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COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AMONG THE DIFFERENT GROUPS OF THE THROWERS

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Abstract:
The present study was conducted to evaluate and compare the anthropometric measurements among the different groups of throwers. 40 (10 javelin throwers, 10 discus throwers, 10 hammer throwers, 10 shot putters) male university level throwers were assessed during the All India Inter University Athletic Meet. The age of athletes was between 18 to 25 years. All the athletes were measured for height, weight, lengths of body parts, diameters of body parts and circumferences of body parts. One-way ANOVA revealed that the significant differences were reported in height ($p<0.05$), weight ($p<0.05$), length measurements ($p<0.05$), diameters of body parts ($p<0.05$) and circumferences of the body parts ($p<0.05$) among the different groups of throwers. Post-hoc analysis revealed that discus throwers were the tallest among the throwers. In the same way, the discus throwers had highest diameters among different groups of throwers. The shot putters had highest weight and circumferences among the different groups of throwers.

Keywords: mental imagery, assessment, learning, individual defense tactics

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1. Introduction

There are many factors which contribute to the sports performance. Skill, psychological characteristics, powerful and capacious energy-production systems are all important factors in sports performance, but the main success factor in sports is body size, shape and morphology (Claessens et al., 1994). The study on athletes revealed that usually sprinters are muscular, marathoners are smaller and leaner and throwers are taller and heavier with higher levels of fat. An important concept is morphological optimization most likely to be associated with success in different sports (Norton et al., 1996).

It is a well-known fact that a general relationship exists between morphology and performance. However, specific morphological requirements still needed to be established for some sports. The size, shape and proportions of athletes are important considerations in player's performance and usually the better the performance the more critical the relationship will be (Bell & Rhodes, 1975; Toriloa et al., 1987). Moreover, Olympic studies indicated that successful sports performance is often hindered by lack of appropriate physique (Tanner 1964, Carter 1984). The strongest relationship between anthropometric characteristics and performance is noticed in weight lifting and throwers because there is highest relationship between regional muscle mass and strength. In some sports absolute size is required while in other relative size of body segments is more important. The body proportionality is also found significantly different in different sports events for both the genders. The female athletes have proportionally smaller musculoskeletal size in upper body as compared to lower body and also a different limb, torso and skinfolds distribution when compared to males of same sports. The size, proportions and skinfolds of young athletes are generally consistent with those of older athletes in the same sports.

Throwers have greater body weight because when an object is thrown forward and upward an equal and opposite force is exerted on the thrower which disturbs his body balance. So the effect of this reaction will be more if the athlete is not having heavy body weight. Further to make, the flight of the throwing implement longer in the air the greater height is also advantageous for the athletes (Sodhi, 1991). In the same way, height gives an edge to basketball players and volleyball players. Height helps in their excellence and is an advantageous factor for these players. On the other hand, the shorter height is more helpful for gymnasts and that is why China, Korea, and Japan have produced more sportspersons in the field of gymnastics. The short body physique has helped them to excel in the field of gymnastics, weight lifting, and light weight class in boxing. Europeans have greater height and so European nations have proved their sports acumen in volleyball, basketball, swimming, long jump, shot put. Bulky

musculature helps the sports persons to bring laurels in the field of throwing events and heavy weight class in boxing. The present study, therefore, aims to study the anthropometric characteristics of the different groups of throwers.

2. Methodology

2.1 Participants

The present was conducted on 40 university level throwers which were purposively selected from All India Inter University Athletic Meet held at Manonmaniam Sundaranar University Tirunelveli (Tamilnadu) in January 2006. The throwers from various universities from all over India, of age between 18 to 25 years, were analyzed. The study was conducted only on male throwers. The throwers included discus throwers, javelin throwers, hammer throwers and shot putters.

Table 1: Division of Athletes as Sample

Sr. No.	Event	No. of Throwers
1	Discus Throw	10
2	Hammer Throw	10
3	Javelin Throw	10
4	Shot Put	10
	Total	40

2.3 Data Collection

All the anthropometric measurements of all subjects were taken in the morning hours with empty bowl. All the bilaterally represented anthropometric measurements were taken on the left side. The measurements were recorded in centimeters scale up to the nearest millimeters. Posture of the subject was checked every time so that a correct measurement could be taken. The support of team managers and coaches was taken to contact the athletes. The coaches of the respective teams ensured that the subjects for the collection of data reported on time. Standardized techniques of measurement were used so that different studies may become comparable. Standardized techniques purposed by the International Biological Programme/Human Adaptability (IBP/HA) Growth Sub Committee in 1969 (Weiner and Lourie, 1969) were followed for taking those measurement.

Body weight was measured with portable weighing machine to the nearest 0.5 kg. Height and length measurements were taken by using the standard anthropometric rod (HG-72, Nexgen ergonomics, Canada) to the nearest 0.5 cm. Widths and diameters of body parts were measured by using sliding caliper. Circumferences of the body parts

of the throwers were measured with the help of steel tape to the nearest 0.5 cm. Body mass index (BMI) was calculated by the following formulae:

BMI (Kg/m2) = (Body mass in kg) / (Stature in m) ^ 2 (Meltzer et al., 1988)

2.4 Statistical analysis

Statistical analyses were performed using SPSS version 16.0 for windows (SPSS Inc, Chicago, IL, USA). The data was presented as descriptive statistics such as mean, standard deviation. One Way Analysis of Variance (ANOVA) was employed to compare the throwers. Where 'F' values were found significant, Tukey's Post-hoc test was applied to find out the direction and degree of difference. The level of significance was set at 0.05.

3. Results

Table-2 shows the comparison of anthropometric measurements among the different groups of the throwers and F-values. Table-3 shows the Tukey's post-hoc analysis of the anthropometric measurements of different groups of throwers. Height was significantly different in individuals in the different groups of throwers ($F=21.44$, $p<0.0001$). The height was highest in the discus throwers. This was followed by shot putters, javelin throwers and hammer throwers respectively. The post-hoc analysis showed that shot putters were significantly taller than those of hammer and javelin throwers. Again, discus throwers were also significantly taller than the hammer and Javelin throwers. In relation to weight significant difference was found among the different groups of throwers ($F= 28.37$, $p<0.0001$). Shot putters had the highest mean values in weight and they were followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that javelin throwers had significantly lower weight when compared to shot putters, hammer throwers and discus throwers. Further, the hammer throwers had significantly lower weight when compared to shot putters and discus throwers. When sitting height was evaluated, statistically significant difference was observed among the different groups of the throwers ($F=23.78$, $p<0.0001$). The discus throwers had the highest mean for sitting height and this was followed by shot putters, hammer throwers and javelin throwers respectively. Post-hoc analysis showed that the shot putters had significantly greater sitting height than the hammer throwers and javelin throwers. Similarly, the discus throwers were found to have significantly greater sitting height when compared to hammer throwers and javelin throwers. BMI was significantly different in individuals in different groups of throwers

(F=34.37, p<0.0001). Shot putters had the highest BMI, and they were followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that the shot putters had significantly greater BMI mean values when compared to hammer throwers and javelin throwers. In addition, significantly greater mean values were reported in discus throwers and hammer throwers when compared to javelin throwers. There were significant

Table 2: Comparison of anthropometric characteristics among different groups of throwers

Variables	**Shot Putters (Mean± SD)**	**Hammer Throwers (Mean± SD)**	**Javelin Throwers (Mean± SD)**	**Discus Throwers (Mean± SD)**	**F-Value**
Height (cm)	184.74±3.45	177.92±2.65	178.00±1.93	185.93±3.39	21.44*
Body Weight (kg)	102.50±8.33	90.00±4.32	80.00±5.51	101.00±6.10	28.37*
Sitting Height (cm)	94.97±1.18	92.34±1.21	91.72±1.07	95.53±1.40	23.78*
BMI (kg/m^2)	29.98±1.34	28.41±0.76	25.23±1.36	29.18±0.89	34.37*
Leg Length (cm)	103.37±2.47	99.15±1.55	99.32±1.65	104.25±2.11	18.07*
Upper Leg Length(cm)	54.28±1.42	51.75±0.86	52.12±0.85	54.78±1.41	16.74*
Lower Leg Length (cm)	40.54±0.90	39.23±0.49	39.08±0.54	40.83±0.77	16.34*
Arm Length (cm)	84.16±2.16	79.65±1.97	80.38±1.46	85.36±2.23	19.92*
Upper Arm Length (cm)	36.13±0.99	34.11±0.88	34.45±0.70	36.70±1.01	19.27*
Forearm Length (cm)	27.19±0.66	25.80±0.60	26.01±0.39	27.48±0.65	20.03*
Upper Arm Circumference (cm)	33.21±1.45	31.81±0.43	30.40±0.71	32.85±0.78	18.58*
Forearm Circumference (cm)	27.85±0.83	26.49±0.33	25.50±0.53	27.38±0.54	30.83*
Chest Circumference (cm)	109.61±4.56	104.10±1.80	99.10±2.67	109.00±3.19	23.19*
Abdominal Circumference (cm)	95.88±4.97	89.10±2.62	82.81±3.59	95.40±3.59	26.34*
Thigh Circumference (cm)	58.70±1.75	57.12±1.21	52.65±2.10	58.18±1.48	27.16*
Calf Circumference (cm)	39.46±1.90	37.56±0.81	36.20±0.77	39.05±0.91	15.41*
Bicondylar Humerus Diameter(cm)	7.40±0.18	7.17±0.14	6.98±0.16	7.50±0.22	16.97*
Wrist Diameter (cm)	6.00±0.14	5.82±0.07	5.68±0.12	6.10±0.17	18.71*
Biacromial Diameter (cm)	43.15±0.97	41.29±0.60	41.50±0.94	43.38±0.93	15.36*
Bi-iliocristal Diameter (cm)	30.29±0.67	29.21±0.39	28.14±0.71	30.40±0.66	28.65*
Bicondylar Femur Diameter (cm)	10.30±0.21	9.95±0.14	9.80±0.16	10.40±0.23	21.90*
Ankle Diameter (cm)	7.50±0.23	7.25±0.12	7.20±0.11	7.60±0.17	13.09*

* Indicates p<0.05

Table 3: Tukey's Post-hoc values of anthropometric measurements of different groups of throwers

Variables	Shot Putters Vs Hammer Throwers	Shot Putters Vs Javelin Throwers	Shot Putters Vs Discus Throwers	Hammer Throwers Vs Javelin Throwers	Hammer Throwers Vs Discus Throwers	Javelin Throwers Vs Discus Throwers
Height (cm)	6.82*	6.74*	1.19	0.08	8.01*	7.93*
Body Weight (kg)	12.50*	22.50*	1.50	10.00*	11.00*	21.00*
Sitting Height (cm)	2.63*	3.25*	0.56	0.62	3.19*	3.81*
BMI (kg/m^2)	1.56*	4.74*	0.79	3.18*	0.77	3.95*
Leg Length (cm)	4.22*	4.05*	0.88	0.17	5.10*	4.93*
Upper Leg Length(cm)	2.53*	2.16*	0.50	0.37	3.03*	2.66*
Lower Leg Length (cm)	1.31*	1.46*	0.29	0.15	1.60*	1.75*
Arm Length (cm)	4.51*	3.78*	1.20	0.73	5.71*	4.98*
Upper Arm Length (cm)	2.02*	1.68*	0.57	0.34	2.59*	2.25*
Forearm Length (cm)	1.39*	1.18*	0.29	0.21	1.68*	1.47*
Upper Arm Circumference (cm)	1.40*	2.81*	0.36	1.41*	1.04	2.45*
Forearm Circumference (cm)	1.36*	2.35*	0.47	0.99*	0.89*	1.88*
Chest Circumference (cm)	5.51*	10.51*	0.61	5.00*	4.90*	9.90*
Abdominal Circumference (cm)	6.78*	13.07*	0.48	6.29*	6.30*	12.59*
Thigh Circumference (cm)	1.58	6.05*	0.52	4.47*	1.06	5.53*
Calf Circumference (cm)	1.90*	3.26*	0.41	1.36	1.49*	2.85*
Bicondylar Humerus Diameter (cm)	0.23*	0.42*	0.10	0.19	0.33*	0.52*
Wrist Diameter (cm)	0.18*	0.32*	0.10	0.14	0.28*	0.42*
Biacromial Diameter (cm)	1.86*	1.65*	0.23	0.21	2.09*	1.88*
Bi-iliocristal Diameter (cm)	1.08*	2.15*	0.11	1.07*	1.19*	2.26*
Bicondylar Femur Diameter (cm)	0.35*	0.50*	0.10	0.15	0.45*	0.60*
Ankle Diameter (cm)	0.25*	0.30*	0.10	0.05	0.35*	0.40*

* Indicates $p<0.05$

Differences in leg length and upper leg length among the different groups of throwers (F=18.07, 16.74, p<0.0001). Discus throwers had the highest leg length and upper leg length. This was followed by shot putters, javelin throwers and hammer throwers respectively. Post-hoc analysis revealed that the shot putters had significantly longer leg length and upper leg length when compared to hammer throwers and javelin throwers. Similarly, the discus throwers showed significantly longer leg length and upper leg length when compared to hammer throwers and javelin throwers. Lower leg length was significantly different in the individuals in the different groups of throwers. (F=16.34, p<0.0001). Discus throwers had the longest lower leg length and they were followed by shot putters, hammer throwers and javelin throwers respectively. Post-hoc analysis showed that the shot putters had significantly longer lower leg length when compared to hammer throwers and javelin throwers. Similarly, discus throwers showed significantly longer lower leg length when compared to hammer throwers and javelin throwers. In relation to arm length, upper arm length and forearm length statistically significant differences were found among the different groups of throwers (F=19.92, 19.27, 20.03, p<0.0001). Discus throwers had the highest arm length, upper arm length and forearm length and they were followed by shot putters, javelin throwers and hammer throwers respectively. Post-hoc analysis displayed that the shot putters had significantly longer arm, upper arm and forearm lengths when compared to hammer throwers and javelin throwers. In addition, the discus throwers were also found to have significantly longer arm, upper arm and forearm lengths than those of hammer throwers and javelin throwers. Upper arm circumference was significantly different in the individuals in the different groups of throwers (F=18.58, p<0.0001). Upper arm circumference was the highest in the shot putters. This was followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that the shot putters had significantly greater upper arm circumference as compared to hammer throwers and javelin throwers. It was analyzed that the hammer throwers and discus throwers were found to have significantly greater upper arm circumference than those of javelin throwers. In relation to forearm, chest and abdominal circumferences significant differences were observed among the different groups of throwers (F=30.83, 23.19, 26.34, p<0.0001). Shot putters had the highest forearm, chest and abdominal circumferences and they were followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis displayed that forearm, chest and abdominal circumferences of javelin throwers were significantly lower than those of shot putters, hammer throwers and discus throwers. Again, the hammer throwers also had significantly lower forearm, chest and abdominal circumferences when compared to shot putters and discus throwers. Thigh

circumference was significantly different in the individuals in the different groups of throwers (F=27.16, p<0.0001). Thigh circumference was highest in shot putters. This was followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that thigh circumference of javelin throwers was significantly lower than those of shot putters, hammer throwers and discus throwers. There was significant difference in calf circumference among the different groups of throwers (F= 15.41, p<0.0001). Shot putters had the highest calf circumference and they were followed by discus throwers, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that discus throwers had significantly greater calf circumference as compared to hammer throwers and javelin throwers. On the other hand calf circumference in shot putters was significantly higher when compared to hammer throwers and javelin throwers. In relation to bicondylar humerus and wrist diameters significant differences were observed among the different groups of throwers (F=16.97, 18.71, p<0.0001). Bicondylar humerus and wrist diameters were highest in discus throwers and they were followed by shot putters, hammer throwers and javelin throwers respectively. Post-hoc analysis revealed that shot putters had significantly wider bicondylar humerus and wrist diameters than those of hammer throwers and javelin throwers. Similarly, bicondylar humerus and wrist diameters in discus throwers were significantly wider when compared to javelin throwers and hammer throwers. Biacromial diameter was significantly different in the individuals in the different groups of throwers. (F=15.36, p<0.0001). Discus throwers had the highest biacromial diameter and they were followed by shot putters, javelin throwers and hammer throwers respectively. Post-hoc analysis revealed that discus throwers were found to have distinctly wider biacromial diameter as compared to javelin throwers and hammer throwers. In addition, biacromial diameter in shot putters was significantly wider than those of javelin throwers and hammer throwers.

In relation to bi-iliocristal, bicondylar femur and ankle diameters significant differences were reported among the different groups of throwers (F=28.65, 21.90, 13.09 p<0.0001). Discus throwers had the highest bi-iliocristal, bicondylar femur and ankle diameters and they were followed by shot putters, hammer throwers and javelin throwers respectively. Post-hoc analysis displayed that bi-iliocristal diameter in javelin throwers was significantly lower than those of shot putters, hammer throwers and discus throwers. In the same way, hammer thrower had significantly lower bi-iliocristal diameter when compared to discuss throwers and shot putters. On the other hand, shot putters had significantly greater bicondylar femur and ankle diameters when compared to javelin and hammer throwers. Again, bicondylar and femur ankle diameters in

discus throwers were significantly wider than those of javelin throwers and hammer throwers.

4. Discussion

The results of the present study show that the throwers differed in all the anthropometric measurements. The greater height among throwers provides them mechanical advantage as the distance achieved by the throw is also a function of height of release. The higher body weight is advantageous in throwing events as the throwers require greater strength to throw the implement further and the strength is relative to body mass (Bush and Weiskpot, 1978). The studies on the athletes of different level of performance with regard to their anthropometric characteristics help in the understanding of the morphological, biomechanical and physiological demands of modern training methods and the optimal requirements for successful participation as well as selection, identification and comparison of talented young athletes (Kruger, 2004). The height of the shot putters in present study is lower than the Olympic level shot putters and world class shot putters (Tanner, 1964; de Garry et al., 1974; Fahey et al., 1975) but the shot putters in present study are taller than the Brazilian young shot putters, previously studied Indian shot putters and university level shot putters (Guimaraes and De Rose, 1980; De et al., 1991; Sodhi, 1991; Sumanta et al., 2008; Pritam et al., 2009). The weight of shot putters is lower than the world class shot putters studied by Fahey et al. (1975) and Olympic level shot putters (Tanner, 1964) while it is comparable with the weight of shot putters studied by de Garry et al. (1974) but shot putters in present study have greater weight compared to Brazilian young shot putters, previously studied Indian shot putters and university level shot putters (Guimaraes and De Rose, 1980; Sodhi, 1991; Sumanta et al., 2008; Pritam et al., 2009). In comparison to previous studies on world class and Olympic level hammer throwers (Morrow et al., 1982; de Garry et al., 1974; Terzis et al., 2010) the hammer throwers in present study have lower height and weight whereas they have similar height and greater weight compared to young Brazilian hammer throwers (Guimaraes and De Rose, 1980). The javelin throwers in present study are shorter than the elite javelin throwers studied by Kruger (2004) whereas they have similar height compared to young Brazilian, Olympic level and previously studied Indian javelin throwers (Guimaraes and De Rose, 1980; de Garry et al., 1974; Sodhi, 1991). The weight of javelin throwers in the present study is lower than the elite javelin throwers studied by Kruger (2004) but greater than Indian javelin throwers (Sodhi, 1991). Limb lengths, circumferences and diameters of the javelin throwers are lower than the Olympic level athletes and elite javelin throwers (de

Garry et.al, 1974; Kruger, 2004; Ragad Al, 2010). The height of the discus throwers in present study is lower than the Olympic level discus throwers (Tanner, 1964; de Garry et al., 1974) but the discus throwers in present study are taller than the Brazilian young, previously studied Indian and university level discus throwers (Guimaraes and De Rose, 1980; Sodhi, 1991; Sumanta et al., 2008; Pritam et al., 2009). The weight of discus throwers is lower than Olympic level discus throwers (Tanner, 1964) while it is comparable with the weight of discus throwers studied by de Garry et al. (1974) but discus throwers in present study have greater weight compared to Brazilian young, previously studied Indian and university level discus throwers (Guimaraes and De Rose, 1980; Sodhi, 1991; Sumanta et al., 2008; Pritam et al., 2009).

The results of comparison among different groups of throwers show that discus throwers were the tallest among the throwers. These results are supported by other studies on throwers (Parnell, 1951; Tanner, 1964; Ross and Ward, 1984; Morrow et al., 1982). In the same way, the discus throwers had highest diameters among different groups of throwers. The shot putters had highest weight and circumferences among the different groups of throwers.

5. Conclusion

In conclusion, it was found that the significant differences were existed among different groups of throwers with regard to anthropometric characteristics. The discus throwers were the tallest among the throwers. In the same way, the discus throwers had highest diameters among different groups of throwers. The shot putters had highest weight and circumferences among the different groups of throwers.

References

1. Bell, W. and Rhodes, G. (1975) The Morphological characteristics of the association football player. *Brit. J. Sports Med.*, 9:195-200.
2. Bush, J. and Weiskpot, D. (1978). Dynamic Track and Field.
3. Carter, J.E.L. (1984) Somatotypes of Olympic athletes. From 1948-1976 Med. Sport Science. In: Carter, J.E.L. (eds) Physical Structure of Olympic Athletes, Part – II, Kinanthropometry of Olympic athletes, Karger Basel, 80-109.
4. Claessens, A.L., Hlatkey, S., Lefevre, J. and Holdhaus, H. (1994) The role of anthropometric characteristics in modern pentathlon performance in female athletes. *Journal of Sports Sciences,* 12:391-401.

5. De Garay, A.L. Levine and Carter, J.E.L (1974) Genetic and Anthropological Studies of Olympic Athletes, Academic Press, New York.
6. De, A.K., Ray, A.S., and Debnath, P.K. (1991) Simple anthropometry and peak expiratory flow rate in elite South Asian athletes. *Journal of Sports Medicine and Physical Fitness,* 31:598.
7. Fahey, T., Larsen, A. and Ralph, R. (1975) Body composition and Vo_2 max of exceptional weight-trained athletes. *J. Appl. Physiol,* 39:559-561.
8. Guimaraes, A.C.S. and De Rose, E.H. (1980) Somatotype of Brazilian student track and field athletes of 1976. Kinanthropometry II Blatimere, University Park Press, 231-238.
9. Kruger, A. (2004) Kinantropometriese en asimmetriese profile van internasionale manlike elite-spiesgooiers. M.Sc. thesis, north-west university, Potchefstroom Campus.
10. Meltzer, A., Mueller, W., Annegers, J., Grimes, B. and Albright, D. (1988). Weight history and hypertension. *J. Clin. Epidemiol.*, 41:867–874.
11. Morrow, J.R. Disch, J.C., Ward, P.E., Donavan, T.J., Katch, V.L., Weltman, A.L. and Tellez, T. (1982) Anthropometric Strength and performance characteristics of American world class thrower, *Journal of Sports medicine and Physical Fitness*, 22:73-79.
12. Norton, K.I., Olds, T.S., Olive, S.L. and Craig, N.P. (1996) Anthropometry and sports performance. In: Anthropometrica (edited by Norton, K.I. and Olds, T.S.) Sydney, UNSW Press, 287-364.
13. Parnell, R.W. (1951) Some notes on physique and athletic training with special reference to heart size. *Brit. Med. Journal*, 1:1292.
14. Pritam, S., Kang, S.S., Govind, S., Jaswinder S. and Sukhdev, S. (2009) Anthropometric profile of interuniversity long distance runners and throwers. *Journal of Health and Fitness,* 1(1):30-35.
15. Ragad, Al, R. (2010) Relationship of physical characters and anthropometric measurements and performance of javelin throwing event. *An – Najah University Journal for Research Humanities*, 24(1):263-279.
16. Ross, W.D. and Ward, R. (1984) Proportionality of Olympic athletes. In.: Carter, J.E.L. Physical Structure of Olympic Athletes, Part II Medicines and Sports, Basal Karger, 17:128–129.
17. Sodhi, H.S. (1991) Sports Anthropometry (A Kinanthropometric Approach) Anova Publications, Mohali.

18. Sumanta, K.M., Manimoy, M. and Ashok, M. (2008) A study of anthropometric parameters of Inter University throwers. In: III International Congress on Sports Medicine, Exercise Science, Physical Education and Yogic Science, 171.
19. Tanner, J. M. (1964). The Physique of the Olympic Athletes (Allen & Unwin London).
20. Terzis, G., Konstantinos, S., Stavros, K., Panagiota, M. and Giorgos, G. (2010) Muscle fibre type composition and body composition in hammer throwers. *Journal of Sports Science and Medicine,* 9:104-109.
21. Toriola, A.L., Adeniran, S. and Ogunremi, R.T. (1987) Body Composition and anthropometric characteristics of elite male basketball and volleyball players. *J Sports Med. Phy. Fitness,* 27:235-239.
22. Weiner, J.S. and Lourie, J.A. (1969) Human Biology: A Guide to Field Methods, International Biological Programme, Handbook Number 9. Philadelphia, PA: F.A. Davis, reviewed in American Anthropologist 73:441-442, 1971. 1