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Research Article

Anthropometry and Body Composition in Eastern Indian Soccer and Hockey Players

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ABSTRACT

Background: Anthropometry, body composition and somatotype are of major morphological importance to develop performance in soccer and hockey players. There is lack of comparative data of these parameters in these two groups of sportspersons in the eastern Indian context.

Methods: 120 healthy young male subjects (sedentary=40, soccer player=40, hockey player=40) of 19-23 years of age with similar socio-economic background were recruited in the present study from Kolkata, West Bengal, India to evaluate and compare the anthropometric parameters, body composition and somatotype in soccer and hockey players.

Results: Determination of anthropometric parameters, body composition and somatotype by standard methods and analysis of data by one-way Analysis of Variance (ANOVA) depicted that age, body height and body surface area had no significant inter-group variation. Body mass and body mass index were significantly higher in the sedentary group in comparison to the experimental groups (hockey and soccer). Values of skinfolds, waist-hip ratio, humerus and femur width were significantly lower while calf girth was significantly higher in the hockey and soccer players in comparison to the sedentary group. The sedentary group had significantly ($p<0.05$) higher endomorphic score than the hockey and soccer players.

Conclusion: Furthermore, the soccer players had significantly higher ectomorphic score than the hockey players and sedentary groups. The mean somatotype distribution of the groups illustrated that the sedentary group and hockey players were endomorphic mesomorph while soccer players were ectomorphic mesomorphs which is considered to be more potential characteristic to develop better performance and prevent the risks of injuries.

Keywords: Skinfold; LBM; Ectomorph; Mesomorph; Endomorph

INTRODUCTION

Soccer and hockey are the most popular and widely played sports in the world. Both these games require faster reaction time, less thinking and more demands with highly developed cognitive, functional and athletic abilities [1-4]. Besides its use in the design ergonomics and other pertinent fields, anthropometry is widely used in understanding the physical characteristics associated with performance of athletes at different levels [2-5]. It has been reported that athletes' anthropometric profile largely influences the physical performance [1-3,5,6]. Significant correlations were found between body weight, muscle mass, and power profiles [2,3,7]. A study of young soccer and hockey players revealed that age, %fat, lean body mass, somatotype and physical characteristics are important indicators for identification and selection of game-specific talented players [2,3,8]. Existence of lower values of body mass and body height in soccer players than their international counterparts act as disadvantage for them [9,10]. Due to lower body height, they are unable to accomplish the sort of jumping height required for the optimal heading of the ball in soccer.

Although the importance of anthropometric parameters in the athlete selection process and training is documented, there is a lack of comparative data between soccer and hockey players in the eastern Indian context. Therefore, the present study was aimed to evaluate and compare the body composition and somatotype score in young male eastern Indian soccer and hockey players.

MATERIALS AND METHODS

The 120 healthy young male subjects (sedentary=40, soccer player=40, hockey player=40) of 19-23 years of age with similar socio-economic backgrounds [11] were recruited in the study. Sedentary individuals were selected by simple random sampling method from the postgraduate section of the University of Calcutta, whereas the state level sportspersons with minimum three years of regular involvement in training regimen were recruited from various sports academies in Kolkata, West Bengal, India.

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Each subject filled up one questionnaire to record their demographic data, health status and consent to participate in the study. The subjects were non-smokers and neither suffering from any illness nor under any medication during this study time and they had no history of major diseases, bone fracture or heavy injury. Age of each subject was calculated in the nearest year from the date of birth as obtained from their photo ID card issued by the Government of India.

Sample size calculation

The sample size was computed by using PS (Power and Sample size) calculation version 2.1.30 where power was set at 80 with 95% confidence interval [12]. The alpha (α), delta (δ), sigma (σ) and power were set at 0.05, 0.2, 0.6 and 0.80 respectively [13]. Thus the sample size computed was 37. However, the sample size of the present study was 40 that were higher than the computed sample size.

Preparation of the subjects

Each subject came to the laboratory for two days with a gap of at least seven days between two successive days of the visit. They reported in the laboratory at 10 am on all occasions. A familiarization trial was conducted on the first visit when they were explained and demonstrated all the experiments to allay apprehension. They were asked to avoid any energetic activity on the days of evaluation and took light breakfast 2 to 3 hrs before conducting the experiments. The second visit comprised of determination of body height, body mass, pre-exercise heart rate from the radial pulsation, and measurement of blood pressure by the auscultatory sphygmomanometric method. The skinfold parameters, girth, circumference, breadth was measured during this second visit. The entire study was conducted at laboratory temperature ranging between 20°C-25°C and relative humidity ranging between 40%-45%. Body height and body mass were measured to an accuracy of ± 0.50 cm and ± 0.1 kg, respectively, by using a weight measuring instrument fitted with a height measuring rod (Avery India Ltd., India) with the subject standing barefoot and wearing the lowest amount of clothing. All the measurements were taken by using the same instrument in all individuals. Body Mass Index (BMI) and Body Surface Area (BSA) were calculated by using the following formulae:

BMI (kg/m^2)=Body Mass (kg)/(Body Height in meter)^2 [14]

BSA (m^2)=(Body mass)$^{0.425}$ × (Body height)$^{0.725}$ × 71.84 [15]

Determination of body composition

A skin-fold calliper with constant tension (Holtain Ltd., UK) [16] was used to measure the skinfold thicknesses and the different components of body composition were calculated by using the following formulae:

Body density or BD ($gm.cc^{-1}$)=$1.10938-0.0008267X_1+0.0000016X_1^2-0.0002574X_2$

(X_1=Sum of chest, abdominal and mid-thigh skinfolds, X_2=Age in nearest yrs)

%Fat=495/BD-450 [17]

Total body fat, Lean Body Mass (LBM) and percentage of LBM (%LBM) were calculated from the following equations:

- Total Fat (TF) (kg)=%Fat/100 × Body Mass (kg)
- % Lean Body Mass (%LBM)=100-%Fat
- LBM (kg)=Body Mass (kg-Total Fat (kg)

Determination of Waist-Hip Ratio (WHR)

Waist circumference and hip circumference of the subjects by the protocol of Park, 2007 [18].

Somatotype was determined from the following equations [2]:

(i) Endomorphy=$0.1451(X)-0.00068(X)^2+0.0000014(X)^3$

(Where X=Sum of supra-spinale, subscapular and triceps skinfold and corrected for stature by multiplying the sum of skinfolds by 170.18/Body Height in cm)

(ii) Mesomorphy=(0.858 × Humerus width)+(0.601 × Femur width)+(0.188 × Corrected arm girth)+(0.161 × Corrected calf girth)-(Body height x 0.131)+4.5

(Where corrected arm girth=Arm girth-Biceps skinfold, Corrected calf girth=Calf girth-Calf skinfold)

(iii) Ectomorphy=(HWR × 0.732)-28.58

(Where HWR=(Body Height in cm)/(weight in kg)$^{1/3}$)

Statistical analysis

Data have been presented as Mean ± SD. The normality of the distribution of data for each group was checked by Kolmogorov-Smirnov test. One-way Analysis of Variance (ANOVA) was carried out to detect the significance of difference and Post hoc Turkey analysis was performed to detect the inter group difference. Statistical analysis of the data was performed by employing the Statistical Package for Social Sciences (SPSS) Version 16 software. Level of significance was set at $p<0.05$.

RESULTS

Age, body height and BSA did not depict any significant inter-group variation in the studied populations but body mass and BMI were significantly higher in the sedentary group when compared against their age-matched experimental (hockey and soccer) counterparts (Table 1).

However, physiological variables such as pre-exercise heart rate, systolic and diastolic blood pressure were significantly lower in case of the hockey and soccer groups in contrast to the control group (Table 1). Moreover, a significant inter-group variation was noted for BMI between the hockey and soccer players. Different SkinFolds (SKF) measurements, e.g., biceps, triceps, suprailiac, sub-scapular, chest, abdominal, mid-thigh, supra-spinal

Table 1: Physical and physiological parameters of the subjects.

	Age(yrs)	Body height (cm)	Body weight (kg)	BMI (kg/m^2)	BSA (m^2)	Pre-exercise heart rate ($beats.min^{-1}$)	Blood pressure (mm of Hg)	
							Systolic	Diastolic
Sedentary (n=40)	21.05 ± 1.3	171.93 ± 4.58	71.67 ± 6.71	24.71 ± 1.43$^{@}$	1.84 ± 0.10	78.55 ± 6.78$^{\#@}$	116.38 ± 5.54$^{@\#}$	76.7 ± 3.87$^{@\#}$
Hockey (n=40)	21.03 ± 1.33	171.06 ± 6.17	69.38 ± 5.59	23.71 ± 1.43	1.81 ± 0.1	66.4 ± 4.67	109 ± 4.40	69.55 ± 1.99
Soccer (n=40)	20.75 ± 1.48	172.29 ± 5.26	68.11 ± 5.39	22.91 ± 0.84$^{\$}$	1.81 ± 0.09	65.73 ± 4.56	108.3±4.06	70.6 ± 2.31
F	0.502	0.554	3.704	10.268	1.527	70.594	34.82	73.439
Sig.	0.607	0.576	0.028	0	0.221	0	0	0

Note: Values are mean ± SD, Significance was set at an alpha level of 0.05
$^{\#}$p<0.05 (When compared between Sedentary and Hockey groups)
$^{@}$p<0.05 (When compared between Sedentary and Soccer groups)
$^{\$}$p<0.05 (When compared between Hockey and Soccer groups)

and calf were significantly lower for both the hockey and soccer players when compared with their sedentary counterparts (Table 2).

There was a significant inter-group variation for the calf skinfold measurement between the hockey and soccer players (Table 2).

Sum of skinfolds, %fat and total fat were significantly lower in the experimental groups in comparison to the control group. Body Density (BD), Lean Body Mass (LBM) and %LBM were significantly higher for the hockey and soccer players in comparison to the sedentary counterparts (Table 3).

Calf girth showed significantly higher value in case of experimental groups (hockey and soccer) when compared with their sedentary counterpart (Table 4).

Humerus and femur width showed significantly lower values in the experimental groups (hockey and soccer) than their sedentary group (Table 4). Both the hockey and soccer players depicted significantly lower waist: hip ratio when compared against the sedentary individuals (Table 4).

Significant differences in the endomorphic and ectomorphic components were found among the groups (Table 5).

The post-hoc analysis showed that the sedentary group was markedly more endomorphic ($p<0.05$) than the hockey and soccer players. Furthermore, the soccer players were significantly more ectomorphic ($p<0.05$) than the hockey players and sedentary groups. The mean somatotype distribution of the groups as illustrated in Table 5 shows that the soccer players are predominantly ectomesomorphs.

Table 2: Values of different skinfold measurements of the subjects.

	a	b	c	d	e	f	g	h	i	(a-i)
	Biceps	**Triceps**	**Suprailiac**	**Sub-scapular**	**Chest**	**Abdominal**	**Mid-thigh**	**Supra spinal**	**Calf**	**Sum**
Sedentary (n=40)	4.89 ± 1.03 #@	9.655 ± 1.91 #@	12.33 ± 3.51 #@	12.05 ± 2.53 #@	12.99 ± 1.49 #@	16.71 ± 2.01 #@	18.03 ± 3.01 #@	11.43 ± 2.31 #@	10.89 ± 2.83 #@	108.96 ± 9.25 #@
Hockey (n=40)	3.59 ±0.60	5.82 ± 1.25	6.94 ± 3.08	8.4 ± 1.79	7.24 ± 1.44	10.35 ± 1.92	9.95 ± 2.26	7.47 ± 1.52	6.59 ± 1.59 $	66.54 ± 5.59
Soccer (n=40)	3.65±0.64	5.43 ± 1.01	6.35 ± 2.06	7.82 ± 1.50	7.5 ± 1.23	10.55 ± 1.43	8.78± 1.39	7.56 ± 1.49	5.16 ± 1.09	62.79 ± 5.22
F	35.103	105.012	50.106	53.06	218.41	156.277	189.474	61.952	91.03	318.74
Sig.	0	0	0	0	0	0	0	0	0	0

Note: Values are mean ± SD, difference between group is 2, within group is 117 and total is 119, Significance was set at an alpha level of 0.05
#$p<0.05$ (When compared between Sedentary and Hockey groups)
@$p<0.05$ (When compared between Sedentary and Soccer groups)
$$p<0.05$ (When compared between Hockey and Soccer groups)

Table 3: Values of body composition and sum of skinfolds in sedentary and experimental groups.

	Sum of SKF	Body density (gm/cc)	%fat (%)	Total body Fat or TF (kg)	%LBM (%)	LBM (kg)
Sedentary (n=40)	47.73 ± 4.57 #@	1.07 ± 0.003 #@	13.41 ± 1.42 #@	9.65 ± 1.61 #@	86.59 ± 1.42 #@	62.02 ± 5.46
Hockey (n=40)	27.72 ± 4.78	1.08 ± 0.004	7.36 ± 1.49	5.13 ± 1.34	92.64 ± 1.49	64.22 ± 4.63
Soccer (n=40)	26.83 ± 2.97	1.08 ± 0.002	7.05 ± 0.97	4.83 ± 0.93	92.94 ± 0.96	63.27 ± 4.66
F	318.741	305.854	307.979	171.149	307.979	2.017
Sig.	0	0	0	0	0	0.138

Note: Values are mean ± SD, SKF= skinfolds, difference between group is 2, within group is 117 and total is 119
Significance was set at an alpha level of 0.05
#$p<0.05$ (When compared between Sedentary and Hockey groups)
@$p<0.05$ (When compared between Sedentary and Soccer groups)

Table 4: Girths, widths and waist-hip ratio of the subjects.

	Girth (cm)			Width (cm)		Waist circumference (cm)	Hip circumference (cm)	W-H Ratio
	Arm	Calf	Sum	Bi-Humerus	Bi-Femur			
Sedentary (n=40)	24.3 ±2.39	36.17±2.26 @#	60.47±3.33 @#	6.37±0.53 @#	9.22±0.61 @#	75.24±7.95 @#	90.01±5.14 @	0.84±0.06 @#
Hockey (n=40)	20.7 ±1.38	33.99±1.75	54.69±2.55	6.73±0.41	9.91±0.36	70.83±4.99 $	87.94±4.91 $	0.81±0.02
Soccer (n=40)	17.93±1.02	33.98±1.79	51.92±1.94	6.66±0.30	9.96±0.42	64.74±4.43	79.61±5.94	0.81±0.03
F	0.546	16.72	106.88	7.582	30.405	31.018	42.458	3.858
Sig.	0.581	0	0	0	0	0	0	0.024

Note: Values are mean ± SD, Significance was set at an alpha level of 0.05, W-H ratio = waist-hip ratio, difference between group is 2, within group is 117 and total is 119.
#$p<0.05$ (When compared between Sedentary and Hockey groups)
@$p<0.05$ (When compared between Sedentary and Soccer groups)
$$p<0.05$ (When compared between Hockey and Soccer groups)

Table 5: Values of ectomorph, endomorph and mesomorph in sedentary group and experimental groups.

	Ectomorph	Endomorph	Mesomorph
Sedentary (n=40)	2.19 ± 0.60 #@	3.01 ± 0.39 #@	3.36 ± 0.79 #@
Hockey (n=40)	2.35 ± 0.84	2.82 ± 0.39	3.87 ± 0.78
Soccer (n=40)	2.76 ± 0.44 $	2.72 ± 0.33	3.69 ± 0.89
F	8.158	5.993	3.986
Sig.	0.000	0.003	0.021

Values are mean ± SD
df of between group is 2, within group is 117 and total is 119
Significance was set at an alpha level of 0.05
#p<0.05 (When compared between Sedentary and Hockey groups)
@p<0.05 (When compared between Sedentary and Soccer groups)
$p<0.05 (When compared between Hockey and Soccer groups)

DISCUSSION

Body mass and BMI differed distinctly in case of hockey and soccer players when compared against their age-matched, sedentary counterparts. Lower values of body mass and body height among the footballers than their international counterparts [9,10,19-21] are also disadvantages for them. Due to lower body height, they are unable to accomplish the sort of jumping height required for the optimal heading of the ball.

The significant inter-group variation in BMI for the hockey and soccer players may be attributed to the greater body height and body mass in the soccer players. Further, the significantly less Waist Hip Ratio (WHR) for both soccer and hockey players compared to their sedentary counterparts might be reflective of better health conditions in the athletic groups (Table 4). WHR is significantly associated with cardiac stroke, ischemic heart disease, hypertension and gall bladder disease [22]. It has further become accepted that a high WHR (>1.0 in men) indicates abdominal fat accumulation, the potential risk factor of central obesity [22].

Sum of skinfolds, %fat and total fat were significantly lower of the hockey and soccer players when compared against their sedentary counterparts whereas Body Density (BD), Lean Body Mass (LBM) and %LBM were significantly higher for the hockey and soccer players in comparison to their sedentary counterparts indicated that the sedentary population had greater quantity of subcutaneous fat deposition (Table 3). This present finding depicted higher LBM data achieving better performance [4,23]. Conversely, the greater %fat in the Indian soccer players will act as a hindrance to their performance [4,23]. All the skinfolds and calf girths are significantly higher in the sedentary group, indicating that the sedentary population has a greater value of subcutaneous fat deposition, which was also reflected in their significantly higher (P<0.001) value of %fat than the players. However, the LBM was significantly higher among the experimental groups. The present data of %fat accords with the proposal that %fat value among soccer and hockey players should be within the players range of 4%-10% and 5-10%, respectively [24]. Canadian hockey players showed a greater value of %fat than the present study [25]. Rico-Sanz proposed that footballers should have a body %fat of around 10% and this is in agreement with the present finding. The footballers of California and Hong Kong had lower values of %fat [21,26] whereas higher %fat values have been reported in American, British and Spanish athletes [10,20,27]. Conversely, the greater fat content in the Indian footballers will act as a hindrance in their performance [4,23].

Humerus and femur width showed significantly lower values in the experimental groups (hockey and soccer) than their sedentary group (Table 4). The work-rate profile of a player depends on the type of competition and playing position, which are highly correlated with the anthropometric contour and somatotype scores [7]. The sedentary group was markedly more endomorphic (p<0.05) than the hockey and soccer players. This finding also corroborated with young Macedonian Soccer Players [28]. But the greater endomorphic score was noted in the hockey group than the soccer group. This finding was also in agreement with Nigerian hockey players where the endomesomorphic characteristics observed in the hockey players [2]. Furthermore, the soccer players were significantly more ectomorphic (p<0.05) than the hockey players and sedentary group. The soccer players are predominantly ectomesomorphs. According to the findings of Toriola, et al. the sprinters and soccer players were ectomesomorphs. By contrast, it could be observed that the hockey players and sedentary individuals were endomesomorphs [2,3]. As observed in this present study, sedentary group is endomorphic as proposed in some investigations the nonathletes as being predominantly endomorphic [3,29]. On the other hand, Indonesian soccer players exhibited a greater mesomorphic score than their counterparts of the present study [30]. According to Bandyopadhyay research, significantly higher endomorphic and significantly lower mesomorphic scores among the sedentary individuals, and the sportspersons were found to be mesomorphic ectomorph. The mesomorphic score is significantly (p<0.001) higher among the soccer players [4]. This finding corroborated with the present study as well as previous studies [20,28]. The present research displayed the mesomorphic score is significantly (p<0.05) higher among the hockey and soccer players whereas the ectomorphy is significantly higher (p<0.05) in the soccer than the hockey and sedentary group. This finding also corroborated with previous studies [3,31,32]. A high mesomorphic score generally found in athletes, is advantageous since it quantifies the musculoskeletal system whose strengthens is essential for better sports performance [28,33]. Macedonian, British, Russian, South American soccer and hockey players showed higher somatotype scores [7,27,28]. Somatotyping, as a constitutional approach, may provide insight into the causative mechanisms underlying human conditions and characteristics such as disease and behaviour, in addition to its relationship to athletic performance [3,34]. A previous study suggested that after 8-weeks of training of Nigerian soccer players, 44% of the mesomorphs (n=50) and 45% of the meso-ectomorphs (n=65) were injured while 85% of the ectomorphs (n=25) and 50% of the ectomesomorphs (n=40) were injured that determined the soccer players whose somatotypes range between meso-ectomorphic to the mesomorphic builds are less prone to injuries than their more fragile linear counterparts [35]. Therefore mainly mesomorphic type and partially mesoectomorphic type plyer should ultimately be considered as potential players [35]. In general, the differences observed in this study's subjects are related not only to genetic and environmental influences [3] but also to regular participation in competitive sports. Sedentary people had higher skinfolds, girth measurements, fat component and endomorphic values, indicating that extra fat may be due to their lack of daily working activity [28,36]. According to previous reports, a mild to a strong training programmer, such as that of athletes, significantly reduces body fat weight [28,36-38].

Practical application

The obtained results can serve as normative anthropometric indicators for regular sports medical examinations of young soccer and hockey players in our country or can be used as a template for comparison of the anthropometric and somatotype information of young players at a similar level of different countries. In addition, complex protocols are involved in determining body composition but this data can recommend a predictor from BMI to get a first impression of the body composition of the population under study. However, because certain positional roles in soccer and hockey require special technical skills, determine whether changes in the position of Indian soccer and hockey players are related to differences in morphological characteristics. Further investigation is essential for this. Therefore, in this study, the injury rate can be reduced by selecting soccer players according to their somatotype score, and, mainly mesomorphic type and partially mesoectomorphic type should ultimately be considered as potential soccer players.

CONCLUSION

The present study showed that the experimental groups have lower values of body fat percentage and waist-hip ratio. The sedentary group was markedly endomorphic ($p<0.05$). Furthermore, the soccer players were significantly more ectomorphic ($p<0.05$) than the hockey players and sedentary groups. The mean somatotype distribution of the groups illustrated that the soccer players are predominantly ectomesomorphs. That may be helpful to them to achieve better performance and fewer injuries.

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ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the human ethical committee of the department of physiology, university of Calcutta.

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CONFLICT OF INTEREST

There is no competing interest in the present study.

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