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Body composition and pulmonary functional correlates in Nigerian male amateur boxers

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Abstract. Optimal pulmonary function is essential to good performance in all sports and normal life, the search for all related variables to excellent sports performance is never ending. This study aimed to determine the correlation between body composition (BC) and the pulmonary functions (PF) in male amateur boxers. *Material and Method*. Twenty one male boxers who were at the training camp preparatory to an international game willingly participated in this prospective study. Participants' ages ranged between 21 and 27years, and their weights and heights ranged between 50.00 and 99.35kg and 1.62 and 1.88m respectively. Participants' body compositions of percentage body fat (%BF) and fat mass per weight (FMWt) were measured and analyzed by OMRON Body fat monitor (BF 302; Omron Co. Ltd., Japan) and the pulmonary parameters of Forced Expiratory Volume in 1 second (FEV1) and the Forced Inspiratory Volume (FIV) were measured with the use of full range peak flow meter (Philips, Respironics, UK) and portable hand held spirometer (Voldyne, Sherwood medicals, USA) respectively. Pearson Product-Moment and Spearman-rank order Correlation Coefficient statistical techniques were used to test correlation between the male amateur boxers' BC and their PFs parameters, PFs and fighting results, while multiple regression analysis was used to determine the best BC predicting variables of PFs, at a significance of 0.05. *Results*. The results revealed that there was a significant positive correlation between FIV and weight, height, %BF, and FMWt; and also between FEV1 and height. However, the results demonstrated that there was a negative insignificant correlation between FEV1 and age, as well as WHR. *Conclusion*. It was therefore concluded that BC parameters have significant relationship with the inspiratory capacity of male amateur boxers but not the expiratory capacity. However, both forced expiratory and inspiratory capacities of male amateur boxers are not enhanced by increasing body fat content (adiposity) as measured by BMI and WHR.
Key words: *amateur boxing, pulmonary function, body composition.*

Introduction

Boxing is an endurance sport that involves two men or women fighting each other using premeditated punching strikes to the opponent's head and body (trunk) for competition in order to achieve victory, both at professional and amateur levels (1).

It is a sport where a fight between two people of similar weights lasts three rounds of three minutes each for a competition, if there is no knockout, technical or otherwise (2).

The aerobic capacity which is the most important criterion for endurance performance is defined as the transfer of oxygen into blood by the pulmonary system, its distribution into active muscles together with blood and the ability of these muscles to use oxygen during physical work (3).

Training results in increased capacity for aerobic exercise as oxygen delivery and skeletal muscle utilization are enhanced. The onset of anaerobic metabolism is delayed, resulting in deferred rise in minute ventilation and carbon dioxide (VCO_2) out of proportion to oxygen consumption (VO_2). Furthermore, for a given level of exercise lactate levels, minute ventilation and VCO_2 are reduced after training and the trained person also reports reduced perception of dyspnea with training (4).

Amateur boxers are categorized by their body weights ranging from fly weight of fifty kilograms to super heavy weight of over ninety kilograms of body weight. Those in the same category possess essentially the same body features in terms of musculature, low body fat percentage with more fat-free weight except for super heavy category.

The physiques of the other weight categories provide for speed, flexibility, agility and heavy punches, while the super heavy weight fighters possess heavier body weights with higher fat content and thereby tend to possess less speed and flexibility. Their modes of training are basically the same.
A previous study had reported that the relationship between percentage body fat (%BF) and body mass index (BMI) variation may be due, in part, to differences in central fatness and muscularity (5). Several studies have reported the relationship of body composition parameters with physical functional performance in different groups of people and across different ages (6-8).
Performance in sport is believed to be dependent on many factors some of which are body composition, respiratory functions (believed to be, in turn, dependent on genetic factors of age, gender, height), and level of training (9).
Many studies have revealed that the percentage and distribution of body fat have a significant effect on the pulmonary functions (10-12) with the conclusion that increasing body fat percentage decreases the activity of the respiratory muscles, resulting in a general decrease in the dynamic compatibility of lungs, and in lung capacity (13).
Some authors have demonstrated that strength development is also important for endurance performance in young athletes (14,15), and that reduction in muscular strength influences the decrease in aerobic capacity during aging in the elderly (16).
It has been reported that people who engaged in regular exercise had greater ventilatory endurance, as well as higher lung volumes and inspiratory and expiratory flow rates than the general population (17).
The physiological events that take place during maximum oxygen consumption are the introduction of oxygen into the pulmonary system, its transfer to blood from there and its use in muscles (3,18).
The aim of this study was to investigate the relationship between body composition parameters and pulmonary functions in amateur boxers in Nigeria.

Material and Method

This was a 2-month prospective study carried out on twenty-one (21) out of twenty-six (26) male Nigerian amateur boxers who were in national camp preparatory to an international boxing competition.
Body compositions of percentage body fat and fat mass per weight were measured and analyzed by OMRON Body fat percentage monitor (BF 302; Omron Co. Ltd., Japan). The pulmonary parameters of Forced Expiratory Volume in 1 second (FEV1) and the Forced Inspiratory Volume (FIV) of the participants were measured by the use of full range peak flow meter (Philips, Respironics, UK) and portable hand held spirometer (Voldyne, Sherwood medicals, St. Louis, MO, USA) respectively. Each participant was instructed to blow out maximally as fast as possible into the mouth piece of a hand held peak flow meter after taking a deep breath. Participants were also instructed to suck air into their lungs as maximally as they possibly could from an incentive spirometer through an individualized mouth piece. The volume each participant was able to inhale was taken and recorded. The mean of two deep inspiratory efforts was recorded for each participant. All measurements were taken in standing position in accordance with the American Thoracic Society and European Respiratory Society guidelines (19).
Anthropometric parameters of body weight and height were used as surrogates for determining the body mass index while the waist and hip girth measurements taken with the use of tape were used to compute the waist-to-hip ratio of the participants. Anthropometric parameter of body weight was measured with the subject in light clothing with bare feet using a digital weighing scale (Seca, England). It was recorded in kilogrammes to the nearest whole number. The height was measured to the nearest 0.01 meter in standing barefoot using a stadiometer rule (Seca, England).
All measurements were taken at the camp medical room in the morning between 6.30 and 8.00am before breakfast and before morning training and under normal room temperature.
The mean of two attempts of body composition and three attempts of lung functions were taken as the required parameters and recorded for each participant.
Inclusion criteria were that all the participants must have been in amateur boxing training for at least three (3) years period, must have been medically certified fit for involvement in training camp before the time of the present study, had no symptom of any chest (rib) injury, infectious

respiratory condition or did not have chest pain on deep inspiration or expiration.

Exclusion criteria included suspicion of the use of a performance enhancing aid of any sort, difficulty in understanding the use of the equipment (peak flow meter and spirometer) or presence of asthmatic condition in any of the boxers or chest pain during deep inspiration as well as involvement in smoking as a habit. Two (2) athletes were excluded based on previous history of chest injury, one (1) had a history of heavy smoking while two (2) did not properly understand the procedures of the study.

Ethical permission was sought and approval obtained from the Sports Medicine Department of the National Sports Commission, Nigeria.

Statistical analysis. Parameters obtained were fed into SPPSS version 16.0 package software. Descriptive statistics of means, standard deviations and ranges were analyzed. The Pearson product–moment correlation statistics was used to investigate possible relationship between the body composition and respiratory parameters analyzed. Spearman-Rank order correlation coefficient was used to explore the relations between pulmonary function and fighting results. Multiple regression analysis was used to determine the best predicting variable(s) of pulmonary parameters. Significance was accepted as $p<0.05$, statistical power was 90%. The results were evaluated as inverse correlation for the values that came out negative and as direct (positive) correlation for those that came out positive.

Results

The ages of the participants ranged between 17-27 years (mean= 22.60 ± 2.91 years), body weight ranged between 50 and 99.35kg (mean= 71.43±13.42kg) and heights ranged between 1.62 and 1.88m (mean= 1.75±0.08m). The weight classifications ranged between light fly (49Kg) and heavy weight (91Kg) (Table I).

Table I also shows the descriptive statistics of means, standard deviations and range for body composition parameters of percentage body fat and fat mass per weight of the athletes as 11.38(4.21%), 15.90% and 8.95(4.43Kg), 18.00Kg respectively.

The values for forced expiratory volume in 1 second and forced vital capacity were 525(73.15mL); 270:00mL, 2712.5(855.69mL), 3825:00mL respectively. Pearson product-moment correlation statistics revealed a positive significant correlation between FIV and each of the body composition parameters of body weight, percentage body fat and fat mass per weight, as well as with height. It also revealed a significant positive correlation between FEV1 and height at both $p<0.05$ and $p<0.01$. However, a negative non-significant statistical correlation was found to exist between FEV1 and age and waist-to-hip ratio (table II). The results also showed that whereas there was a positive significant correlation between forced inspiratory volume and body weight, there was no significant correlation between weight and forced expiratory volume. There was no statistically significant correlation between body mass index and waist-to-hip ratio and pulmonary parameters of forced expiratory volume and forced inspiration capacity as measured in this study in these athletes.

The result also revealed that pulmonary functions of forced inspiratory and expiratory volumes do not have statistically significant correlation with fighting results. The result of multiple regression analysis revealed that BC parameters of weight, BMI, percentage body fat and FMWt all have statistically significant influence on FEV1 ($p=0.048$; $r2=0.464$) and not on FIV ($p=0.845$). However, when each of the other variables was controlled, whereas no individual BC parameter has a statistically significant influence on FIV, only height was found to be the best predicting variable for FEV1 ($b= 0.770$; $p= 0.035$).

Table I. Descriptive statistics of the body composition and pulmonary function parameters of the amateur boxers

Parameter	Mean± Standard Deviation	Range	N
Age (yrs)	22.60±2.91	10.00	21
Weight (Kg)	71.43± 13.42	49.35	21
Height (m)	1.75 ± 0.08	0.26	21
Body Fat (%)	11.38± 4.21	15.90	21
Fat Mass per Weight (Kg)	8.95± 4.43	18.00	21
Body Mass Index (Kg/m^2)	23.17±3.26	13.65	21
Waist-to-Hip ratio	0.86±0.03	0.13	21
FEV1 (mL)	525.00± 73.15	270.00	21
FVC (mL)	2712.50±855.69	3825:00	21

Yrs= years; m= meters; Kg= Kilograms; %= Percentage; Kg/m2= Kilograms per meter square; mL= milliliter.

Table II. Pearson product-moment correlation statistics of body composition and pulmonary function parameters of the amateur boxers

Parameters	FEV1		FIV	
	r	*p*	*r*	*p*
Age	-0.362	0.107	0.088	0.705
Weight	0.351	0.119	0.530*	0.014
Height	0.520*	0.016	0.614**	0.003
%Body Fat	0.116	0.616	0.530*	0.023
Fat Mass per Weight	0.083	0.728	0.497*	0.047
Body Mass Index	0.171	0.458	0.341	0.130
Waist-to-Hip ratio	-0.116	0.615	0.085	0.715

*** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed); SD= Standard Deviation; FEV1= Forced Expiratory Volume in 1second; FIV= Forced Inspiratory Volume; % Body Fat= Percentage Body Fat*

Discussion

The results of this study showed a correlation between the body composition and pulmonary capacities of forced inspiratory capacity of male amateur boxers suggesting that as the body composition parameters of weight, height, percentage body fat and fat mass per weight of amateur boxers increase, the forced inspiratory capacities increase commensurately.

The result also revealed a correlation between height and forced expiratory capacity of amateur boxers which is indicative of increasing pulmonary capacities of forced expiration as the heights of amateur boxers increase.

The correlation between pulmonary function (FIV) and percentage body fat, and fat mass weight in this study agrees with the reports in the literature that pulmonary functions are under the influence of muscularity and fat distribution rather than body weight (11,13,18,20).

Also, the negative correlation between waist-to-hip ratio, which is a measure of adiposity, and pulmonary function of FEV1 support the conclusion of the previous studies that fat distribution rather than body weight influence pulmonary functions (11,13,18,20). The result of this study revealed no significant correlation between BMI and pulmonary functions (FEV1 and FIV). The researchers conclude that obesity is usually not a problem in amateur boxing judged by the frequency, intensity and type of training boxers are engaged in which result in tensed abdominal musculature which is an essential requirement for optimal boxing performance.

Height was found in this study to have a positive correlation with pulmonary functions of both FEV1 and FIV. The observation is in line with the report of previous study which revealed that height as a genetic factor has influence on pulmonary capacity (18,21). However, the observation of age having a negative insignificant correlation with FEV1 and no correlation with FIV in this study is in contrast with Koziel's report (21) that age is a genetic factor that influences pulmonary functions (18,20,22). Many other studies conducted on normal subjects have revealed positive age relationship with FEV1 especially in men (23,24).

The observation of no significant correlation between pulmonary functions of FEV1 and FIV and a measure of adiposity (BMI); and FIV and WHR on one part, and negative but insignificant correlation between FEV1 and WHR on the other hand, implied that possession of low body fat percentage (especially abdominal fat as measured by WHR) but high level of muscularity offers an advantage for adequate pulmonary functions for optimal physical performance in amateur boxing. Meanwhile, the report of the study on the association of body composition with pulmonary function in normal-weight, overweight, and obese subjects in rural community in Canada revealed negative association between BMI and pulmonary function in overweight and obese subjects, but positive correlation between FEV1 and in normal subjects (25).

The present study's result is in line with the report of research carried out on 930 people from both genders with the age range of 18 to 78, where it was also revealed that increase in upper body fat percentage and waist circumference result to decrease in respiration parameters (11).

To the best of the researchers' knowledge, no previous study in Nigeria and possibly beyond has investigated the correlation between body compositions and pulmonary functional parameters among amateur boxers.

Conclusion

In conclusion, the study has stated that body composition parameters have significant relationship with pulmonary functions especially the forced inspiratory capacity of male amateur boxers. In addition, higher than normal measures of adiposity like body mass index and waist-to-hip ratio pose a negatively influence on both forced expiratory and inspiratory capacities of male amateur boxers. Age in male amateur boxers was found to be negatively correlated with pulmonary function in this study.

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