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Comparative study of anthropometric characteristics among the jumpers

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Abstract

The present study was conducted to evaluate and compare the anthropometric measurements among the different groups of jumpers. 40 (10 high jumpers, 10 long jumpers, 10 triple jumpers, 10 pole vaulters) male university level jumpers 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 ($p<0.05$), sitting height ($p<0.05$), body mass index ($p<0.05$), 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 high jumpers were the tallest among the jumpers. The long jumpers were heaviest among the all jumpers. In the same way the high jumpers had highest sitting height and length measurements among different groups of jumpers. The long jumpers had highest circumferences among the different groups of jumpers.

Keywords: anthropometric measurements, jumpers, body mass index, circumferences

Introduction

Anthropometry is a branch of science concerned with comparative measurements of the human body, its parts, and its proportions and composition. Anthropometry is the measurement of body size and proportions. The measurements include body weight, height, circumference, skin fold thickness and bony widths and lengths [1]. It is the study of measurement of the human body in terms of the dimensions of bone, muscle and adipose tissue. Anthropometry has been used to assess gross structure and function. There are numerous factors which are responsible for the performance of a sportsman. At present, sportsman for superior performance in any sports is selected on the basis of physical structure and body size. Anthropometric measurements are widely used to assess and predict performance in various sports. The physique and body composition, including the size, shape and form are known to play a significant role in this regard. The athletes in a particular sport must possess such specific characteristics which are of advantage to them during the game [2].

Besides the relationship with physical performance, anthropometric status is also important for sports trainers in order to direct young athletes into the sports they are best suited at the beginning of their careers. Studies on the physical characteristics of the human body till date indicate that the morphological characteristics of athletes successful in a specific sport differ in somatic characteristics from the general population. Kopecky and Pridalova [3] stated that sports performance is determined in a differentiated way by somatic, functional, physiological and motor characterstics and capabilities. Therefore, the physique becomes a limiting factor of performance i.e. a direct reflection of the level of movement activities. 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 [4]. The sports which require the body projection such as jumping movements against the gravity, excessive fat and body weight hinder the sports performance. Several studies on various body characteristics of different sports activities have also been carried out by many researchers and they concluded that strong relationship exist between structure and performance. For example, the jumpers have been found with long legs, short trunk and broader feet because height and long legs help them to have their center of gravity at a higher level which help them in crossing greater height [5, 6, 7]. Power to weight ratio is important for jumpers, therefore maximising muscle mass and maintaining low body fat level is desirable. The present study, therefore, aims to evaluate and compare the anthropometric characteristics of the athletes of the various jumping events viz. long jump, high jump, triple jump and pole vault.

Material and Methods

Participants

For the present study, 40 university level jumpers were purposively selected from All India Inter University Athletic Meet held at Manonmaniam Sundaranar University Tirunelveli (Tamilnadu) in January 2006. The jumpers from various universities from all over India, of age between 18 to 25 years, were analyzed. The study was conducted only on male jumpers. 10 subjects from each 4 jumping events viz. high jump, long jump triple jump and pole vault were selected.

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. 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 were followed for taking those measurement [8]. 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 m2) [9].

Statistical analysis

Statistical analyses were performed using SPSS version 16.0 for windows (SPSS Inc, Chicago, IL, USA). The data on anthropometric measurements was presented as descriptive statistics such as mean, standard deviation of the jumpers. One Way Analysis of Variance (ANOVA) was employed to compare the different jumpers with regard to anthropometric measurements. 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.

Results

Table 1 presents the anthropometric measurements of different groups of the jumpers. Tukey's post-hoc values of anthropometric measurements of different groups of jumpers are shown in table 2. F-ratio showed the statistically significant difference in relation to height among the different groups of jumpers ($F=17.91$, $p<0.0001$). The high jumpers were the tallest among all the jumpers and they were followed by the triple jumpers, long jumpers and pole-vaulters. The post-hoc analysis revealed that the pole-vaulters were significantly shorter than the high jumpers, long jumpers and triple jumpers. F-value showed that there was significant difference in weight among the jumpers of different events ($F=6.15$, $p=0.002$). The long jumpers possessed the highest body weight and they were followed by the high jumpers, pole-vaulters and triple jumpers respectively. The post-hoc test revealed that the long jumpers were significantly heavier than the triple jumpers and pole-vaulters. In relation to sitting height significant difference was found among the various groups of jumpers ($F=9.81$, $p<0.0001$). The sitting height was greatest in high jumpers. This was followed by triple jumpers, long jumpers and pole vault respectively. The post-hoc analysis showed that the pole-vaulters had significantly lower sitting height when compared to long jumpers, high jumper and triple jumpers. F-value revealed that there was significant difference in body mass index among the different groups of jumpers ($F=11.45$, $p<0.0001$). The long jumpers had highest body mass index and they were followed by pole-vaulters, triple jumpers and high jumpers respectively. Tukey's post hoc analysis showed that the long jumpers had significantly greater body mass index than those of the high jumpers and triple jumpers. Similarly pole-vaulters also possessed significantly greater body mass index when compared to high jumpers and triple jumpers. Leg length was significantly different in the individuals among the different groups of jumpers ($F=20.58$, $p<0.0001$). High jumpers were found to have highest leg length and they were followed by triple jumpers, long jumpers and pole-vaulters respectively. The post-hoc analysis revealed that the high jumpers had

Table 1: Comparison of anthropometric measurements among different groups of Jumpers

Variables	Long Jumpers (N=10)		High Jumpers (N=10)		Triple Jumpers (N=10)		Pole Vaulters (N=10)		F-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Height (cm)	179.37	4.09	182.50	1.63	179.95	2.65	174.00	1.39	17.91*
Body Weight (kg)	73.25	4.06	69.30	2.79	67.50	3.32	68.00	2.95	6.15*
Sitting Height (cm)	90.45	2.20	91.90	0.79	90.69	1.32	88.51	0.87	9.81*
BMI (kg/m^2)	22.77	1.18	20.80	0.83	20.84	0.99	22.45	0.83	11.45*
Leg Length (cm)	101.16	2.48	103.47	1.06	101.59	1.46	98.03	0.67	20.58*
Upper Leg Length(cm)	52.70	1.30	54.35	0.68	53.08	0.76	51.27	0.53	21.19*
Lower Leg Length (cm)	40.12	1.16	40.57	0.53	40.11	0.51	38.62	1.57	6.60*
Arm Length (cm)	79.74	1.79	80.68	0.88	79.89	1.15	78.13	0.63	7.97*
Upper Arm Length (cm)	33.74	0.75	34.28	0.35	33.84	0.50	33.04	0.36	9.71*
Forearm Length (cm)	26.29	0.63	26.47	0.25	26.30	0.37	25.77	0.51	4.22*
Upper Arm Circumference (cm)	27.68	0.66	26.50	0.46	25.76	0.51	27.78	0.90	21.70*
Forearm Circumference (cm)	24.06	0.47	23.30	0.33	22.68	0.41	23.63	0.50	17.92*
Chest Circumference (cm)	95.74	2.44	95.05	1.14	93.58	1.76	92.32	1.68	7.05*
Abdominal Circumference (cm)	78.55	2.05	78.30	1.17	78.25	1.55	77.42	1.32	0.98
Thigh Circumference (cm)	52.43	2.68	50.37	1.28	49.45	1.06	50.21	0.67	6.21*
Calf Circumference (cm)	36.87	1.66	34.25	0.62	33.93	0.72	34.94	0.50	17.62*
Bicondylar Humerus Diameter (cm)	6.90	0.15	6.92	0.078	6.79	.152	6.70	0.09	6.68*
Wrist Diameter (cm)	5.68	0.12	5.63	0.09	5.58	0.10	5.40	0.09	13.64*
Biacromial Diameter (cm)	39.64	0.93	40.10	0.32	39.60	0.72	39.44	0.58	1.74
Bi-iliocristal Diameter (cm)	27.53	0.65	27.90	0.24	27.53	0.49	26.88	0.32	8.54*
Bicondylar Femur Diameter (cm)	9.50	0.20	9.68	0.13	9.32	0.15	9.50	0.14	8.34*
Ankle Diameter (cm)	7.10	0.16	7.10	0.11	6.90	0.13	6.90	0.20	5.45*

* Indicates $p<0.05$

Table 2: Tukey's Post-hoc values of anthropometric measurements of different groups of jumpers

Variables	Long Jumpers vs High Jumpers	Long Jumpers vs Triple Jumpers	Long Jumpers vs Pole Vaulters	High Jumpers vs Triple Jumpers	High Jumpers vs Pole Vaulters	Triple Jumpers vs Pole Vaulters
Height (cm)	3.13	0.58	5.37*	2.55	8.50*	5.95*
Body Weight (kg)	3.95	5.75*	5.25*	1.80	1.30	0.50
Sitting Height (cm)	1.45	0.24	1.94*	1.21	3.39*	2.18*
BMI (kg/m^2)	1.96*	1.92*	0.31	0.03	1.64*	1.61*
Leg Length (cm)	2.31*	0.43	3.13*	1.88	5.44*	3.56*
Upper Leg Length(cm)	1.65*	0.38	1.43*	1.27*	3.08*	1.81*
Lower Leg Length (cm)	0.45	0.01	1.50*	0.46	1.95*	1.49*
Arm Length (cm)	0.94	0.15	1.61*	0.79	2.55*	1.76*
Upper Arm Length (cm)	0.54	0.10	0.70*	0.44	1.24*	0.80*
Forearm Length (cm)	0.18	0.01	0.52	0.17	0.70*	0.53
Upper Arm Circumference (cm)	1.18*	1.92*	0.10	0.74	1.28*	2.02*
Forearm Circumference (cm)	0.76*	1.38*	0.43	0.62*	0.33	0.95*
Chest Circumference (cm)	0.69	2.16	3.42*	1.47	2.73*	1.26
Abdominal Circumference (cm)	0.25	0.30	1.13	0.05	0.88	0.83
Thigh Circumference (cm)	2.06*	2.98*	2.22*	0.92	0.16	0.76
Calf Circumference (cm)	2.62*	2.94*	1.93*	0.32	0.69	1.01
Bicondylar Humerus Diameter (cm)	0.02	0.11	0.20*	0.13	0.22*	0.09
Wrist Diameter (cm)	0.05	0.10	0.28*	0.05	0.23*	0.18*
Biacromial Diameter (cm)	0.46	0.040	0.20	0.50	0.66	0.16
Bi-iliocristal Diameter (cm)	0.37	000	0.65*	0.37	1.02*	0.65*
Bicondylar Femur Diameter (cm)	0.18	0.18	000	0.36*	0.18	0.18
Ankle Diameter (cm)	000	0.20*	0.20*	0.20*	0.20*	000

* $p<0.05$

significantly greater leg length as compared to long jumpers and pole-vaulters. Further, long jumpers and triple jumpers were found to have greater leg length than the pole-vaulters. Significant difference was observed in relation to upper leg length among various groups of jumpers (F=21.19, p<0.0001). The high jumpers had highest upper leg length. This was followed by the triple jumpers, long jumper jumpers and pole-vaulters respectively. The post-hoc analysis revealed that high jumpers were found to have significantly greater upper leg length as compared to long jumpers, triple jumpers and pole-vaulters. The long jumpers and triple jumpers had significantly greater upper leg length when compared to pole-vaulters. Lower leg length was significantly different in the individuals in the different groups of jumpers (F=6.60, p=0.001). High jumpers had the highest mean value of lower leg length and they were followed by the long jumpers, triple jumpers and pole-vaulters respectively. Post-hoc analysis showed that the pole vaulters had significantly shorter lower leg length when compared to long jumpers, high jumpers and triple jumpers. F-Statistics revealed that there were significant differences in relation to arm length and upper arm length among the different groups of jumpers (F=7.97, 9.71, p<0.0001). High jumpers had the highest arm length and upper arm length and they were followed by triple jumpers, long jumpers and pole-vaulters respectively. The post-hoc analysis showed that pole-vaulters had significantly shorter arm length and upper arm length than those of the long jumpers, high jumpers and triple jumpers. Forearm length was significantly different in the individuals among the different groups of jumpers (F=4.22, p=0.012). High jumpers had greatest forearm length and they were followed by triple jumpers, long jumpers and pole-vaulters respectively. The post-hoc analysis revealed that high jumpers were found to have evidently greater forearm length than the pole-vaulters. In relation to upper arm circumference significant difference was reported among the different groups of jumpers (F=21.70, p<0.0001). The pole-vaulters had highest upper arm circumference. This was followed by long jumpers, high jumpers and triple jumpers respectively. The post-hoc test revealed that long jumpers were found to have significantly higher upper arm circumference than those of high jumpers and triple jumpers. Further the pole-vaulters also had significantly higher upper arm circumference when compared to high jumpers and triple jumpers. F-value showed that there was statistically significant difference in forearm circumference among the different groups of the jumpers (F=17.92, p<0.0001). Forearm circumference was highest in long jumpers and they were followed by pole-vaulters, high jumpers and triple jumpers respectively. The post-hoc analysis revealed that long jumpers had significantly higher forearm circumference than those of high jumpers and triple jumpers. Similarly, pole-vaulters and high jumpers had significantly greater forearm circumference when compared to triple jumpers.

F-ratio showed significant difference in chest circumference among different groups of jumpers (F=7.05, p=0.001). Long jumpers had the highest chest circumference and they were followed by high jumpers, triple jumpers and pole-vaulters respectively. The post-hoc analysis showed that long jumpers and high jumpers had significantly greater chest circumference as compared to the pole-vaulters. In relation abdominal circumference there was no significant difference between the different groups of the jumpers. There was significant difference in relation to thigh circumference of the various groups of jumpers (F=6.21, p<0.002). The long jumpers had maximum thigh circumference and they were followed by high jumpers, pole-vaulters and triple jumpers respectively. The post-hoc analysis revealed that long jumpers had significantly greater thigh circumference as compared to high jumpers, triple jumpers and pole-vaulters. Calf circumference was significantly different in the individuals among the

different groups of jumpers (F=17.62, p<0.0001). Calf circumference was highest in long jumpers and they were followed by pole-vaulters, high jumpers and triple jumpers respectively. The results of Tukey's post hoc analysis showed that the long jumpers were found to have significantly greater calf circumference when compared to the high jumpers, triple jumpers and pole-vaulters. F-value showed significant differences in bicondylar humerus diameter of the various groups of jumpers. (F=6.68, p=0.001). Bicondylar humerus diameter was the highest in high jumpers. This was followed by long jumpers, triple jumpers and pole-vaulters respectively. The post-hoc analysis showed that the long jumpers and high jumpers had significantly higher bicondylar humerus diameter when compared to pole-vaulters. F-ratio revealed that there was significant difference in wrist diameter of different groups of jumpers (F=13.64, p< 0.0001). Wrist diameter was highest in long jumpers and they were followed by high jumpers, triple jumpers and pole-vaulters respectively. The post-hoc analysis revealed that the long jumpers, high jumpers and triple jumpers were reported to have significantly higher wrist diameter as compared to pole-vaulters.

In relation to biacromial diameter no significant difference was observed among the athletes of different jumping events. F-value showed significant differences in bi-iliocristal diameter among the different jumping groups (F=8.54, p<0.0001). Bi-iliocristal diameter was highest in high jumpers and they were followed by long jumpers, triple jumpers and pole-vaulters respectively. The post-hoc analysis reported that the pole-vaulters had significantly lower bi-iliocristal diameter as compared to long jumpers, high jumpers and triple jumpers. There was significant difference in relation to bicondylar femur diameter among the different groups of jumpers (F=8.34, p<0.0001). The high jumpers had the highest bicondylar femur diameter and they were followed by pole-vaulters, long jumpers and triple jumpers respectively. The post-hoc analysis revealed that the high jumpers were found to have significantly greater bicondylar femur diameter when compared to the triple jumpers. In relation to ankle diameter significant difference was reported among the various groups of jumpers (F=5.45, p=0.003). Ankle diameter was similar in long jumpers and high jumpers whereas triple jumpers and pole-vaulters had same ankle diameter. The post-hoc analysis showed that the long jumpers had significantly higher ankle diameter as compared to triple jumpers and pole-vaulters. Again, the high jumpers also had significantly higher ankle diameter as compared to the triple jumpers and pole-vaulters.

Discussion

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 [10]. The results of the present study show that the jumpers differed in most of the anthropometric measurements. The height and weight of the long jumpers in the present study is greater than the Indian long jumpers reported by Sodhi [11] and is comparable with the jumpers from Brazil [12] and Olympic level jumpers studied by de Garry *et al*. [13] and Carter *et al.* [14]. The long jumpers also possess higher circumferences and diameters which show better growth and development as compared to low performer long jumpers. The height of the high jumpers in the present study is greater than the Indian high jumpers reported by Sodhi[11] and is comparable with the jumpers from New Zealand[15] and Olympic level jumpers studied by de Garry *et al*. [13] and Carter *et al*. [14] whereas the high jumpers in our study are shorter than Czech, Slovak and Danish high jumpers [16]. The weight of the high jumpers is lower than their counterparts from New Zealand, Czechoslovakia, Denmark and Czech Republic [15, 16] But they have greater weight than the Indian high jumpers reported by Sodhi [11]. The tall persons with less weight are capable of achieving high performance in high jump event, therefore, the height of sportsperson is an essential component and much importance must be given to this parameter during talent search [17]. Greater body height raises the centre of gravity in the body of the athlete and thus advantageous to clear the higher height. Athletes who take part in jumping events particularly high jump and triple jump, need to be tall and have long lower limbs [18, 19, 20]. The height and weight of the triple jumpers in the present study is greater than the Indian jumpers reported by Sodhi [11] and is comparable with the triple jumpers from Brazil [12] and Olympic level jumpers studied by de Garry *et al*. [13] and Carter *et al*. [14]. The height of the pole-vaulters in the present study is comparable with the previously studied Indian and Olympic level pole-vaulters [11, 13]. The weight of the pole-vaulters is lower than their counterparts from New Zealand [15]. But they have greater weight than the pole-vaulters reported by Sodhi [11]. The pole-vaulters possessed greater circumference measurements. Greater development at these regions is due to the fact that the regular and high level training program resulted in the muscular development of the pole-vaulters.

The results of comparison among different groups of jumpers showed that high jumpers are tallest among the groups of jumpers. These results are supported by other studies on jumpers and throwers [20, 21, 22, 23]. The high jumpers have longest upper and lower extremity lengths among all the jumpers whereas long jumpers have greater circumferences, diameters among the groups of jumpers.

Conclusion

It was found that the significant differences were existed among different groups of jumpers with regard to anthropometric characteristics. The different jumping events require different kind of techniques and physical capabilities for higher performance. This might be the reason for significant variations in the anthropometric characteristics of athletes of different jumping groups.

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