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Original Article

Body Composition in Selective Groups of Elite Indian Sportsmen : A Comparative Study

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Abstract

Body composition is an important indicator of the physical fitness and health of athletes. Excess fat% in body acts as dead weight which must be lifted against gravity during sports leading to increase in energy demands thereby decreasing performance. Endurance athletes require less fat-free mass% and fat %, as they have to move their total body mass horizontally for extended periods thereby reducing performance. Body composition was analysed in 30 subjects each of Wrestling, Weightlifting, Boxing, Fencing and Archery. The results were analysed using SPSS and Kolmogorov-Smirnov test and one way ANOVA were used for analysis. Boxers were found to have the least percentage fat % and highest fat free mass% (FFM) (9.57±2.80, 90.43±2.80) whereas Weightlifters had the maximum fat% and least FFM% (11.47±2.52, 88.53±2.52) out of five disciplines of sports studied. Weightlifters needing firm hold and to maintain the centre of gravity, have a tendency for higher fat % compared to other sports. Boxers require muscle strength for forceful and explosive activities and tend to have least fat % and maximum FFM%. Indian Wrestlers and Fencers have comparable fat% to international standards.

Introduction

Body size, build and composition are known to be important determinants of sporting discipline and performance. Body composition refers to composition of the body in terms of fat mass and fat free mass. Body size and build can be moderately altered but body composition is substantially modified with diet and exercise. Resistance training can increase muscle mass but decrease in body fat requires vigorous aerobic exercise with sound dietary practices. Increased muscle mass and reduced body fat play an integral part in achieving optimal athletic performance. Excess proportion of fat to total body mass (fat%) in the body acts as a dead weight which must be repeatedly lifted against gravity leading to unnecessary increase in the energy demands, ultimately decreasing performance (1). Muscles generate power for sporting activity which is difficult to measure in an athlete. Bio-impedence method can measure fat free mass (FFM) which is a fair indicator of muscle mass (2). Boxing is a sport requiring strength, power, and muscular endurance for which maximum FFM is mandatory. Interestingly, increased

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FFM is undesirable for distance runners as they have to move their total body mass horizontally for extended periods and this extra load reduces performance. Fat % and FFM% (proportion of fat free mass to total body mass) are of lesser importance for relatively stationary sports, such as archery and shooting. Heavyweight Weightlifters are an exception to the general rule of less fat is better, as they add large amounts of fat weight just before competition under the premise that the additional weight will lower their centre of gravity and give them a greater mechanical advantage in lifting weights (3, 4).

Body composition analysis is an assessment tool in optimizing competitive performance and monitoring the success of training regimens in sports professionals (4, 5). Sharpened body composition analysis parameters are associated with enhancements in cardio-respiratory fitness (6) and strength (7) in athletes. Athletes typically have a lower Fat% (6) and more FFM% than age matched non-athletes. Athletes engaged in high intensity training possess higher FFM compared to non-athletes due to increased skeletal muscle mass (8, 9). A number of studies on sports persons have highlighted this difference in body composition in athletes versus sedentary individuals. However, few such studies have been done in Indian elite athletes who compete at National and International levels. Since sedentary Asian Indian populations are known to have greater body fat per unit weight, it was relevant to study the body composition of elite athletes. The present study reports body composition of elite Indian athletes as well as serves as reference body composition database for elite Asian Indian athletes.

Material and Methods

Body composition was analysed in National level elite sportsmen of five different disciplines. They were actively involved in respective field–specific classical training for the last 5–10 years. All the study subjects were thoroughly examined with particular emphasis on history of disease, psychological problems and drug history. The inclusion criteria of the study were active sportsmen training for at least for the last 6 months regularly without any break. Training records were ascertained by checking the available training register. The exclusion criteria were subjects suffering from any minor or major illnesses, surgeries, hospitalisation periods and undertaking any diet restrictions or modifications.

A total of 150 subjects from five different sports disciplines were registered under this study. Sample size for the study was calculated considering level of significance as 0.05 (two-tailed), an effect size i.e. difference between groups as 0.3% with 80% power. Hence required sample size was 28 for each sports discipline. Stratified random sampling was done for chosing the subjects in the study. List of all the sportsmen belonging to different disciplines was prepared. They were segregated on the basis of weight (64-70 Kg) across all the disciplines. 30 sportsmen were then randomly selected from each discipline. The age groups of these five sports disciplines were as follows: Wrestling (Age 15-24 yrs), Weightlifting (Age 19-25 yrs), Boxing (Age 17-25 yrs), Archery (Age 17-23 yrs) and Fencing (Age 16-25 yrs). A cross-sectional study was carried out at a Tertiary Sports Training Institute. The ethical clearance for the study was provided by the Institutional Review Board and written informed consent obtained from the participants after briefing the aims and scope of the present study.

The study started with measurement of body weight and height followed by body composition analysis using BC-Analyzer machine Bodyscan with Four channel measurements (Quadscan 4000, Data Input GmbH, Germany) based on the principle of bioelectric impedance. Bio-impedence method is a rapid, non-invasive, and relatively inexpensive method with acceptable accuracy (10). The training programmes of these five sport disciplines tested are very different from each other due to their diverse nature. Hence to alleviate the effect of the varied training programmes, this study was conducted in the pre-competition phase as the fitness training was being tapered off with more emphasis on skill training. Measurements were performed in the morning before breakfast (7:30–8:30 AM) in all the monitored groups. In the 24 hours prior to the measurements, the participants did not consume any drugs (including

tea, caffeine and alcohol) or pharmacological agents that could influence the results of the measurement. They were also told not to eat or drink after 10 PM the day before the measurement. Furthermore, in the 48 hours preceding the tests, the subjects did not perform any high intensity physical activity. We included only two variables i.e Fat% and FFM% for analysis. Measurements were performed according to the ethical standards of the Helsinki Declaration and the ethical standards in sport and exercise science research.

Results

Table I shows the findings of body composition analysis of sportsmen of different disciplines. Mean age of athletes varied from 18.5±3.64 yrs in Wrestlers to 21.6±2.53 years among Boxers. Lowest mean weight was observed in Archers as 64.3±6.53 kg and highest weight was observed as 69.5±8.10 kg in Fencers. The maximum height was recorded as 175.0±6.80 cm in Fencers.

Discipline wise summary statistics including mean and standard deviation (SD) were calculated for anthropometry, body fat (%) and FFM (%). FFM was calculated as FFM% = 100-body fat (%). Hence statistical testing was applied to body fat (%) only to avoid co-linearity in the analysis. Statistical analysis was done in SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL). Kolmogorov-Smirnov test was used to test the normality of continuous variables. One way ANOVA was used to test the difference in mean values of body fat (%) between five sports disciplines. Further Tukey HSD post hoc analysis was done to test which sports disciplines have different body fat among the five disciplines. 95% Confidence Intervals (CI) were calculated for mean of body fat (%) and the difference in the means of body fat (%) between two disciplines of Boxers and Weighlifters. Statistical significance was set at $p \geq 0.05$.

In body composition analysis, lowest body fat (%) was observed in Boxing (Mean=9.7, 95% CI=8.741, 10.742), followed by Fencing (Mean=10.0, 95% CI=9.175, 10.748), Archery (Mean=10.1, 95% CI=9.352, 10.870), Wrestling (Mean=11.2, 95% CI=10.049, 12.257) and highest body fat (%) as (Mean=11.6, 95% CI=10.787, 12.477) in Weight-lifting Table II.

Body fat % data was normally distributed (p=0.503). It was observed that mean body fat (%) of at least two groups, of the many groups tested, are significantly different from each other ($F_{4,145}$=3.449, p=0.010). In post hoc Tukey HSD test, it was observed that body fat (%) was significantly lower in Boxers as compared to Weight-lifters (Mean difference=1.89, 95% CI of difference=0.155, 3.626, p=0.025).

TABLE II : Discipline wise comparison of body fat (%) of athletes.

Discipline		*Mean difference in body fat (I-J)*	*p-value*	*95% confidence Interval*
(I)	*(J)*			
Wrestling	Weight lifting	-0.48	0.941	-2.215, 1.256
	Boxing	1.41	0.169	-0.324, 3.147
	Archery	1.04	0.463	-0.694, 2.777
	Fencing	1.19	0.324	-0.544, 2.927
Weight lifting	Boxing	1.89	0.025	0.155, 3.626
	Archery	1.52	0.116	-0.214, 3.256
	Fencing	1.67	0.065	-0.065, 3.406
Boxing	Archery	-0.37	0.977	-2.105, 1.366
	Fencing	-0.22	0.997	-1.955, 1.515
Archery	Fencing	0.15	0.999	-1.586, 1.885

Test applied – Post hoc Tukey HSD

TABLE I : Discipline wise anthropometry and body composition of athletes.

Discipline	*Age (yrs)*	*Weight (kg)*	*Height (cm)*	*Duration of training*	*Fat(%)*	*FFM(%)*
Wrestling	18.5±3.64	65.5±10.51	165.5±5.49	7 months	11.2±2.96	88.8±2.96
Weight-lifting	20.0±3.22	67.0±7.83	165.1±5.46	6½ months	11.6±2.26	88.4±2.26
Boxing	21.6±2.53	65.0±11.67	170.1±8.20	6 months	9.7±2.68	90.3±2.68
Archery	19.4±2.11	64.3±6.53	169.8±5.50	8 months	10.1±2.03	89.9±2.03
Fencing	20.9±2.71	69.5±8.10	175.0±6.80	7 months	10.0±2.11	90.0±2.11

Values are shown as Mean±SD.

Discussion

The present study was an endeavour to provide an overview of the body composition in Asian Indian Wrestlers, Boxers, Weightlifters, Archers and Fencers. We could not find similar studies in the databases like Pubmed, Medline and Cochrane by using different keywords like elite, athlete, body composition, Boxers, Weightlifters, Archers, Fencers and combination of words. The present study is the first of its kind in “Asian Indian male athletes”. We found that Boxers showed the least fat% of 9.57% and Weightlifters had the maximum of 11.47%. Body fat% and FFM% have an inverse relation to each other and this indicates that Boxers have the highest percentage of FFM% of 90.43% and Weightlifters had the lowest FFM% of 89.16%. Boxers and Weightlifters exhibit differences in body fat% because of different motor qualities, training programmes and diet. Boxing is a mixed aerobic and anaerobic sport whereas Weightlifting is mainly anaerobic in nature. These disciplines were chosen purely by matching their body weights, which may be the reason for the significant differences in body fat%. Sedentary males generally have body fat% between 19-21% as per a study conducted on Indian college male recreation players (11).

Health professionals use standard height-weight-age tables for assessing the desirable weight for any individual but in case of sportsmen, this method may not be the most appropriate. Body composition on the other hand is a better guide for determining desirable weight in sports persons, as it shows differential percentages of the body weight in terms of fat and fat free mass which is informative for different disciplines of sports (12, 13). Boxing is a combat sports involving punches, quick movements and changing pace hence the power output during these activities depends on the strength of the muscles involved (13). Boxers fight and train generally at very high intensity of rounds of 2-3 min duration continuously, which requires a very quick and efficient energy delivery system. Hence higher FFM is required to meet these energy requirements in Boxers.

Different studies have quoted different values of fat% in amateur Boxers due to the differences in the gender (male 9-16%, female 14-26%), practice methods and weight categories (14, 15, 16). These studies show that mean body composition of international-level male Boxers is approximately 12% fat. Our results of fat% in the Indian Boxers i.e 9.57% matches with that of Smith et al (15) who reported body fat% (10.1%) among junior elite-level Boxers. Khanna et al (16) studied body composition in elite Indian Boxers, reporting body fat% of 11.6% in medium-weight Boxers. However Khanna et al had a sample size of 7 Boxers, compared to 30 in the present study. They used the Siri equation for calculating the body fat% based on skin fold thickness measurement whereas we have used Bio-impedence method which could have led to the higher fat% in the study by Khanna et al.

Indian Wrestlers were found to have fat % of 10.78% which matches with that of a previous study in lighter Wrestlers (17). However, Vardar SA et al found lower body fat% as 9.7% (18) and the possible reasons for finding lesser fat% than the present study could be differences in ethnicity, levels of training, levels of competition for which trained and body fat measurement method. Horswill et al have reported a high degree of leanness in amateur wrestlers excluding heavy-weight category Wrestlers (19).

Many studies have found body fat percentages of 5–10% in light- to middle-weight male Weightlifters (i.e. ≤56 kg to ≤85 kg) with body compositional characteristics similar to weight restricted Wrestlers and Sprinting/Jumping athletes (20, 21). Heavy to unlimited weight classes (i.e. ≤94 kg to >105 kg) of Weightlifters on the other hand tend to have body fat percentages of ≥17% (22). The present study found higher body fat% than light to middle-weight Weight-lifters and lower than that reported in heavyweight weight-lifters in the above-mentioned studies.

Fencing is a relatively new sport which requires quick and accurate movements along with well-developed

mental abilities and physical skill. American College of Sports Medicine recommends that a typical fencer should have an average of 8-12% fat% compared to 15-18% in healthy sedentary/non-athletic individuals (23). The findings of the present study (fat%- 9.92 %) fall within these values. Kuwaiti fencers on the other hand have an average of 13.9% fat% which is slightly above the recommended range (24). An earlier study reported an average fat% in case of National-class Polish fencers as 12.2% (25).

Archery is a comparatively static sport requiring strength and endurance of the forearm and shoulder girdle hence body composition parameters like fat% appear to have a smaller role in performance (26). The present study found fat% values in Archers similar to Fencers because the sportsmen were in the same residential sports training institute with same dining facilities and a similar menu.

Conclusion:

Weightlifters tend to have higher fat% compared to other sports to maintain stability and centre of gravity. Boxers on the other hand, tend to have less fat% and maximum FFM% as it is a combat sports associated with powerful and explosive activities utilising muscle strength and strength endurance. Indian athletes appear to have body composition similar to their western counterparts in these five sports disciplines studied, though sedentary Asian Indians have more body fat per unit body weight. Further studies on elite Asian Indian sportsmen with larger sample sizes as per the different weight categories are needed to corroborate or negate our study findings.

References

1. Reilly T. Fitness assessment. In: Science and Soccer. Reilly T, ed. London: E. & F. Spon; 1996; p. 25–50.
2. Evans WJ, Cyr-Campbell D. Nutrition, exercise, and healthy aging. *J Am Diet Assoc* 1997; 97: 632–638.
3. Kenney W, Wilmore J, Costill D. Physiology of sport and exercise. 5th ed. US: Human Kinetics; 2011.
4. Rodriguez NR, Di Marco NM, Langley S. American College of Sports Medicine position stand. Nutrition and athletic performance. *Med Sci Sports Exerc* 2009; 41: 709–731.
5. Malina RM. Body composition in athletes: assessment and estimated fatness. *Clin Sports Med* 2007; 26: 37–68.
6. Hogstrom GM, Pietila T, Nordstrom P, Nordstrom A. Body composition and performance: influence of sport and gender among adolescents. *J Strength Cond Res* 2012; 26: 1799–1804.
7. Silva AM, Fields DA, Heymsfield SB, Sardinha LB. Body composition and power changes in elite judo athletes. *Int J Sports Med* 2010; 31: 737–741.
8. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign IL: Human Kinetics Books; 1988.
9. Midorikawa T, Sekiguchi O, Beekley MD, Bemben MG, Abe T. Acomparison of organ-tissue level body composition between college-age male athletes and non-athletes. *Int J Sports Med* 2007; 28: 100–105.
10. Lukaski H C, Bolonchuk W W, Hall C B, Siders W A. Validation of tetrapolar bioelectrical impedance method to assess human body composition. *J Appl Physiol* 1986; 60: 1327–1332.
11. Tyagi S, Vanaik A K, Wasuja M, Grover J, Bajaj V. Anthropometric and body composition status of university level Indian male team game players. International Journal of Adapted Physical Education & Yoga, 2016; 1(9): 1–10.
12. Beunen, G. and Malina, B.M. Growth and physical performance relative to the timing of the adolescent spurt. *Exercise and Sports Science Review* 1988; 16: 503–546.
13. Reilly TN, Snell SP, Williams C. Physiology of sports. London, England: E. & F.N. Spon/Chapman & Hall; 1990.
14. El-Ashker S, Nasr M. Effect of boxing exercises on physiological and biochemical responses of Egyptian elite boxers. *J Phys Ed Sport* 2012; 12: 111–116.
15. Smith M. Physiological profile of senior and junior England international amateur boxer. *J Sports Sci Med* 2006; 5 (CSSI)(Jul): 74–89.
16. Khanna GL, Manna I. Study of physiological profile of Indian Boxers. *Journal of Sports Science and Medicine* 2006; 5: 90–98.
17. Sterkowicz-Przybycieñ K L, Sterkowicz S, ¯arów R T. Somatotype, Body Composition and Proportionality in Polish Top Greco-Roman Wrestlers. *Journal of Human Kinetics* 2011; 28: 141–154.
18. Vardar S A, Tezel S, Öztürk L and Kaya O. The relationship between body composition and anaerobic performance of elite young Wrestlers. *Journal of Sports Science and Medicine* (2007); 6(CSSI-2): 34–38.
19. Horswill C.A. Applied physiology of amateur Wrestling. *Sports Medicine* 1992; 14(2): 114–143.
20. Stone MH, Pierce KC, Sands WA, Stone ME. Weightlifting: a brief overview. *Strength Cond J* 2006; 28(1): 50–66.
21. Fry AC, Ciroslan D, Fry MD, LeRoux CD, Schilling BK, Chiu LZ. Anthropometric and performance variables discriminating elite American Junior men weightlifters. *J Strength Cond Res* 2006; 20(4): 861–866.
22. Fahey TD, Akka L, Rolph R. Body composition and VO2max of exceptional weight-trained athletes. *J Appl Physiol* 1975; 39(4): 559–561.

23. Thompson WR, Gordon NF, Pescatello LS. ACSM's guidelines for exercise testing and prescription. 8th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2010.

24. Ghloum K and Hajji S. Comparison of diet consumption, body composition and lipoprotein lipid values of Kuwaiti fencing players with international norms. *Journal of the International Society of Sports Nutrition* 2011; 8(1): 13–21.

25. Sterkowicz-Przybycieñ K. Body composition and somatotype of the elite of Polish fencers. *Coll Antropol* 2009; 33(3): 765–772.

26. Mann DL, Littke N. Shoulder injuries in Archery. *Canadian Journal of Sport Science* 1989; 14: 85–92.