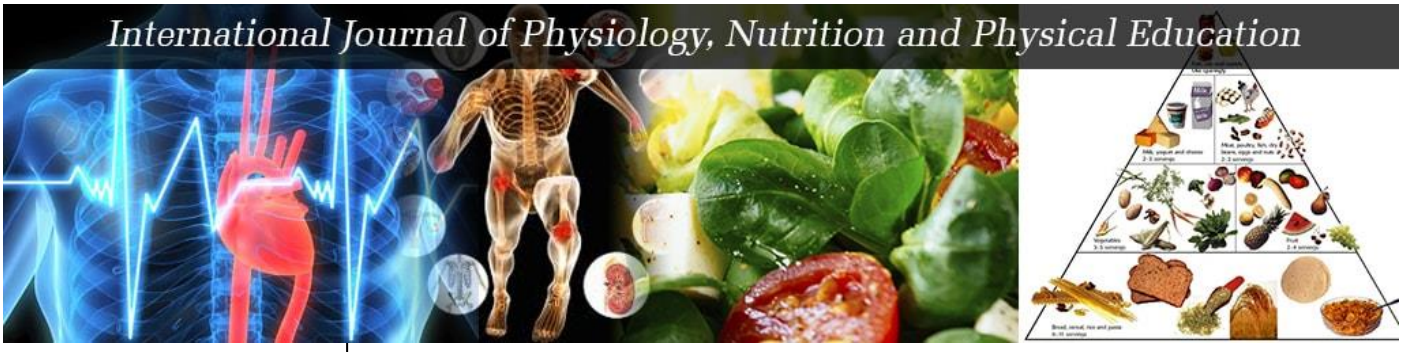

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Anthropometric characteristics among compound, Indian round and recurve archers

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Abstract
The present study aims at evaluating the anthropometric characteristics of the university level archers and association of these parameters with performance of archers also assessed. A total 30 university level archers (n= 30; 13 compound, 13 Indian round, 4 recurve) were selected as subjects. The height, weight, body lengths, diameters, circumferences and skinfold thicknesses were measured of the subjects. From these variables, the body composition components were calculated. The one-way ANOVA revealed that there were significant differences in body mass index ($p< 0.05$), upper arm length ($p< 0.05$), upper arm circumference ($p< 0.05$), percent body fat ($p< 0.05$) and total body fat ($p< 0.05$) among the compound, Indian round and recurve archers. The correlation analysis showed that the anthropometric characteristics did not show any association with the performance among the compound, Indian round and recurve group archers.

Keywords: Anthropometric measurements, archers, percent body fat, lean body mass, compound archers

Introduction
The term anthropometry invented by J.S. Elsholtz, a German Physician, in Seventeenth Century refers to measurement of human body and its various proportions. It encompasses a wide variety of measurement procedures for determining endless number of body dimensions. Anthropometry has begun an important tool in the hands of physical educationists and sports scientists. Scientists have to study the size shape and body composition of sports person in relation to their performance. At the basic level, for the identification of sports person, various anthropometric measurements and indices and their bearings on motor skill performance have been extensively studied. Thus sports anthropometry has developed as a special branch, not only as a parameter of selective diagnostic procedure but also as a performance prediction tool. However mere identification is not enough. There is need to find out the special area of sports where in that person would fit best so that specialized training, may be imparted in that direction. This is possible if an advanced study is made of the size, shape, proportion, body composition of the concerned persons. Anthropometry is an emerging scientific technology and is fast becoming important with the passage of time. This is a discipline, which tries to assess the physical structure of individual in terms of gross motor performance. Anthropometric techniques are used to access body composition.

Anthropometrics measurements are complete reflect of body fitness that have main role in determining performance and success of athletes. Identification and discovering sports talents is a main factor in determining success of athletes and their teams. In international high levels events for achieving high levels of performance related skills, survey of anthropometric measurements and body composition are essential. Recent information have showed that in most sports there is close and direct relationship between anthropometric and physiological measurements. It has been well established that specific physical characteristics or anthropometric profiles indicate whether the player would be suitable for the competition at the highest level in a particular sport [1, 2, 3, 4, 5, 6]. These anthropometric and morphological parameters are the vital indicators of physical growth and nutritional status of the athletes for their optimal performances [7, 8].

When this relationship is strong you can guaranties advance of athlete in their professional career using proper technique and equipment.

Archery is not excluded from this role. In archery anthropometric measures like wrist girth, length of three main fingers for drawing bowstring and length of palm are important factors. Because of specific technique in archery, this sport classified as sport that anthropometric and psychological profile had very important role. As well as this in archery upper body limps especially shoulder, elbow, wrist and fingers had major roles that both muscular strength and endurance of them can affects athletes performance and success. According to our knowledge no research in relation to anthropometric characteristics correlation with performance of elite archery athlete's found. The present study, therefore, undertaken to evaluate the anthropometric measurements and ascertain the relationship of anthropometric characteristics with the performance of the archers.

Methodology

The purpose of the study was to evaluate anthropometric characteristics and to determine the relationship of anthropometric characteristics with performance among archers. For this purpose, 30 archers (13 compound, 13 Indian round, 4 recurve) were purposively selected from Guru Nanak Dev University, Amritsar. The portable weighing machine was used to assess the body weight of the subjects. Height and lengths of upper and lower extremities were measured using the standard anthropometric rod. Sliding caliper was used to record the widths and diameters of body parts of the subjects. Flexible steel tape was used to measure the circumferences of the body parts of the subjects. Slimguide skinfold caliper was used to measure the skinfold thicknesses of the body parts of the subjects. The best score of the subjects during competitions *viz*. inter-college or inter-university was taken as the performance score.

Body Composition

Siri [9] and Durnin and Womersley [10] equations were used to calculate the percentage body fat from the sum of skinfolds. Body density was calculated using the following regression equations

Table 1: The composition for mal and females

For Males	For Females
17 to 19 years age group	17 to 19 years age group
Body Density (gm/cc) = 1.1620-0.0630 (X)	Body Density (gm/cc) = 1.1549-0.0678 (X)
20 to 29 years age group:	20 to 29 years age group:
Body Density (gm/cc) = 1.1631-0.0632 (X)	Body Density (gm/cc) = 1.1599-0.0717 (X)

Where X = log (biceps + triceps + Subscapular + suprailliac).

Percent Body Fat = [4.95/ body density-4.5] × 100

Total Body Fat (kg) = (%body fat/100) × body mass (kg)

Lean Body Mass (kg) = body mass (kg) – total body fat (kg)

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 test for differences among the three groups of archers. Following the detection of a significant main effect, Tukey post-hoc analyses were performed to locate where specific mean differences were laid. Karl Pearson's product moment co-efficient of correlation was computed to assess the relationship of anthropometric characteristics with performance of the archers. Significance levels were set at $p<0.05$.

Results

Table 2: Anthropometric Characteristics of the Compound, Indian round and Recurve archers

Variable	Compound (N=13)		Indian Round (N=13)		Recurve (N=4)		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
Height (cm)	166.69	5.10	166.62	5.99	164.00	4.00	0.417	0.663
Weight(kg)	60.23	8.08	54.61	4.48	60.75	5.73	2.922	0.071
Body mass index ($kg/m^{2)}$	21.63	2.36	19.69	1.63	22.54	1.08	4.81	0.016*
Arm Length (cm)	75.55	2.05	77.92	4.05	75.37	2.28	2.203	0.130
Upper Arm Length (cm)	32.69	1.66	33.92	1.11	31.00	2.16	6.145	0.006*
Lower Arm Length (cm)	42.86	2.07	44.00	3.54	44.37	1.25	0.750	0.482
Hand Length (cm)	17.47	.811	18.07	1.08	17.50	1.08	1.377	0.269
Biacromial Diameter (cm)	37.99	2.12	37.60	1.77	37.17	1.26	0.323	0.726
Bicondylar Humerus Diameter (cm)	6.06	0.460	6.20	0.637	6.32	0.350	0.425	0.658
Wrist Diameter (cm)	4.95	0.330	4.81	0.380	4.90	0.439	0.467	0.632
Hand Diameter (cm)	6.77	0.641	6.86	0.636	6.62	0.745	0.225	0.800
Bicondylar Femur Diameter(cm)	8.54	0.504	8.51	0.634	8.52	0.434	0.010	0.990
Upper arm circumference	25.69	1.67	26.10	1.90	28.50	2.12	3.650	0.040*
Fore arm circumference	22.30	1.67	22.89	2.03	23.45	1.51	0.721	0.495
Wrist circumference	16.12	1.02	16.16	.987	16.00	1.15	0.038	0.963
Thigh circumference	43.78	5.88	43.00	5.05	42.50	5.74	0.111	0.895
Calf circumference	33.26	2.95	32.98	2.54	33.62	2.56	0.092	0.912
Biceps skinfold	11.14	2.80	9.92	3.22	9.90	0.616	0.681	0.515
Triceps skinfold	13.60	3.53	14.00	3.51	14.62	4.02	0.132	0.877
Subscapular skinfold	14.11	2.66	12.76	2.86	13.17	3.37	0.746	0.484
Supra-iliac skinfold	9.67	3.36	7.92	2.36	10.75	2.98	1.950	0.162
Calf skinfold	15.40	4.21	16.30	3.61	19.25	9.50	1.626	0.215

Percent Body Fat (%)	26.20	2.63	20.11	3.70	18.32	2.20	16.492	0.000*
Total Body Fat (kg)	15.81	2.85	10.97	2.79	11.21	2.33	13.212	0.000*
Lean Body mass (kg)	44.41	6.01	43.64	4.28	49.53	3.58	2.123	0.139

Table-3 depicts the descriptive statistics and one-way analysis of variance (ANOVA) of the anthropometric characteristics among the compound, Indian round and recurve archers. The mean height of the compound, Indian round and recurve archers were 166.69 cm, 166.62 cm and 164.00 cm respectively. The weight of the compound, Indian round and recurve archers were 60.23 cm, 54.61cm and 60.75 cm. The ANOVA analysis revealed that there were no significant differences in height and weight among the compound, Indian round and recurve archers. The mean body mass index of the compound, Indian round and recurve archers were 21.63 kg/m^2, 19.69 kg/m^2 and 22.54 kg/m^2 respectively. The ANOVA analysis revealed that there were significant differences in body mass index (F=4.81, p=0.016) among the compound, Indian round and recurve archers. The Tukey's post-hoc analysis (table-3) revealed that compound archers had significantly higher body mass index than the Indian round archers. Similarly the recurve archers were found to have significantly greater body mass index than the Indian round archers. The mean arm length of the compound, Indian round and recurve archers were 75.55 cm, 77.92 cm and 75.37 cm respectively. The upper arm length of the compound, Indian round and recurve archers were 32.69 cm, 33.92 cm and 31.00 cm respectively. The ANOVA analysis revealed that there were significant differences in upper arm length (F=6.145, p=0.006) among the compound, Indian round and recurve archers. The Tukey's post-hoc analysis revealed that Indian round archers had significantly higher upper arm length than the compound and recurve archers. The lower arm length of the compound, Indian round and recurve archers were 42.86 cm, 44.00 cm and 44.37 cm respectively. The hand length of the compound, Indian round and recurve archers were 17.47 cm, 18.07 cm and 17.50 cm respectively. The ANOVA analysis revealed that there were no significant differences in arm length, lower arm length and hand length among the different groups of archers. The mean biacromial diameter of the compound, Indian round and recurve archers were 37.99 cm, 37.60 cm and 37.17 cm respectively. The bicondylar humerus diameter of the compound, Indian round and recurve archers were 6.06 cm, 6.20 cm and 6.32 cm respectively. The wrist diameter of the compound, Indian round and recurve archers were 4.95 cm, 4.81 cm and 4.90 cm. The hand diameter of the compound, Indian round and recurve archers were 6.77 cm, 6.86 cm and 6.62 cm respectively. The bicondylar femur diameter of the compound, Indian round and recurve archers were 8.54 cm, 8.51 cm and 8.52 cm respectively. The ANOVA analysis revealed that there were no significant differences in biacromial, bicondylar humerus, wrist, hand and bicondylar femur diameters among different groups of archers. The mean upper arm circumference of the compound, Indian round and recurve archers were 25.69 cm, 26.10 cm and 26.10 cm respectively. The ANOVA analysis revealed that there were significant differences in upper arm circumference (F=3.650, p=0.040) among the compound, Indian round and recurve archers. The Tukey's post-hoc analysis revealed that Indian round archers had significantly higher upper arm length than the compound archers. Similarly the Recurve archers were found to have significantly greater upper arm circumference than the Indian round archers. The forearm circumference of the compound, Indian round and recurve archers were 22.30 cm, 22.89 cm and 23.45 cm respectively. The wrist circumference of the compound, Indian round and recurve archers were 16.12 cm, 16.16 cm and 16.00 cm respectively. The thigh circumference of the compound, Indian round and recurve archers were 43.78 cm, 43.00 cm and 42.50 cm respectively. The calf circumference of the compound, Indian round and recurve archers were 33.26 cm, 32.98 cm and 33.62 cm respectively. The ANOVA analysis revealed that there were no significant differences in forearm, Wrist, thigh and calf circumferences among different groups of archers. The mean biceps skinfold of the compound, Indian round and recurve archers were 11.14 mm, 9.92 mm and 9.90 mm respectively. The triceps skinfold of the compound, Indian round and recurve archers were 13.60 mm, 14.00 mm and 14.62 mm respectively. The subscapular skinfold of the compound, Indian round and recurve archers were 14.11 mm, 12.76 mm and 2.86 mm respectively. The Supra-iliac skinfold of the compound, Indian round and recurve archers were 9.67 mm, 7.92 mm and 10.75 mm respectively. The calf sinfold of the compound, Indian round and recurve archers were 15.40 mm, 16.30 mm and 19.25 mm respectively. The ANOVA analysis revealed that there were no significant differences in biceps skinfold, triceps skinfold, subscapular skinfold, supra-iliac skinfold and calf skinfold among different groups of archers.

Table 3: Tukey's post-hoc analysis with regard to anthropometric measurements among compound, Indian round and recurve archers.

Variables	Mean Difference		
	Compound vs Indian Round	Compound vs Recurve	Indian Round vs Recurve
Body Mass Index	1.93*	0.90	2.84*
Upper Arm Length (cm)	1.23	1.69	2.92*
Upper Arm Circumference (cm)	0.41	2.81*	2.40
Percent Body Fat (%)	6.08*	7.87*	1.78
Total Body Fat (kg)	4.83*	4.59*	0.24

*Indicates $p<0.05$

The mean percent body fat of the compound, Indian round and recurve archers were 26.20 %, 20.11 % and 1.32 % respectively. The ANOVA analysis revealed that there were significant differences in percent body fat (F=16.492, p=0.000) among the compound, Indian Round and Recurve archers. The Tukey's post-hoc analysis revealed that Compound archers had significantly higher percent body fat than the Indian round archers. Similarly the Indian round archers were found to have significantly greater percent body fat than the recurve archers. The total body fat of the compound, Indian round and recurve archers were 15.81 kg, 10.97 kg and 11.21 kg respectively. The ANOVA analysis revealed that there were significant differences in total body fat (F=13.212, p=0.000) among the compound, Indian Round

and Recurve archers. The Tukey's post-hoc analysis revealed that Compound archers had significantly higher total body fat than the Indian round archers. Similarly the recurve archers were found to have significantly greater total body fat than the Indian round archers. The lean body fat of the compound, Indian round and recurve archers were 44.41 kg, 43.64 kg and 49.53 kg respectively. The ANOVA analysis revealed that there were no significant differences in lean body mass among the compound, Indian Round and Recurve archers.

Table 4: Association of anthropometric characteristics with performance among the Compound, Indian round and Recurve archers

Variable	Compound		Indian		Recurve	
	r	p-value	R	p-value	R	p-value
Height(cm)	0.085	0.783	0.212	0.487	0.347	0.653
Weight (kg)	0.118	0.700	0.133	0.665	0.535	0.465
Body Mass Index (kg/m^2)	0.091	0.766	0.053	0.864	0.691	0.309
Arm Length (cm)	0.059	0.848	0.155	0.614	0.639	0.361
Upper Arm Length (cm)	0.130	0.672	0.100	0.746	0.134	0.866
Lower Arm Length (cm)	0.046	0.881	0.145	0.636	0.938	0.062
Hand Length (cm)	0.003	0.992	0.189	0.537	0.911	0.089
Biacromial Diameter (cm)	0.128	0.677	0.037	0.903	0.174	0.826
Bicondylar Humerus Diameter (cm)	0.063	0.839	0.169	0.581	0.372	0.628
Wrist Diameter (cm)	0.097	0.754	0.002	0.995	0.892	0.195
Hand Diameter (cm)	0.111	0.718	0.169	0.603	0.951	0.049
Bicondylar Femur Diameter(cm)	0.451	0.122	0.254	0.403	0.965	0.035
Upper Arm Circumference (cm)	0.306	0.309	0.011	0.973	0.696	0.304
Forearm circumference (cm)	0.416	0.158	0.188	0.538	0.960	0.040
Wrist Circumference (cm)	0.028	0.927	0.292	0.334	0.050	0.950
Thigh Circumference (cm)	0.054	0.861	0.383	0.196	0.796	0.204
Calf Circumference (cm)	0.125	0.684	0.330	0.271	0.943	0.057
Biceps Skinfold (mm)	0.049	0.873	0.010	0.974	0.596	0.404
Triceps Skinfold (mm)	0.204	0.504	0.265	0.381	0.032	0.968
Subscapular Skinfold (mm)	0.313	0.297	0.367	0.218	0.654	0.346
Supra-iliac Skinfold (mm)	0.013	0.968	0.248	0.415	0.107	0.893
Calf Skinfold (mm)	0.028	0.929	0.289	0.338	0.347	0.653
Percent Body Fat (%)	0.250	0.410	0.135	0.661	0.189	0.811
Total Body Fat (kg)	0.172	0.573	0.036	0.906	0.359	0.641
Lean Body Fat (kg)	0.077	0.802	0.158	0.607	0.623	0.377

Table 4 presents the association of performance with the anthropometric measurements and body composition components among the compound, Indian round and recurve archers. The Karl Pearson's coefficient of correlation revealed that the anthropometric measurements and body composition components did not show any significant relationship with the performance of the compound, Indian round and recurve archers.

Discussion

The primary aim of the present study was to evaluate the anthropometric measurements of compound, Indian round and recurve university level archers and to assess the relationship of anthropometric measurements with the performance score of the archers. The compound, Indian round and recurve were also compared on anthropometric characteristics. There are scant studies on the anthropometric characteristics among the archers in the literature. The findings of the present study, therefore, could not be comparable with other studies. The findings revealed that there were significant differences in body mass index among the compound, Indian round and recurve archers. The post-hoc analysis showed that compound and recurve archers had significantly higher body mass index than the Indian round archers. There were significant differences in upper arm length among the compound, Indian round and recurve archers. The post-hoc analysis showed that Indian round archers had significantly higher upper arm length than the compound and recurve archers. The results also revealed that there were significant differences in upper arm circumference among the compound, Indian round and recurve archers. The post-hoc analysis revealed that Indian round archers had significantly higher upper arm length than the compound archers. Similarly the recurve archers were found to have significantly greater upper arm circumference than the Indian round archers. There were significant differences in percent body fat among the compound, Indian round and recurve archers. The compound archers had significantly higher percent body fat than the Indian round archers. Similarly the Indian round archers were found to have significantly greater percent body fat than the recurve archers. The results revealed that there were significant differences in total body fat among the compound, Indian round and recurve archers. The compound archers had significantly higher total body fat than the Indian round archers. Similarly the recurve archers were found to have significantly greater total body fat than the Indian round archers. The correlation analysis showed that there were no significant associations between anthropometric characteristics and performance among the archers. These findings are not in line with those reported on baseball and softball players [11, 12]. There were no significant associations between body composition components and performance among the archers. The excess of fat mass and lack of lean body mass among the players may have a negative effect on the performance. These findings are in line with those reported on baseball and softball players [12, 13, 14]. Studies in different sports showed that the muscle mass have been in a better association to success in sport (maximum aerobic performance, running time, strength etc.) than the percentage body fat [15, 16, 17, 18]. On the basis of results of present study, it can be concluded that the anthropometric characteristics and body composition components did not have any association with the performance of archers.

Conclusions

The study evaluated the anthropometric characteristics of the university level archers and association of these parameters with performance of archers also assessed. Significant differences were reported in body mass index, upper arm length, upper arm circumference, percent body fat and total body fat among the compound, Indian round and recurve archers. The anthropometric characteristics did not show any association with the performance among the compound, Indian round and recurve group archers.

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