting*

Introduction

Body size, build, and composition are crucial factors in determining sporting disciplines and athletic performance. Body composition refers to the proportion of fat mass and muscle (fat-free mass) in person's body. It is an important aspect of overall health and fitness, and is especially important for sports persons. Built & body size can be moderately modified, body composition can be significantly altered through physical exercises & diet. Resistance exercises increases muscle bulk, but reducing body fat needs strenuous aerobic exercise & proper dietary practices.

Body composition can play a significant role in determining an athlete's success. However, it is important to note that optimal body composition can vary depending on the individual athlete and the specific demands of their sport.

Maintaining an optimal body composition is crucial for achieving success in various sports, including boxing. To excel in boxing, it's essential to have high levels of power, strength, and muscle

endurance, which makes having maximum fat-free mass (FFM) critical. Also in sports that require agility and speed, having a lower body fat percentage can be advantageous. This is because excess fat can limit an athlete's mobility and hinder their ability to move quickly.

On the other hand, weightlifting and wrestling that needs power and strength may get advantage from higher muscle mass. This is because muscle mass helps an athlete to generate more force and power, which is important for sports specific movements like lifting heavy weights or grappling with an opponent. Muscle mass generates power for athletic activity, whereas excess body fat acts as a dead weight which must be repeatedly lifted against gravity, increasing energy demands and reducing performance.[1]

Optimal body composition is a key characteristic for sports performance, it helps to improve performance and prevent injuries and plays a significant role in determining an athlete's success and in improving overall health and well-being. To achieve optimal body composition and to maintain appropriate balance between fat & muscle mass, athletes often work with coaches, trainers, and nutritionists. They work together to develop individualized plans that focuses on proper healthy diet and exercises, which involves a combination of strength training, cardiovascular exercises, that is tailored to meet the athlete's specific needs.

Body composition analysis is an essential tool for monitoring training regimens &optimizing competitive performance in sports professionals.**[2, 3]** Improved body composition parameters are associated with enhancements in cardiorespiratory fitness and various performance parameters like strength, endurance, agility in athletes.**[4,5]** Athletes generally have lower fat percentages and more percentage of fat free mass than age-matched non-athletes.**[4]** High-intensity training increases skeletal muscle mass and FFM, leading to higher FFM in athletes than in sedentary individuals.**[6,7]** Although many studies have highlighted the differences in body composition between sedentary individuals and sports persons, few have been conducted on Indian boxers & weightlifters competing at national levels. Given that sedentary Indian population tend to have considerably more body fat per unit weight, studying the body composition of elite Indian boxers & weightlifters is relevant. The current study reports body composition of Indian boxers & weightlifters of national level and also serve as a reference database of body composition for best Indian boxers & weightlifters.

Materials and Methods

Participants

This was a cross-sectional descriptive study conducted on a total of 152 subjects (76 boxers & 76 weightlifters) who participated in national level boxing &weightlifting tournaments. The study was approved by the Research Ethics Committee of the Department of Sports Medicine & Physiotherapy, GNDU, Amritsar, Punjab, India (letter No 348/SMP/22/09/16). Prior to participation, all participants were fully informed about the study procedures and provided with a consent form to read, sign, and provide written informed consent. Participants were free to withdraw from the study at any time, as participation was voluntary. The study procedures were carried out in accordance with the guidelines provided by the ethics committee.

Inclusion & Exclusion

To be included in the study, athletes had to meet the following criteria: engaged in boxing & weightlifting (Olympic style) training (including clean-and-jerk, snatch, snatch or clean and jerk/hang, and specified weightlifting training) regularly for at least one-year (a minimum of four days/week during this period) and have taken part in national level boxing & weightlifting (Olympic-style) championships within the past year. Athletes with any hand, wrist, or elbow joint problems, a history of neurological or musculoskeletal disorders, or upper limb deformities were excluded from the study.

Anthropometric Measurements

Prior to testing, participants were given detailed instructions on the testing procedures. Various anthropometric measurements were performed following the international standards for anthropometric assessment outlined in the publication by the International Society for the

Advancement of Kinanthropometry **[8]**. Body weight was recorded using a digital platform scale with 100-gram gradation and 0.1 kg precision (Tanita HD-382). Participants were instructed to step on the weighing scale barefoot and wearing t-shirt and shorts only. Height was measured using a portable stadiometer with a 1-millimeter gradation and 0.01 cm precision (Seca, Medical Scales and Measuring Systems, Hamburg, Germany). Body mass index (BMI) was calculated using the formula: body weight / (height)^2 in kg/m^2. Skinfold thickness at the biceps, triceps, suprailiac, and subscapular sites were measured using a calibrated skinfold caliper. Non-extensible metal tape was used to measure upper arm circumference, waist circumference & hip circumference. The final values were taken as the average of the three measurements of each anthropometric variable measured at different sites.

Calculation of % Body Fat & % Lean Body Mass

The log of the sum of the four skinfolds (triceps, biceps, subscapular, and suprailiac) was used in conjunction with the age and gender-specific Durnin and Womersley equation **[9]** to calculate body density in grams per milliliter (g/ml).

Siri equation was used to convert the density value to percent body fat **[10]**. Siri equation establishes constants of fat free mass and fat mass.

$$\text{Percent Body Fat} = (495 / \text{Body Density}) - 450$$

Statistical Analysis

In order to analyze the collected data, SPSS (Version 27.0) for windows, a statistical software package developed by IBM Corp. in 2019 was utilized. To compare various anthropometric variables between national level boxers & weightlifters an independent t-test was employed.

Results

The study population comprised of total 76 boxers (38 males & 38 females) & 76 weightlifters (38 males & 38 females), that participated at national level boxing & weightlifting tournaments respectively. Mean age (Yrs) of boxers (male= 24.421 ± 2.585 & females = 22.763 ± 1.965) and weightlifters (male= 23.816 ± 2.949 & females = 24.132 ± 3.095). The variables measured in this study includes height, weight, body mass index (BMI), biceps & triceps skin folds, supra-iliac & subscapular skin folds, waist circumference, hip circumference, upper arm circumference, percent body fat, and percent lean body mass. For each variable, the mean and standard deviation values are reported separately for male and female athletes in each sport. Table 1 presents the mean ± standard deviation values for various anthropometric and body composition variables, as well as the results of t-tests and associated p-values, for male and female boxers and weightlifters. The purpose of the study is to compare the physical characteristics of boxers and weightlifters within these two sports and identify any significant differences. Statistically significant differences were observed in various anthropometric variables & body composition of national level boxers and weightlifters.

Table 1: Comparison of anthropometric variables & body composition in national level boxer's & weightlifters

S. No	Variable	Gender	Sport	Mean ± SD	t-value	p-value
1	Height (cms)	Male	Boxer	177.382 ± 8.688	6.44	$p \leq 0.001$**
			Weight Lifter	166.387 ± 5.940		
		Female	Boxer	161.289 ± 6.959	3.480	$p \leq 0.001$**
			Weight Lifter	155.721 ± 6.991		
2	Weight (Kg)	Male	Boxer	66.126 ± 12.736	4.805	$p \leq 0.001$**
			Weight Lifter	82.985 ± 17.482		
		Female	Boxer	55.750 ± 7.255	3.760	$p \leq 0.001$**
			Weight Lifter	66.537 ± 16.128		
3	BMI (Kg/m^2)	Male	Boxer	20.838 ± 2.428	10.169	$p \leq 0.001$**
			Weight Lifter	29.691 ± 4.786		

		Female	Boxer	21.341 ± 1.385	7.475	p ≤ 0.001**
			Weight Lifter	27.109 ± 4.550		
4	Biceps Skin Fold (mm)	Male	Boxer	3.937 ± 0.439	5.009	p ≤ 0.001**
			Weight Lifter	4.455 ± 0.463		
		Female	Boxer	3.337 ± 0.261	7.292	p ≤ 0.001**
			Weight Lifter	4.095 ± 0.585		
5	Triceps Skin Fold (mm)	Male	Boxer	7.768 ± 0.802	4.101	p ≤ 0.001**
			Weight Lifter	8.487 ± 0.723		
		Female	Boxer	4.676 ± 0.563	1.809	P = 0.075
			Weight Lifter	4.926 ± 0.639		
6	SupraIliac Skin Fold (mm)	Male	Boxer	7.545 ± 0.720	3.560	p ≤ 0.001**
			Weight Lifter	8.042 ± 0.472		
		Female	Boxer	4.629 ± 0.529	3.349	P = 0.001**
			Weight Lifter	5.124 ± 0.742		
7	Subscapular Skin Fold (mm)	Male	Boxer	8.471 ± 0.720	5.328	p ≤ 0.001**
			Weight Lifter	9.216 ± 0.473		
		Female	Boxer	5.955 ± 0.334	4.110	p ≤ 0.001**
			Weight Lifter	6.429 ± 0.627		
8	Waist Circumference (cms)	Male	Boxer	78.187 ± 4.245	4.617	p ≤ 0.001**
			Weight Lifter	84.858 ± 7.829		
		Female	Boxer	72.287 ± 5.169	1.367	P = 0.176
			Weight Lifter	74.021 ± 5.870		
9	Hip Circumference (cms)	Male	Boxer	82.932 ± 3.078	9.556	p ≤ 0.001**
			Weight Lifter	92.339 ± 5.231		
		Female	Boxer	83.953 ± 1.775	7.412	p ≤ 0.001**
			Weight Lifter	88.713 ± 3.539		
10	Upper Arm Circumference (cms)	Male	Boxer	35.221 ± 1.518	6.346	p ≤ 0.001**
			Weight Lifter	37.132 ± 1.068		
		Female	Boxer	30.171 ± 2.305	2.711	P = 0.008*
			Weight Lifter	31.479 ± 1.879		
11	Percent Body Fat	Male	Boxer	11.843 ± 1.216	4.178	p ≤ 0.001**
			Weight Lifter	12.972 ± 1.137		
		Female	Boxer	13.069 ± 0.978	4.311	p ≤ 0.001**
			Weight Lifter	14.382 ± 1.601		
12	Percent Lean Body Mass	Male	Boxer	88.157 ± 1.216	4.178	p ≤ 0.001**
			Weight Lifter	87.028 ± 1.137		
		Female	Boxer	86.931 ± 0.978	4.311	p ≤ 0.001**
			Weight Lifter	85.618 ± 1.601		

Discussion

The objective of this study was to provide an insight of the body composition of Indian weightlifters and boxer. Despite using various keywords such as elite, body composition, boxers, weightlifters, and their combinations, we could not found any similar studies in various databases such as Medline, Pubmed etc. Therefore, this study is the first of its kind among "Indian Boxers & Weightlifters." The study revealed that Boxers had the lowest fat% of 11.843±1.216%& 13.069±0.978% for male & female respectively, while Weightlifters had the highest fat% of 12.972±1.137%& 14.382 ± 1.601% for male and females respectively. Moreover, there was an inverse relationship between body fat% and FFM%, with Boxers having the highest FFM% of 88.157±1.216% (males) & 86.931 ± 0.978% (females), and Weightlifters had the lowest FFM% of males = 87.028±1.137%& females = 85.618±1.601%.

The variations in percent body fat among boxers and weightlifters may be due to differences in motor abilities, training regimens, and diet. Weightlifting is mainly anaerobic while boxing being a mix of anaerobic and aerobic activities. Significant differences in percent body fat might be due to the matching of their body weights, during the selection of these disciplines. A study based on male Indian college recreation players showed that sedentary males typically have a body fat% range of 19-21% **[11]**.

Standard height-weight-age tables are commonly used by health professionals to determine desirable weight for individuals, but this method may not be the best approach for sportsmen. Body composition, which reveals the proportions of fat and fat-free mass in the body, is a better indicator for determining desirable weight in athletes, particularly for different sports disciplines **[12, 13]**. For example, boxing being a combat sport that involves punches and quick movements, and the strength of the involved muscles decides the power output during these activities **[13]**. Boxers typically trains and fight at high intensities, with rounds lasting 2-3 minutes, requiring a rapid and efficient energy delivery system. Therefore, boxers need a higher percentage of fat-free mass to meet these energy demands.

Various studies have reported varying levels of body fat percentage in amateur boxers, which may be due to gender differences (male 9-16%, female 14-26%), practice methods, and weight categories **[14, 15, 16]**. It has been shown that male Boxers at the international level have an average body fat percentage of around 12%. Our study's findings of 11.843±1.216% body fat in Indian Boxers align with those of Smith et al **[15]**, who reported a body fat percentage of 10.1% in junior elite-level Boxers.

Findings of the present study are also in concurrence with the findings of the previous study by Khanna et al **[16]**, the body composition of elite Indian boxers was examined, and it was reported that medium-weight boxers had a body fat% of 11.6%. However, it should be noted that study of Khanna et al had a small sample size of only 7 boxers, whereas the present study had a sample size of 76. Additionally, the method used to calculate body fat % is same which was used by Khanna et al i.e., the Siri equation, which is based on skin fold thickness measurements.

The fat % of Indian weightlifters in our study was found to be 12.972±1.137%, which matches with the results of a previous study conducted by Krishan et al **[17]** who demonstrated that fat % in Indian elite weightlifters to be 11.6±2.26%. Krishan et al used bioimpedence method and we used Siri equation based on skinfold thickness measurement to calculate body fat %, which could have contributed to the lower fat % reported in their study.

The present study found that the body fat percentage of Indian Weightlifters was higher than that of Indian boxers. Boxers and weightlifters have different body composition requirements for their respective sports, which can result in differences in their percent body fat. Boxers typically aim for a lean body composition, with high levels of muscle mass and low levels of body fat, to optimize their power-to-weight ratio and maximize their agility and speed in the ring. As a result, male boxers may have 10 to 13 percent body fat, while female boxers may have 12 to 14 percent body fat.

On the other hand, weightlifters may have a higher percent body fat, as they require more muscle mass to generate the strength needed to lift heavy weights. However, this can vary depending on the weight class they compete in and their personal training goals. Male weightlifters may have a percent body fat ranging from 12% to 14%, while female weightlifters may have a percent body fat ranging from 13% to 16%.

Fat percentage and FFM percentage are less important for stationary sports like shooting and archery. As an exception to the general rule that less fat is better, weightlifters add large amounts of fat weight before competition, to lower their center of gravity and gain a mechanical advantage **[18, 2].**

Conclusion

Boxers tend to have a lower percentage of body fat and higher maximum fat free mass since boxing being a combat sport that involves explosive and powerful activities that utilizes muscle strength and endurance. On the other hand, weightlifters typically have a higher fat percentage compared to athletes in other sports, to maintain a lower center of gravity and stability. However, further studies are required to corroborate or refute these findings, specifically in Indian boxers and weightlifters, with larger sample sizes that reflect different weight categories.

Funding
No source of funding.

Acknowledgement
None

Conflict of Interest
Authors have no conflict of interest.

Author contributions:
Vikram Singh Yadav and Maman Paul wrote and revised the manuscript.

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