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# Analysis of anthropometry, body composition and performance variables of young Indian athletes in southern region

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## Abstract
The purpose of this study was to analyze the anthropometry and body composition associated with performance of university level male track and field athletes of South India. This study was conducted on 93 track and field athletes from South India, comprised of 22 sprinters (100 & 200 mts), mean age 19.5 years, height 172.1 cm and weight 68.2 kg, 20 middle distance runners (800 & 1500 mts), mean age 19 yrs, height 166.8 cm and weight 62.5 kg, 16 long distance runners (5000 & 10000 mts), mean age 18.7 years, height 167.2 cm and weight 62.1 kg, 20 throwers, (shot, discus & hammer throw), mean age 19 years, height 170.8 cm and weight 72.6 kg and jumpers (High, long & triple jump), mean age 18.3 years, height 169.9 cm and weight 64.1 kg. Besides height and weight, six skin folds (triceps, chest, subscapular, abdomen, suprailiac & calf), two bicondylar breadths (humerus & femur) and two girths (biceps & calf) were measured. Somatotype evaluations were made according to Carter and Heath (1990) method. BMI was calculated as body mass divided by square of height (kg/m$^2$). The somatochart indicated that sprinters and middle distance runners are ectomorphic mesomorphs, long distance runners are mesomorph ectomorphs while throwers are endomorphic mesomorphs. The jumpers fell into the somatotype category of balanced mesomorphs. Among all groups body fat percent is lowest in sprinters (6.23±0.83%) and highest in throwers (7.38±0.85%). This was reflected in their endomorphic components which is lowest in sprinters (2.53±0.45) and highest in throwers (3.39±0.65). Ectomorphic component is highly marked in long distance runners (3.56±0.65) while mesomophy was highest in sprinters (4.31±0.91). Throwers have significantly higher values of skin folds than other groups. Compared to their overseas counterparts, the athletes of both track and field events in the present study exhibited greater endomorphic values. The present data will serve as a reference standard for the anthropometry and body composition of south Indian track and field athletes.

**Keywords:** Body composition, Somatotype, Endomorphic, Ectomorphic, Mesomorphic, Anthropometric.

## Introduction

Specific anthropometric characteristics are needed to be successful in certain sporting events. It is also important to note that there are some differences in body structure and composition of sports persons involved in individual and team sports. The tasks in some events, such as shot put or high jump, are quite specific and different from each other and so are the successful physiques. This process whereby the physical demands of a sport lead to selection of body types best suited to that sport is known as "morphological optimization" (Bloomfield *et al.,* 1995). Track and field events are marked by an exceptional variety of duration of a single event, energetic demands and the tempo of energy release. The fact that runners need to carry their body weight, which means they need to overcome the force of gravity on different distances, stipulates a specific (lean) body composition as a prerequisite for more efficient and economic performance in a single event. Athletes who have (or) acquired the optimal physique for a particular event are more likely to succeed than those who lack the general characteristics (Carter, 1984). Studies on somatotype of athletes, elite athletes and Olympic athletes have generally shown that strength and speed dependent athletes tended to be basically mesomorphic while distance dependant athletes were found to be more ectomorphic with limited amount of mesomorphic muscularity (Battinelli, 2000). A somatotype is a description of present morphological confirmation. It is expressed in ratings, consisting of three sequential numbers, always recorded in the same order. Each number represents evaluation of one of the three primary components of physique, which describe individual variation in human morphology and composition. Endomorphy, or the first component, refers to relative fatness and leanness of the physique; mesomorphy, or the second component, refers to musculo-skeletal development relative to height; and ectomorphy, or the third component, refers to the relative linearity of individual physique (Carter & Heath, 1990).

In athletes, body composition measures are widely used to prescribe desirable body weights, to optimize competitive performance, and to assess the effects of training (Sinning, 1996). It is generally accepted that a lower relative body fat is desirable for successful competition in most of the sports. This is because additional body fat adds to the weight of the body without contributing to its force production or energy producing capabilities, which means a decrease in relative strength. It is obvious that an increased fat weight will be detrimental in sporting activities where the body is moved against gravity (e.g. high jump, pole vault, volleyball spiking action) or propelled horizontally (e.g. running). In running at any sub maximal speed, the oxygen requirement is increased with any increment in body weight that is, oxygen consumption is increased due to

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the greater energy demand required to initiate and sustain movement of a larger weight. Previous research has demonstrated that athletes in all running events have less body fat compared to most other disciplines (Martin & Coe, 1997; Gore, 2000; Matkovic *et al.,* 2003).

Morphological parameters are an essential part of the evaluation and selection of sports persons for diverse fields of sports, standard data on such parameters are still lacking in the Indian context in track and field athletic events. The present study was therefore aimed at evaluating the physical parameters, anthropometric measurements, body composition and somatotype of male track and field athletes from India, and to compare the data with their overseas counterparts.

## Material and methods

*Subjects:* 93 track and field athletes comprised of 22 sprinters (100, 200 & 400 mts) aged 19.5±1.22 years, 16 middle distance runners (800 & 1500 mts) aged 19±1.26 years, 20 long distance runners (5000 & 10000 mts) aged 18.1±0.94 years, 16 jumpers (high jump, long jump & triple jump) aged 19.0±12.4 years and 20 throwers(shot, discus & hammer throw) aged 18.3±1.30 years were randomly selected from four states of India (Karnataka, Andhra Prasesh, Tamil Nadu & Kerala) for the purpose of the study.

*Procedures:* 12 morphological body measures were taken: Height, weight, breadth of femur and humerus, girths of upper arm and lower leg, skinfolds of triceps, supra-iliac, sub-scapular, chest, abdomen and calf. The height was measured by means of stadiometry to the nearest 0.5 cm and a bathroom scale was used to measure body mass to the nearest 0.1 kg. Skinfold measurements were taken using Lafayette skin-fold caliper (U.S.A) with constant tension, Vernier caliper was used for assessing breadths and steel measuring tape used for measuring circumferences. Guidelines of Johnson and Nelson (1982) were followed for these measurements. Body composition (% of lean body mass & body fat), body mass index and body somatotype (according to Heath-Carter, 1984) were calculated from anthropometric measures using the following equations:

Body density or BD (gm/cc) = 1.107-(0.000280) x (A) – (0.000736) x B – (0.000883) x C Where,

(A) = Abdominal Skinfold, (B) = Chest skinfold and (C) = Triceps skinfold (Shaver, 1982)

Percent of body fat or PBF =

(4.570/BD-4.142) x 100 (Brozek *et al.,* 1963)

Lean body weight or LBW (kg) =

(Total body weight – Total weight of fat)

$$\text{Total weight of fat} = \frac{\text{(Weight x percent of fat)}}{100}$$

BMI (Kg/$m^2$) = (Body mass in Kg)/ (Stature in mts) (Meltzer *et al.,* 1988).

*Statistical analysis*

Considering the purpose of the study mean and standard deviation were computed for the statistical treatment of the data. The obtained data were treated with analysis of variance (ANOVA) for finding out the difference between groups. When the obtained F ratio found to be significant at 0.05 level, Sheffe's test was used as Post Hoc test to find out the mean differences.

## Results

Table 1 represents various physical parameters and anthropometric measurements of the subjects. The throwers are the heaviest of all athletes while long distance runners have the lowest body mass. BMI values in all the groups fell into the normal recommended range indicating that all the athletes are non-obese and fit to be sportspersons (Chatterjee *et al.,* 2006). Among all groups the highest value of BMI was observed in throwers. The calf girth was significantly higher in sprinters while throwers exhibited the highest measurement of biceps girth where as no significant difference existed between middle distance runners, long distance runners and jumpers. Femur and humerus breadth is highest in sprinters but significant difference occurred only between long distance runners and sprinters in humerus breadth. Different skinfold measurement of the subjects is presented in Table 2. Among all the athletes, throwers are found to have significantly higher average skinfold values at all sites indicating a greater quantity of subcutaneous fat deposition in them. The sprinters exhibited lowest values of all the skinfold measurements except at triceps. No significant differences in skinfold value were found between sprinters, middle distance and long distance runners. Among all groups, the lowest value of skin fold was noted at calf (5.38±46 for sprinter) and the highest at supra-iliac site (11.64±3.11 for throwers). Considering the field events, lower values of skin folds are seen among jumpers than discus, shot and hammer throwers.

Table 3 summaries the body composition and somatotype values of the subjects. Significant difference was observed in the body fat % between sprinters and throwers. The sprinters had the lowest % body fat of 6.23±0.83% while throwers had a highest value of 7.38±0.85% as expected. There was only insignificant variation in body fat % among middle distance runners, long distance runners and jumpers. Weight of fat was found to be lowest among long distance runners (3.92±0.33 kg) and highest in throwers (5.33±0.70 kg). Lean body mass differed significantly between sprinters and throwers.

Analysis of the somatotype data revealed a general finding, i.e., higher mesomorphic (4.31±0.45) and lower endomorphic scores (2.53±0.45) in sprinters and they fall into the somatotype category of ectomorphic mesomorphs. Throwers had the highest value of endomorphy with an endomorphic score of 3.39±0.65 while ectomorphic component was found to be highest in long distance runners (3.56±0.65). The somatotype scores indicate that throwers are endomorphic mesomorph, middle and long distance runners

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*Table 1. Various physical parameters & anthropometric characteristics of the subjects.*

| | Sprint | MD | LD | Throwers | Jumpers | F | CI |
|---|---|---|---|---|---|---|---|
| Age (yrs) | 19.5±1.22 | 19.0±1.26 | 18.1±0.94 | 19.0±1.24 | 18.3±1.30 | 3.16* | 1.32 |
| Height (cm) | 172.1±3.19 | 166.8±4.41 | 167.2±2.70 | 170.8±5.56 | 169.9±4.69 | 5.98* | 4.73 |
| Weight (kg) | 68.2±2.97 | 62.5±3.65 | 62.1±3.06 | 72.6±5.35 | 64.1±3.67 | 19.59* | 4.2 |
| BMI (kg/m$^2$) | 23.0±1.09 | 22.5±1.54 | 22.3±1.31 | 24.7±1.55 | 22.2±1.34 | 11.20* | 4.73 |
| B. Humerus (cm) | 7.01±0.48 | 6.40±0.29 | 6.28±0.28 | 6.45±0.74 | 6.61±0.28 | 9.27* | 0.39 |
| B. Femur (cm) | 9.50±0.36 | 9.16±0.25 | 9.10±0.22 | 9.35±0.68 | 9.33±0.57 | 1.53 | 0.51 |
| G. Biceps (cm) | 30.4±1.04 | 28.2±1.22 | 28.4±0.82 | 31.1±1.65 | 29±1.12 | 22.00* | 1.31 |
| G. Calf (cm) | 35.6±0.86 | 33.3±0.99 | 33.4±1.51 | 34.8±2.21 | 34.5±1.22 | 8.25* | 1.52 |

*The values are mean±SD, *Significant at 0.05 level of confidence, CI: Confidence interval.*

*Table 2. Different skinfold measurements of the subjects.*

| | Sprint | MD | LD | Throwers | Jumpers | F | CI |
|---|---|---|---|---|---|---|---|
| Triceps | 8.88±2.00 | 8.96±0.83 | 8.67±0.82 | 10.1±1.57 | 9.35±1.08 | 3.28* | 1.77 |
| Supra-iliac | 7.84±1.27 | 9.25±0.78 | 9.02±1.04 | 11.64±3.11 | 9.96±1.19 | 10.87* | 1.96 |
| Sub-scapular | 9.15±0.55 | 9.08±0.92 | 9.09±1.42 | 10.89±1.99 | 9.20±1.09 | 6.26* | 1.46 |
| Chest | 6.15±1.23 | 6.65±0.70 | 6.35±0.54 | 7.82±0.73 | 6.73±0.60 | 10.18* | 0.9 |
| Abdomen | 8.39±1.25 | 9.36±0.73 | 9.24±0.75 | 10.7±2.25 | 9.35±1.06 | 7.17* | 1.54 |
| Calf | 5.38±0.46 | 6.34±3.64 | 6.03±3.06 | 6.85±1.72 | 5.84±0.67 | 4.12* | 1.19 |

*The values are mean±SD, *Significant at 0.05 level of confidence, CI: Confidence interval.*

*Table 3. Values of somatotype & body composition of the subjects.*

| | Sprint | MD | LD | Throwers | Jumpers | F | CI |
|---|---|---|---|---|---|---|---|
| Body fat (%) | 6.23±0.83 | 6.5±0.37 | 6.31±0.40 | 7.38±0.85 | 6.65±0.61 | 8.76* | 0.74 |
| TWF (kg) | 4.24±0.53 | 4.07±0.39 | 3.92±0.33 | 5.33±0.70 | 4.28±0.61 | 15.77* | 0.62 |
| LBM (%) | 93.76±0.83 | 93.48±0.37 | 93.68±0.40 | 92.61±0.85 | 93.33±0.61 | 12.77* | 0.74 |
| LBW (kg) | 64.28±2.21 | 58.41±3.37 | 58.21±3.35 | 59.77±3.17 | 5.32±0.76 | 8.68* | 3.08 |
| Endomorph | 2.53±0.45 | 2.81±0.44 | 2.60±0.42 | 3.39±0.65 | 2.87±0.42 | 9.30* | 0.52 |
| Mesomorph | 4.31±0.91 | 3.96±0.69 | 3.72±1.16 | 4.23±0.82 | 4.03±1.16 | 1.55 | 0.95 |
| Ectomorph | 3.06±0.67 | 3.31±0.44 | 3.56±0.65 | 2.10±0.63 | 3.18±0.65 | 9.09* | 0.74 |

*The values are mean±SD, *Significant at 0.05 level of confidence, CI: Confidence interval.*

ectomorphic mesomorphs and jumpers balanced mesomorphs. Regarding endomorphic and ectomorphic components, significant differences were obtained only between sprinters and throwers. Among track athletes, from sprinters to the long distance runners, the value of average ectomorphic components are found to be gradually increasing as the running distance increases.

## Discussion

Thorland *et al.* (1981) attempted to determine and differentiate the body characteristics of junior Olympic athletes in track and field and other events. He found that the most frequent differences within either the male or female junior Olympic samples was in performers in throwing events (shot put, discus & javelin), who were taller, heavier, fatter and of unique somatotype when compared to all or most other competitors. Similar results reflected in the present study as well, the throwers were the heaviest among all groups and they exhibited high level of body fat percentage. The mean somatotype values of the present study athletes are comparable with that of African runners studied by Ridder *et al.* (2000) which placed both middle distance and long distance runners in meso-ectomorph category. This contradicts the results of the present study. The somatotype scores of the African middle and long distance runners who are currently the best in the world were 1.4-3.2-4.2 and 1.6-2.9-4.3 respectively which shows that they have extremely low endomorphic characteristics and their ectomorphic component is highly marked. Compared to the above, the present study middle distance and long distance runners exhibited a higher value of endomorphic component and lower value of ectomorphic component. This may not be desirable and will become disadvantage for them and hinder their performance at international level competitions. In another recent study conducted in the Asian continent, the Nepalese long distance runners and sprinters exhibited somatotype scores of 1.6-3.3-3.8 and 2.0-3.5-3.4 respectively (Amatya, 2009). It can be observed that the Indian runners have higher endomorphic characteristics than the runners in both African and Asian studies discussed above. This may be due to the fact that the data was collected during the beginning of the annual training cycle, so a greater amount of body fat may be expected and hence, the higher value of endomorphic component may be justified.

Carter (1984) analysed the somatotype characteristics of 452 athletes from two Olympic games and the results showed that the sprinters (1.5-5-3) and jumpers (high jump, long jump & triple jump) are ectomorphic mesomorphs (1.5-4.3-2) while throwers (shot, discus & hammer) are endomorphic mesomorphs (3-7-1). This agrees with the findings of the present study. But, compared to the Olympic athletes the Indian athletes had lower mesomorphic developments. Researchers in the past have pointed out that sprinters are highly mesomorphic in nature (Tanner, 1964; Sodhi, 1984; Vucetic *et al.,* 2005). This is found to be conversant with the results of the present study in which mesomorphic component was highly marked in sprinters compared to the athletes of both track and field events. As expected,

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the highest level of body fat % was in throwers (7.3±0.83%), but surprisingly, no significant variation was observed among sprinters, jumpers, middle distance and long distance runners. The lowest body fat % was in sprinters with a value of 6.23±0.83%. Similar value of body fat % was obtained in a study on the estimation of body composition of Olympic athletes by Fleck (1983). The sprinters had a low level of body fat % of 6.5±1.2%. Regarding % body fat in the study here, middle distance and long distance runners are placed between the sprinters and throwers which seems logical considering the energy demands of such events, as well as the volume and characteristics of the training programme they are undergoing.

## Conclusion

The results of the present study indicate that in comparison to other sports disciplines track and field athletes have lower body fat percentage. The analysis showed that athletes of various track and field events statistically differ in morphological measures, especially in dimensions of body volume and body fat. On the manifest level, only upper arm and lower leg circumference statistically differ, being significantly higher in sprinters and throwers, as well as the sub-scapular, supra-iliac and abdominal, chest and arm skinfolds, which is significantly higher in throwers. The lowest value of % body fat was present among sprinters which are reflected in their lower values of skinfold measurement. It was also evident that in relation to their skeletal dimensions they tend to be more heavily muscled than others and this may be advantageous for them at the start of the race and in the initial stages of acceleration as greater force is created by these muscles. In all groups, mesomorphic component is highly dominant while endomorphic component is the least marked. The present data may be considered to serve as a reference standard for the anthropometry and body composition of Indian track and field athletes.

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