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A Study on selected anthropometric characteristics of height-weight matched female athletes and non-athletes

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Abstract: *Height and weight are the most important aspects of man from the anthropometric view point. Height is determined by a combination of genetics and environment. Body weight is essential for health of a person. So, height and weight are so important for everybody. The study aimed to assess the selected anthropometric characteristics of height-weight matched 20-25 year old female athletes and non-athletes. Sixty (N=60) height-weight match females were selected as the subject of this study out of sixty, thirty (n=30) were state level athletes and thirty (n=30) were non-athletes. The height range was 157.5cm – 162.5 cm and weight was 52.5 kg– 55.5 kg. Selected anthropometric parameters were two body circumference and four skin-fold sites. Derived six body composition measures, namely - body mass index (BMI), body fat percentage (% BF), fat mass (FM), lean body mass (LBM), body surface area (BSA) and waist-to-hip ratio (WHR) were from respective anthropometric components. Statistics used in this study were descriptive statistics (mean and standard deviation), percentile and t-test for data analysis. Differences were considered significant at 0.05 level. Both groups were significantly differ ($p<0.05$) in four skin-folds. In the two body circumferences only waist circumference of athletes group was significantly differ from other group. Significant difference was exist between the groups. The results of selected anthropometric characteristics of both the groups were at par, yet the athletes group was healthier than their counter part. So, it could be concluded that the athletes group was healthier and they could lead a quality of life.*

Key Words*: Height, Weight, Athletes, Non-athletes, Anthropometry.*

I. Introduction:

Height and weight are the most important measurements of human being from the anthropometric view point. Height is determined by a combination of genetics and environment. Average height is relevant to the measurement of the health and wellness (standard of living and quality of life) of populations [1]. Certain studies have shown that height is a factor in overall health while some suggest tallness is associated with better cardiovascular health and shortness with longevity [2]. Cancer risk has also been found to grow with height [3]. On the other hand body weight is measured in different situation of human life i.e. in games and sports, in the medical treatment and for the measurement of obesity etc. Participants in games and sports such as boxing, mixed martial arts, wrestling, rowing, judo, Olympic weightlifting, and powerlifting are classified according to their body weight [2]. Ideal body weight is used clinically for multiple reasons, most commonly in estimating renal function in drug dosing, and predicting pharmacokinetics in morbidly obese patients [4, 5]. "Anthropometry" is the study of human body measurements to assist in understanding human physical variations and aid in anthropometrical classification [6]. Kin -anthropometry is a scientific discipline that is concerned with the measurement of individuals in a variety of morphological perspectives, its application to movement and those factors which influence movements including: component of body build, body measurements, proportions, compositions, shape and nutrition, motor abilities and cardio- respiratory system; physical activity including recreational activity as well as highly specialized sports performance. A person's body fat consists of essential and storage body fat. Essential fat is necessary to maintain life and productive functions. The percentage of essential body fat of women is greater than that of men, due to the demands of child bearing and other hormonal functions. Essential fat is 3-5%in men and 8-12% in women. Storage body fat consists of fat accumulation in adipose tissue part of which protects internal organs in the chest and abdomen [7].

In the ancient (lower palaeolithic period) times human lived in forests and woodlands, which allowed them to collect food, eggs, nuts and fruits besides scavenging rather than killing large animals for meat [8, 9]. It is seen from the cave painting in the upper palaeolithic period that human being participated in sprinting, wrestling and swimming [10, 11, 12]. So, Games and sports have played a significant role in human history since pre-historic times as it was essential to be physically fit for survival. Therefore, the physical activities have been used by all the societies to safeguard the self, promote health and wellbeing, and of course for entertainment [13]. In the ancient time in Greece two competitive sports were arranged by the human civilization. One in 776 BC named ancient Olympic Games for men participant only and another game was started in six century BC, the ancient Heraean Games were the first sanctioned women's athletic competition to be held in the stadium at

Olympia [14], prior to the men's Olympic events. But, only the unmarried women were the participant of the game Heraea.

On that time women were separated in two distinctive groups according to their activities one is athletes and another is non-athletes group. From that time till now two groups are performing according to their needs and demands. Here athletes could be expressed as a sports person who competes in one or more sports that involve physical strength, speed and/or endurance. Athletes may be professionals or amateurs [15]. On the other hand non-athletes mean a person who voluntarily participate in any physical activity or frequently not involve in any sports. As the groups were athletes and non-athlete, so there will definitely some question arises. Are they similar according to their physical characteristics, physiological perspective and psychological endowment? So, in this study both the groups were analysed according to selected anthropometric characteristics only.

II. Methods & Materials:

A total of sixty (N = 60) height-weight match females were selected as the subjects, out of which thirty state level athletes and thirty non-athletes. Height range of the subjects was 157.5cm to 162.5 cm and weight of the subjects was between 52.5kg to 55.5 kg. Anthropometric profile was the criterion measure for this study to predict the health status of two groups. Selected anthropometric parameters for this study were: direct measure parameters- height, weight, WCR, HCR and derived measure parameters- body fat percentage (% BF), body mass index (BMI), fat mass (FM) lean body mass (LBM) body surface area (BSA) and waist-to-hip ratio (WHR). The anthropometric tape was used to measure heights to the nearest 0.1 cm. For each height reading, the heel, buttocks and shoulder blades were in contact with the vertical surface. Weight was recorded to the nearest 0.5 kg. All subjects wore light clothing and removed their shoes before the measurement of weight. BMI was measured from weight and height ratio (kg/m^2). The measurement of WCR (in cm) was taken midway between the sub- costal margin and iliac crest while the HCR (in cm) was taken at the point of maximum circumference over the buttock. WHR was predicted from dividing waist circumference by hip circumference. Body Surface area (BSA) was measured through the formula of Mosteller, (1987) [16]: [{Height (cm) x Weight (kg)}/ 3600]$^{1/2}$. The Biceps skinfold site is marked over the most anterior part of the biceps. The Triceps skinfold site is marked over the most posterior part of the triceps. Subscapular skin-folds site is 2 cm along a line running laterally and obliquely downward from the sub-scapular landmark at a 45° angle.

Supraspinale/suprailiac site at the intersection of towlines: (1) the line from the marked iliospinale to theanterior axillary border, and (2) the horizontal line at the level of the marked iliocristale. Body fat percentage was measured by 4 skin-fold sites, namely- biceps, triceps, sub-scapular and suprailiac (Durnin and Womersley, 1974) [17]. The fat mass was obtained from the weight multiplied by percentage body fat. The lean body mass (LBM) of a subject was obtained by deducting the fat mass from body weight (LBM = Body weight – Fat mass). Mean, standard deviation (SD) and independent t- test were the statistics used in this study for data interpretation. Level of significant difference between two groups was set at $p<0.05$ level.

III. Results and Discussion:

Table-1 represents the direct measure anthropometric variables of athletes and non-athletes group. The value of height and weight of both the groups were quite similar as they were selected in a specified range i.e. height range was 157.5 cm to 162.5 cm and weight range was 52.5 kg to 55.5kg.

Table 1: Personal data of athlete and non-athlete groups

Variables	Group	N	Mean ± SD	SE_M (±)
Height (cm)	Gr - A	30	159.43 ± 2.13	0.39
	Gr - B	30	159.37 ± 1.70	0.31
Weight (kg)	Gr - A	30	53.88 ± 1.14	0.21
	Gr - B	30	53.95 ± 1.12	0.20
BMI (kg/m^2)	Gr - A	30	21.21 ± 0.84	0.15
	Gr - B	30	21.28 ± 0.58	0.11
BSA (m^2)	Gr - A	30	1.54 ± 0.02	0.001
	Gr - B	30	1.55 ± 0.02	0.003

Athletes = Gr-A, Non-Athletes = Gr-B

As the height and weight of both groups were in a selected range, so the value of BMI of both the group was 21.21 ± 0.84 kg/m^2 and 21.28 ± 0.58 kg/m^2 as mean and SD respectively and difference was not found. And the value of BSA of both groups were quite same.

Table-2: Comparison of data of direct measure anthropometric variables.

Variables	Group	N	Mean ± SD	SE_M (±)	t-ratio
Waist Circumference (cm)	Gr - A	30	69.2 ±4.3	0.78	2.09*
	Gr - B	30	71.3 ±4.02	0.72	
Hip Circumference (cm)	Gr - A	30	90.8 ±3.5	0.63	1.19^{NS}
	Gr - B	30	91.7 ±2.8	0.51	

* $t_{0.05}$ (58) = 2.00 * NS= Not Significant

The mean and SD values of waist circumference were 69.2 ± 4.3 cm for athletes and 71.3 ±4.02 cm for non-athletes groups and significant difference was prevailed ($p<0.05$) in waist circumference. The mean value of hip circumference was quite nearer to each group so, significant difference was not there.

Table - 3: Comparison of data of four direct measure skin-fold sites.

Variables	Group	N	Mean ± SD	SE_M (±)	t-test
Biceps skin-fold (mm)	Gr - A	30	5.9 ±2.1	0.39	2.91*
	Gr - B	30	7.4 ±1.6	0.29	
Triceps skin-fold (mm)	Gr - A	30	13.3 ±3.4	0.61	3.01*
	Gr - B	30	16.2 ±3.7	0.60	
Sub-scapular skin-fold (mm)	Gr - A	30	14.2 ±3.2	0.58	2.97*
	Gr - B	30	16.77 ±3.5	0.65	
Supra-spinale skin-fold (mm)	Gr - A	30	15.2 ±4.4	0.81	5.81*
	Gr - B	30	25.77 ±9.4	1.62	

* $t_{0.05}$ (58) = 2.00 *

Table -3 represent the analytical structure of four direct measure skin-fold variables. The value of mean and SD of the four sites of both the groups were: 5.9 ±2.1 mm and 7.4 ±1.6 mm for biceps, 13.3 ±3.4 mm and 16.2 ±3.7 mm for triceps, 14.2 ±3.2 mm and 16.77 ±3.5 mm for Sub-scapular and 15.2 ±4.4 mm and 25.77 ±9.4 mm for supra-spinale of athlete and non-athlete groups respectively. All the four direct measure skin-fold sites of athletes group was less in compare to their counterpart. The data of athletes group was significantly differ with the other group in all the four sites skin-fold.

Table - 4: Comparison of data of derived measure of Body Composition variables.

Variables	Group	N	Mean ± SD	SE_M (±)	t-ratio
WHR (cm)	Gr - A	30	0.75 ± 0.04	0.01	2.16^*
	Gr - B	30	0.78 ± 0.06	0.01	
%BF	Gr - A	30	26.75 ± 3.56	0.65	4.98^*
	Gr - B	30	30.85 ± 2.76	0.50	
FM (kg)	Gr - A	30	14.4 ± 2.1	0.38	4.71^*
	Gr - B	30	16.6 ±1.5	0.27	
LBM (kg)	Gr - A	30	39.45 ± 1.71	0.31	4.89^*
	Gr - B	30	37.29 ± 1.71	0.31	

* $t_{0.05}$ (58) = 2.00 *, NS= Not Significant

Table -4 represents the six derived measure body composition parameters of athletes and non-athletes The value of mean and SD of WHR was 0.75 ± 0.04 cm for athletes and 0.78 ± 0.06 cm for non-athletes group and significant difference was observed between the group at 0.05 level. The mean and SD value of body fat percentage (% BF) of the groups were 26.75 ± 3.56 and 30.85 ± 2.76 respectively and significant difference was observed in between the groups at 0.05 level. The mean and SD value of fat mass was 14.4 ± 2.1 kg for athletes and 16.6 ±1.5 kg for non-athletes group and significant difference was prevailed in fat mass between the groups. The value of lean body mass (LBM) was 39.45 ± 1.71 kg and 37.29 ± 1.71 kg as mean and SD for the two groups and significance difference was observed at 0.05 level.

Table - 5: Profile of the Athletes and Non-Athletes groups of the study

Variables	Group	Mean ±SD	Range		Percentile				
			Min	Max	5^{th}	25^{th}	50^{th}	75^{th}	95^{th}
Biceps skf (mm)	Gr -A	5.9 ±2.1	3.0	13.0	3.0	5.0	5.8	7.0	11.4
	Gr -B	7.4 ±1.6	4.5	11.0	4.8	6.0	7.5	8.3	10.5
Triceps skf (mm)	Gr -A	13.3 ±3.4	7.0	20.0	7.3	10.4	13.0	16.0	19.5
	Gr -B	16.2 ±3.7	10.0	25.0	10.6	14.0	16.0	18.3	23.9
Sub-scapular skf (mm)	Gr -A	14.2 ±3.2	9.0	22.0	9.6	11.9	14.0	16.0	20.9
	Gr -B	16.8 ±3.5	11.0	25.0	11.0	14.0	17.0	19.0	23.9
Supra-spinale skf (mm)	Gr -A	15.2 ±4.4	10.0	25.0	10.0	12.0	14.0	18.5	24.5
	Gr -B	25.8 ±9.4	10.0	45.0	11.1	19.8	25.5	32.3	45.0

% BF	Gr -A	26.8 ±3.6	20.1	35.8	20.7	23.6	27.3	29.0	33.7
	Gr -B	30.9 ±2.8	25.3	36.6	25.5	29.1	30.9	33.2	35.7
FM (kg)	Gr -A	14.4 ±2.1	10.6	19.7	10.9	12.6	14.6	15.7	18.5
	Gr -B	16.6 ±1.5	13.4	19.4	13.6	15.6	17.0	17.7	19.0
LBM (kg)	Gr -A	39.5 ±1.7	35.3	43.0	36.0	38.2	39.4	40.6	42.7
	Gr -B	37.3 ±1.7	33.6	40.3	33.9	36.6	37.4	38.3	40.2
Waist Circ (cm)	Gr -A	69.2 ±4.3	62.0	82.0	62.0	66.8	69.0	71.2	79.8
	Gr -B	71.3 ±4.0	61.0	78.0	62.7	69.0	70.5	74.1	78.0
Hip Circ (cm)	Gr -A	90.8 ±3.5	85.7	98.0	85.9	88.0	90.6	93.1	97.5
	Gr -B	91.7 ±2.8	85.0	96.0	86.1	90.0	91.5	94.1	95.7
WHR	Gr -A	0.7 ±0.04	0.7	0.8	0.7	0.7	0.7	0.8	0.8
	Gr -B	0.8 ±0.1	0.6	0.9	0.7	0.7	0.8	0.8	0.9

Athlete = Gr – A, Non-athlete = Gr- B

Table - 5 represents the mean standard deviation, range and the value of percentiles (5^{th}, 25^{th}, 50^{th}, 75^{th}, and 95^{th}) of all the direct and derived measure physical characteristics of two groups (Athletes and Non-Athletes). The profile of the subjects in all the variables has derived with the help of the degree of variability (with range and percentiles) and the centeredness of the groups in the form of mean.

IV. Discussion:

The study was conducted to examine the physical characteristics and health status of female participants of west Bengal. Sixty height-weight matched female participants, thirty athletes (Group – A) and thirty non-athletes (Group – B) were selected as the subjects. The present study do not convey the athletic and non-athletic characteristics only. The groups were selected on the basis of athletic performance as well as their non-athletic characteristics and also which was very important, i.e., height-weight range and education level of the subjects.

Body composition is an important indicator for evaluating health and nutritional status. It is a consequence of biological and non-biological factors such as genetic, processes of aging, lifestyle and socio-economic level [18,19]. So, assessment of body composition is an important and crucial aspects of human body. It could be assessed by two distinctive methods as direct and indirect. Direct method is basically lab based, expensive and time consuming whereas, indirect method is easy process- easily calculated and vastly used. Indirect methods tend to have larger predictive errors than direct methods [20]. Anthropometric measurements are the most basic indirect method of assessing body composition [21]. It describes body mass, size, shape, and level of fatness. Height is well related to wellness of population and height of athlete is significant effects on performance [22]. Body weight is the most frequently used for measuring obesity. In general, persons with high body weights typically have higher amounts of body fat. Changes in weight correspond to changes in body water, fat, and/or lean tissue. Person's body weight is highly related to stature e.g., tall people are generally heavier than short people [23]. Another aspect of body composition i.e., body mass index (BMI) which is useful also in monitoring the treatment of obesity [24].

The ratio of waist circumference to hip circumference is an index for describing adipose tissue distribution [25]. Waist circumference is considered as powerful predictor of Typ- 2 diabetes. Waist circumference greater than 102 cm for men and 88 cm for women lead to higher risk of Type-2 diabetes [26]. WHR higher than 0.9 for men and 0.8 for women have been associated with cardiovascular risk factors [27]. However, recent studies show that waist circumference has better potential than WHR for assessing health risks [28], even though there is often no significant difference between waist circumference and WHR in the accuracy of risk factor prediction. Therefore, the use of waist circumference is widely recommended in prevention and management of risk factors.

Determination of body composition from skinfold measurements is based on the fact that a large proportion of total body fat is stored directly underneath the skin. In the present study the four skinfold sites, i.e., biceps, triceps, subscapular and suprailiac- were taken to measure the % body fat. Body fat percentage and waist circumferences are very good measure of body composition of any body. Study finding revealed on anthropometric measurements [29] and body composition that the measurements were significantly different between athletes and non-athletes. The study revealed that the waist circumference, four skin-folds, waist- to-hip ratio, body fat percentage and fat masses were less in athlete group. However, the LBM of athlete group was higher than the non-athlete group. In spite of the similar height-weight, athlete group was better in the measurements related to their health condition than non-athlete group.

V. Conclusion:

From the analysis of the selected height-weight matched subjects (athlete and non-athlete of 20-25 years female groups) in regard to their anthropometric data the following conclusion were drawn.

1) Athletes were having less waist circumference, thickness of four skin-fold, waist- to- hip ratio, body fat percentage; fat mass but higher in lean body mass than the non-athletes.
2) The two groups did not differ in their hip circumference.
3) Athletes' health status was better than non-athletes according to the anthropometric measurements.

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