Original Article

Comparing the Physiological, Socio-economic and Nutritional Status among Male and Female Undergraduate College Students of Metropolitan City of Kolkata

Sengupta P

Department of Physiology, Universal College of Medical Sciences, Bhairahawa, Nepal

Address for correspondence:
Dr. Pallav Sengupta,
Department of Physiology, Universal College of Medical Sciences, Bhairahawa, Nepal.
E-mail: pallav_ucms@yahoo.com

Abstract

Background: In the present days, increasing trend of eating disorders are noticed among college students (both male and female) which can disturb their overall physiological and health status. It is more prevalent in metropolitan cities, like Kolkata. But, the existing literature about the physiological and nutritional status of the undergraduate college students of Kolkata is insufficient. **Aim:** Thus, the objective of this small-scale cross-sectional study is to report and compare the prevalence of malnutrition (both obesity and undernutrition) among undergraduate male and female college students of Kolkata, based on body mass index (BMI) and some direct and derived anthropometric measures describing the body composition of the subjects. **Subjects and Methods:** This cross-sectional study conducted in October-December 2011. The present investigation was carried out in randomly selected male (mean age 20.9 [2.25]) and female college students (mean age 20.3 [2.34]) of Kolkata. A total of 100 students of different colleges has participated, having the age of 18-22 years. Measures included a total of 24 variables which included thirteen direct anthropometric measures and 11 derived variables. **Results:** Analysis of collected data showed significantly higher BMI, fat mass, body adiposity index, but, lower waist-to-hip ratio, conicity index in female students. Anthropometric data also showed lower waist circumference and abdominal extension in female college students. Conversely, male students showed a higher fat free mass (FFM), mid-upper arm circumference (MUAC) and thigh circumferences (TCs). **Conclusion:** Based on the findings of the present study, it can be reported that higher body fat distribution and increased propensity of being overweight/obese was observed in female students, though they have shown lower abdominal fat distribution, which is a cue of female physical attractiveness. However, male students are found to have a higher FFM, MUAC and TCs, which is the indicator of strength and energy.

Keywords: Anthropometry, Body mass index, Conicity index, Obesity, Waist-to-hip ratio

Introduction

Anthropometric data is a collection of the dimensions of the human body and are useful for apparel sizing, forensics, physical anthropology and ergonomic design of the workplace.[1] Reliable anthropometric data for a target population are necessary when designing for that population.[1] Jung and Jung surveyed different dimensions and characteristics of different populations and found that age, gender and ethnic characters were determinants of physical dimensions.[2]

It is also widely accepted that, for practical purposes, anthropometry is the most useful tool for assessing the nutritional status of a population. There are many anthropometric indicators in use, such as mid-upper arm circumference (MUAC), body mass index (BMI) of Quetlet.[3] Malnutrition in women and men can result in reduced productivity, slow

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recovery from illnesses, increased susceptibility to infections and a heightened risk of adverse pregnancy outcomes.[1] Female nutritional status with reference to body composition are well-documented in numerous reports. A woman's nutritional status has important implications for her health as well as the health of her children. A woman with poor nutritional status, as indicated by a low BMI, short stature, or other micronutrient deficiencies, have a greater risk of obstructed labor, having adverse pregnancy outcomes, producing lower quality breast milk, death due to postpartum hemorrhage.[1,2] Malnutrition is one of the most devastating problems world-wide and is inextricably linked with poverty. Malnutrition among women has long been recognized as a serious problem in India, but national-level data on levels and causes of malnutrition have been scarce.[4] Conversely, reports on male obesity and malnutrition are scanty. But, male undernutrition can result in infertility and reproductive problems along with reduced physical fitness and thus, cut productivity in the workplace.[1]

Body composition along with morphometric characters are useful measures of nutritional status of a population. In general, the composition of the human body is assessed to determine percentage of body fat (PBF). However, it is now clear that in addition to the amount of fat in the body, its topography particularly the abdominal fat deposition is considered to be the most atherogenic, diabetogenic and hypertensiogenic fat deposition of the human body.[5] The three most commonly used measures of abdominal or central adiposity are waist circumference (WC), waist-to-hip ratio (WHR) and BMI. These parameters have been utilized in recent investigations to study abdominal or central adiposity.[6,7] Recent studies have also reported that central as well as subcutaneous adiposity is associated with body composition measures like PBF and fat mass (FM).[8,9] The present investigation was therefore undertaken to investigate the relationship of various anthropometric measures with body composition variables among college students of Kolkata, India.

Subjects and Methods

Participants

In this cross-sectional study (carried out during October-December, 2011) two different groups of male and female ($n = 50$) subjects between 18 and 22 years of age were randomly selected to participate. Subjects were undergraduate students of different colleges of Kolkata. Subjects were instructed to take their last meal at least 2 h before conducting the test in order to avoid the specific dynamic action of food. All the experiments were carried out and measurements were taken at a temperature of 20-25°C and relative humidity of about 45-50% in winter season in India, to avoid the seasonal influence on fitness pattern. The entire experimental protocol was explained to them to allay their apprehensions. Consent from each participant was taken for conducting the study and the experiments were carried out following Institutional ethical permission. To minimize the experimenter bias each measurement was taken three times and the mean was represented as the final result. Subjects with any type of disease, especially cardiac and respiratory ailments, under medication or any supplement were excluded. Normal healthy randomly selected subjects who are residents of Kolkata of the above mentioned sex and age group are included in this study. Each subject was given sufficient rest before each experiment to get accurate results.

Socioeconomic status

SES of the students was carried out by questionnaire method. Their family income, educational status, family type etc., were recorded to assess their SES.[1]

Assessment BMI

The BMI of Quetelet is the statistical measure which compares a person's weight and height by the following formula:[10,11] BMI (kg/m^2) = mass (kg)/(Height in m)^2. The World Health Organization (WHO)[12] regard a BMI of <18.5 kg/m^2 as underweight and may indicate malnutrition, an eating disorder, or other health problems, whereas a BMI >25 kg/m^2 is considered overweight and above 30 kg/m^2 is considered obese.

Measurement of PBF

Body fat can be estimated from the BMI. There is a linear relationship between densitometrically-determined PBF and BMI, taking age and gender into account. Based on the following, prediction formulas have been derived which showed a valid estimate of body fat at all ages, in males and females. However, in obese subjects the prediction formulas are slightly overestimated. The prediction error is comparable to other methods of estimating PBF, such as skinfold thickness measurements or bioelectrical impedance.[13-15] The following formula (10) to predict PBF is based on current BMI, age and gender: PBF = (1.20 × BMI) + (0.23 × Age) − (10.8 × gender) −5.4, where gender values for male is 1 and female is 0.[13]

Determination of body surface area

BSA is the measured or calculated surface of a body. Various calculations have been published to arrive at the BSA without direct measurement. Banerjee and Sen formula was used for estimating body surface BSA.[16]

Anthropometry

A total of twenty four metric measurements was taken for each subject including direct and derived anthropometric and physiological variables. The anthropometric measurements taken for each subject were: Height, weight, eye height standing, elbow rest height standing, abdominal extension, sitting height, knee height, buttock-to-knee length and five circumferences, i.e., MUAC, thigh circumferences (TCs), calf circumferences, minimum WC and maximum hip (BC). 11 derived variables: BSA, BMI, body adiposity index (BAI), FM, fat mass index (FMI), fat free mass (FFM), fat free mass index, waist-to-height ratio, WHR, MUAC-to-height ratio and Conicity index (C-index) were included. All anthropometric

measurements were made by using the standard anthropometric techniques as proposed by Lohman *et al.*[17] All the derived variables were computed using standard equations.[18]

Nutritional assessment

Nutritional status of students was carried out by dietary survey following an interactive 24 h recall method to gauge a typical day's actual intake. By questionnaire subjects were asked for the volume of food, preparation of food and time of consumption. From this data cooked and raw foods were separated and different nutrients according to their calorific value and other factors were determined.[1]

Statistical analysis

Results were expressed as mean (standard deviation). If differences between groups were established, the values of the treated groups were compared with those of the control group by a modified *t*-test. To carry out the analysis of the data statistically SPSS version 15.0, IBM Corporation and MS-Excel version 2013 (Microsoft Office, 2013) were used. A value of $P < 0.05$ was interpreted as statistically significant.[19]

Results

The SES of the studied population showed that most of them are unmarried (88%. *i.e.,* 44/50) and the average monthly income of the families of the subjects was about 10,000-30,000 rupees which indicate they basically belong to middle income group and most of the families are nuclear family (64%). Most of the parents are educated enough to take care of their child's health [Table 1]. These data are almost similar both in boys and girls.

The direct and derived anthropometric parameters that indicate the prevalence of obesity and malnutrition of the studied population based on PBF, WC and WHR are presented in Table 2. It also represents comparative aspects of physical variables (BSA and BMI). The results though indicate lower body weight in female students than in males ($P < 0.05$), the fat distribution in quite higher in females. It could be observed that, PBF, FM, FMI and BAI were significantly higher in female students, which indicate increased propensity of being obese. Their BMI values were also significantly higher than male students.

The frequency of overweight and underweight students (both male and female) is presented in Table 3. The overall prevalence of obesity (BMI > 30.00) was almost absent in the studied sample, but the frequency of overweight (BMI: 25.0-29.9) was higher in females (27.88% i.e., 7/50) than in males (9.09% i.e., 2/50). However, most of the student population was found to have normal range of body weight, on the basis of BMI. It may be noted that this estimation is based on an indirect technique, i.e., anthropometry and international classification of BMI cutoff points.[12]

Based on the data of the interactive dietary survey, nutritional assessment of college students was done. It has been found that boys are deficient in vitamin C, while girl students are deficient in vitamin A, vitamin C and iron. But they consume more fat than their recommended dietary allowance (RDA)

Table 1: Socio-economic status of male and female college students

Parameters	*n* (%)	
	Male (*n*=50)	Female (*n*=50)
Father's education level		
Nil	0	0
Up to class 10	6 (12.0)	7 (14.0)
Up to higher secondary	10 (20.0)	8 (16.0)
Graduation or post-graduation	34 (68.0)	35 (70.0)
Mother's education level		
Nil	0	0
Up to class 10	8 (16.0)	7 (14.0)
Up to higher secondary	15 (30.0)	14 (28.0)
Graduation or post-graduation	27 (54.0)	29 (58.0)
Monthly income (Rs.)		
<10,000	6 (12.0)	8 (16.0)
10,000-30,000	37 (74.0)	35 (70.0)
>30,000	7 (14.0)	7 (14.0)
Marital status		
Married	0	6 (12.0)
Unmarried	50 (100.0)	44 (88.0)
Family type		
Nuclear family	36 (72.0)	32 (64.0)
Extended family	14 (28.0)	18 (36.0)

Table 2: Comparison of body composition anthropometrics (derived variables) of male (*n*=50) and female (*n*=50) college students

Variables	Male		Female		*P* value
	Mean	SD	Mean	SD	
Age (years)	20.9	2.25	20.3^{NS}	2.34	0.10
Physical parameters					
Height (cm)	166.6	7.21	153.2*	4.23	0.03
Weight (kg)	59.3	7.50	54.9*	5.14	0.04
BSA (m^2)	1.70	0.18	1.48*	0.27	0.02
BMI (kg/m^2)	21.9	2.49	23.2^{NS}	3.03	0.06
Adiposity measures					
PBF (%)	20.5	1.73	26.1†	2.70	0.04
FM (kg)	12.1	3.88	14.3†	4.18	0.03
FMI (kg/m^2)	4.48	1.76	6.09†	1.88	0.02
FFM (kg)	47.1	4.25	40.6†	4.08	0.02
FFMI (kg/m^2)	17.40	1.84	17.29^{NS}	1.68	0.08
BAI	30.01	4.44	34.08†	5.46	0.04
WHR	0.92	0.02	0.87^{NS}	0.02	0.09
WHTR	0.46	0.02	0.45^{NS}	0.01	0.54
MUAC-for-height	0.16	0.01	0.14^{NS}	0.01	0.48
C-index	1.16	0.09	1.07†	0.06	0.03

Values bearing superscripts (*,†) are significantly different. NS: Not significant, BSA: Body surface area, BMI: Body mass index, PBF: Percentage of body fat, FM: Fat mass, FMI: Fat mass index, FFM: Fat free mass, FFMI: Fat free mass index, BAI: Body adiposity index, WHR: Waist-to-hip ratio, WHTR: Waist-to-height ratio, C-index: Conicity index, MUAC: Mean upper arm circumference, SD: Standard deviation, MUAC: Mid-upper arm circumference

recommends [Table 4], especially girls who consume almost double fat of their recommended value.

Discussion

BMI is considered as a better index for assessing obesity, because it does away with the need of height-weight tables and is independent of type of obesity frame and it can be used to estimate the prevalence of obesity within a population.[20] Therefore in the present study, the body composition of the undergraduate college students was calculated according to critical limits of BMI as recommended by WHO.[20] Table 2 shows various physical parameters and obesity indicators; female students have a lower BSA because they have lower stature than male students. They also showed significantly higher PBF, FM, FMI and BAI, which are indicators of their higher fat distribution. Conversely, they showed significantly lower FFM and C-index which revealed lower abdominal fat and muscle mass distribution. Simultaneously, these results indicate higher overall fat distribution in females, though, they have lower fat distribution in their abdominal regions.

Table 3 presents the distribution of subjects according to BMI classification. Though it that most of the subjects have a normal BMI (in average 86.00% i.e., 86/100), the results indicated a higher propensity of being obese was observed in females. Among undergraduate female students, 14% (i.e., 7/50) were overweight (24.9-29.9) and also showed higher mean BMI value than the male counterparts. The results of female students also indicated an important trend, that as they get older, they gain more weight, which is reflected in age-wise BMI distribution of students [Table 3]. In this present study, it was found that the females in the age group of 20-22 years have a higher number of overweight students than those in the 18-20 years age group. It has been observed in earlier studies that Bengalee/Hindu females of Kolkata, gain more weight and becomes obese as they become aged.[21] They rank third in the prevalence of obesity in India, after Uttar Pradesh and Jammu and Kashmir.[21] While comparing the present data with other populations of India, it is apparent that the prevalence rate of overweight/obesity seen in the present study shows the similar trend with other Indian studies which have also shown a high prevalence of overweight and obesity. Gopinath *et al*.[22] studied urban women of Delhi and reported the prevalence rate of obesity as 33.4%. Rao *et al*.[23] studied females belonging to high SES of Hyderabad and reported the prevalence rate of obesity as 36.3%. The nutrition Foundation of India has just completed a study on the prevalence of obesity in urban Delhi and has reported the prevalence rate of overweight (BMI 25+) and obesity (BMI >30) as 50% and 14% respectively.[24]

Among male students, only 4% (i.e., 2/50) of the students were found to be overweight. Conversely, they showed a higher degree of undernutrion (8.00%) as found on the basis of BMI. But, it could be due to their young age, thus tends to be leaner than obese.

Overweight and obesity have been found to be associated with many diseases particularly heart disease, type 2 diabetes and osteoarthritis.[25] The prevention and control of this problem must, therefore, claim priority attention. Therefore, appropriate precautionary measures have to be taken to prevent further

Table 3: Distribution of BMI and prevalence of malnutrition and obesity among undergraduate college students of Kolkata, both male (*n*=50) and female (*n*=50)

Age (in years)	Sample size	Obese (BMI>30)	Overweight (BMI 24.9-29.9)	Normal (BMI 18.5-24.9)	Underweight (BMI<18.5)
Males (*n*=50)					
18-20	22 (44.00)	0 (0.00)	2 (9.09)	18 (81.81)	2 (9.09)
20-22	28 (56.00)	0 (0.00)	0 (0.00)	26 (92.85)	2 (7.14)
Females (*n*=50)					
18-20	24 (48.00)	0 (0.00)	3 (12.50)	20 (83.33)	1 (4.16)
20-22	26 (52.00)	0 (0.00)	4 (15.38)	22 (84.61)	0 (0.00)

Figures in parenthesis indicates percentages. BMI: Body mass index

Table 4: Nutrient intake of college students of Kolkata (18-22 years)

Nutrients[#]	Males students			Female students		
	Nutrients intake	Recommended intake[†]	Percentage of the recommended intake	Nutrients intake	Recommended intake[†]	Percentage of the recommended intake
Energy (Kcal)	2414.1	2875.0	83.9	1525.0	1800.1	84.7
Protein (g)	56.6	60.0	94.3	39.1	42.0	93.1
Fat (g)	24.4	20.0	122.0	39.6	20.0	198.0
Iron (mg)	21.8	28.0	77.8	9.5	28.0	34.0
Vitamin A (IU)	2415.0	3000.0	80.5	1118.8	2984.0	37.5
Thiamin (mg)	1.2	1.2	100.0	1.2	0.9	132.2
Riboflavin (mg)	1.4	1.3	107.6	0.5	1.2	43.3
Vitamin C (mg)	40.0	90.0	44.4	24.6	30.0	82.0

[#]Mean values of per day intake is represented in each column, [†]NAS dietary reference intakes. IU: International unit, NAS: National Academy of Sciences

progression of the problem into the young population. Because, if the present trends of overweight/obesity continue, the situation can get as worse as to be the single most important public health problem in adults in future.

Morphometric analysis of the body is virtually the investigation of the process of life which reflects the general health status of an individual. From the public health point-of-view, anthropometry is the most valid measure for the identification of subclinical forms of malnutrition.[26] Various direct and derived anthropometric indices including BMI and body circumferences, are available those play an important role in predicting the health status of an individual. In this present study, significantly lower stature, eye height, acromial height, elbow rest height, abdominal extension and the mean upper arm, TC and WCs were found in female students ($P < 0.05$). Lower WC and abdominal extension reflects lower abdominal fat distribution in females, which has again reflected in WHR. Among WC and WHR, WC is considered to be a better index for fat location than WHR for predicting lipid profile in adult women.[27] However, it is a well-known fact that BMI also has a negative correlation with WHR, as reflected in our study, which is very much important in case of women, because, this interrelation is a cue to the female physical attractiveness and the beauty of women.[28-30]

On the other hand, it is well-known that MUAC is an estimate of energy storage and protein mass of the body which is an indirect estimate of strength,[31] which has found to be higher in male students. As the studied population is comprised young adults, they also showed expected higher values in MUAC and TC, which are also indicative of distribution of muscle mass.

A potential limitation of this data is that the population of undergraduate students in our study was limited and may not be generalized. Further investigations are necessary to have a generalized view of nutritional status of undergraduate students of Kolkata.

The present article also reports nutritional status of fifty age-matched young adults of Kolkata, as found in dietary survey. It has been found that young Calcuttans are lacking in energy intake, but they consume more fat than the RDA. These data support their BMI values, especially in girls among which tendency of being overweight is noticeable. They also lack sufficient protein in their diet, but, more fat consumption was observed in interactive 24 h recall method, as mentioned earlier. They also deficient in iron, vitamin A and vitamin C in diet. Vitamin C, which is beneficial for endurance and better physical performance, was also found to be inadequate in the diet of the students. Conversely, dietary intake of Vitamin B_1 (thiamin) and Vitamin B_2 (riboflavin) were found to be sufficient in boys (girls also lack riboflavin) which may be correlated to their better physical fitness level, because these vitamins play a major role in maintaining muscle strength and endurance.

Conclusion

The present study revealed that young female undergraduate students have more propensity toward being overweight than the male students. Thus, some precautionary measures must be taken to prevent the spread of this health problem among adults and have to stop of being the single most important public health problem.

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