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Original Research Article

Anthropometric measures in Bangladeshi schoolchildren to determine body composition and nutritional status: a descriptive cross-sectional study

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ABSTRACT

Background: The development of improved health and nutrition in adulthood is significantly influenced by early nutrition. It is, however, almost ever investigated how to determine the nutritional condition of Bangladeshi children using anthropometric measurements including height, weight, biepicondylar width of the humerus and femur, BMI, and BSA.

Methods: A descriptive cross-sectional study was conducted among 400 government elementary school students aged between 9 and 12 years in Dhaka, Bangladesh. Data was collected using a semi-structured questionnaire and analyzed using SPSS.

Results: For the B1 and B2 groups, heights ranged from 124.00 to 151.00 cm and 129.00 to 157.00 cm, respectively. Height ranges for the C1 and C2 groups were respectively 129.50-153.00 cm and 129.00-160.00 cm. The B2 study group had a greater weight than the B1 study group ($p<0.001$), where C2 was heavier than the C1 research group ($p<0.001$). The A1 study group's biepicondylar width of the humerus was greater than the A2 study group's ($p<0.05$) and biepicondylar humerus width was greater in the B2 study group compared to the B1 study group ($p<0.05$). On the other hand, the B1 study group's biepicondylar femur width was higher than the B2 study group ($p<0.05$). The B2 group's body surface area was larger than the B1 study group's ($p<0.001$) and body surface area of C2 group was greater than C1 study group ($p<0.001$).

Conclusions: Analyses of body composition and anthropometric measurements suggest that children and adolescents' nutritional status was below the reference requirement, according to the results of the current study.

Keywords: Anthropometry, Nutritional status, Children, School health, Bangladesh

INTRODUCTION

Anthropometry has a long history of measuring individuals' nutritional and health condition since it is a low-cost, non-invasive technology that offers extensive information on various body structure components, particularly muscle and fat components.[1,2] Furthermore, anthropometric measures are very sensitive to a wide range of nutritional status, whereas biochemical and clinical indicators are only relevant in cases of severe malnutrition. Body mass index (BMI) and mid-upper-arm-circumference (MUAC) are the most important and trustworthy of the regularly used anthropometric measures.[1] Anthropometry is the science of measuring the human body in respect of bone, muscle, and adipose tissue measurements.[3] In a word, it is a scientific discipline that deals with the measuring of the human body.[3] Anthropometric measurements include weight, height (standing height), recumbent length, skinfold thickness, circumferences (head, waist, limbs, etc.), limb lengths, and breadths (shoulder, wrist, etc.).[3] Anthropometric measures may be used to calculate a variety of indices and ratios. The body mass index, or "BMI," is perhaps the most well-known metric of body fatness and is widely regarded as a reliable metric for determining chronic energy shortage in people, particularly in underdeveloped nations.[1,3] It has a strong relationship with fat and fat-free mass, therefore it may be used to assess the body's protein and fat stores.[1] The ratio is roughly constant in normal individuals, and someone with a low BMI is underweight for their height.[1] However, there are several drawbacks to relying just on BMI; for example, the ratio of sitting to standing height or the cormic index might affect BMI.[4] The cormic index varies across and among populations.[5] As a result, without using the cormic index as a correction factor, the sensitivity and specificity of BMI as a nutrition indicator may be poor. Because humans tend to lose fat free mass and gain fat mass as they get older, ageing can affect the functional importance of BMI at various ages.[5-7] The importance of BMI can also be influenced by oedema. When adults are extremely undernourished, they may develop oedema, which falsely raises their weight, making their BMI look more normal than it is.[8] Furthermore, the BMI's universal cut-off cannot be used across diverse populations.[9] As a result, BMI's use as an accurate screening tool for assessing adult undernutrition is limited.[1] Body surface area was designed as a metric for modulating different pharmacological therapies as well as a standard tool for indexing various physiologic parameters including glomerular filtration rate and cardiac output.[10] There are several methods for calculating an individual's body surface area (BSA), but the Du Bois and Du Bois formula is one of the most regularly used.[11] The following is the formula:

$$Body\ surface\ area\ (BSA) = 0.007184 x Height(m)^\wedge 0.725 x Weight(kg)^\wedge 0.425$$

Many different formula are utilised in the computation of body surface area, which is a major source of worry [12]. As a result, certain equations may provide drastically different answers than others.[12] This is a considerable difficulty in the clinical setting.[12] Many drugs, for example, employ body surface area to determine dosage regimens to ensure the medication's therapeutic window is maintained and side effects are avoided.[12] Significant differences in body surface area estimations may result in either overdosing or underdosing, as well as failure to achieve the drug's intended results.[12] Body surface area can also be used to determine the severity of burn injuries.[13] To adequately stratify the severity of a patient's burn injuries and guide their therapy, it's critical to precisely measure the proportion of total body surface area that has been burned.[13] Body surface area can be used to compute physiologic data in part.[11] Furthermore, clinical tools such as nomograms employ the patient's height and weight, which are graphically shown, to compute the patient's body surface area.[11] There is limited study specifically looking at anthropometric measurements including height, weight, biepicondylar breadth of the humerus and femur, BMI, and BSA, despite the fact that anthropometric measurements are often used to assess nutritional status across the world, including Bangladesh. Therefore, the purpose of this study was to determine whether primary school pupils had the aforementioned anthropometric measures.

METHODS

Participants and study site

The present study was carried out on 400 government elementary school students in Dhaka aged between 9 and 12 years and the students in this age group ranged from class III to class V. Both boys and girls are included in this study. They were grouped as A1, A2, B1, B2, C1 and C2; Group A1=Boys of 9-10 years of age, Group A2=Girls of 9-10 years of age, Group B1= Boys of 10-11 years of age, Group B2=Girls of 10-11 years of age, Group C1=Boys of 11-12 years of age and Group C2=Girls of 11-12 years of age. Four government elementary schools in the Dhaka district were chosen purposefully.

Study design and sampling technique

A descriptive cross-sectional study was conducted among schoolchildren from January 2012 to December 2012 and a convenience sampling procedure was used to get the needed sample. Among the total of 580 students, 400 students participated in the present study. Thus, the response rate was 68.97%. Only the students aged between 7 and 15 years and without any disabilities or chronic conditions were included in the study.

Research instrument and research tool

Data was collected using a semi-structured questionnaire. This questionnaire was adapted from earlier research and modified to fit the needs and circumstances of the study location. The developed tool was pretested with 20 students to test the feasibility of the proposed study.

Interview procedure

Students were contacted in their classroom before or after lectures for data collection after obtaining students' assent and parental or legal guardian consent. Study objectives was explained before data collection.

Anthropometric measurements

Anthropometric measurements were taken following standard protocol and instrument [14]. The height of the body was measured by stadiometer in centimeters (cm) and the weight was measured by weighing scale in kilogram (kg). Biepicondylar breadth of the humerus and femur was measured by a digital slide caliper in centimeters (cm). Biepicondylar breadth of the humerus was determined by measuring the distance between the medial and lateral epicondyles of the humerus, with the shoulder and elbow flexed to 90 degrees and biepicondylar breadth of the femur was determined by measuring the greatest distance between the lateral and medial epicondyles of the femur. Body Mass Index (BMI) has been calculated using the formula mentioned below and body surface area was calculated by following Du Bois's formula as mentioned in introduction section.

$$BMI = weight\ in\ Kg/(height\ in\ meter)^2$$

Statistical analysis

All data were checked and edited after collection. Later on, the data were inputted and analyzed using SPSS version 17.0 for windows. Statistical analyses were done by unpaired student's 't' test.

RESULTS

Height and weight of students

The height status of students of selected Government primary schools is depicted in (Table 1). Groups A1 and A2 had heights ranging from 125.00 to 144.00 cm and 122.00 to 154.00 cm, respectively, with mean (±SD) heights of 135.01±3.70 cm and 133.43±6.62 cm. There was no statistically significant difference in height between the A1 and A2 research groups (p=0.088). B1 and B2 groups' heights varied from 124.00 to 151.00 cm and 129.00 to 157.00 cm, respectively, with mean (±SD) heights of 136.89±5.04 cm and 141.89±6.64 cm. The B2 study group was taller than the B1 study group. There was a statistically significant difference in height between the B1 and B2 research groups (p<0.001). C1 and C2 groups had heights ranging from 129.50-153.00 cm and 129.00-160.00 cm, respectively, with mean (±SD) heights of 140.70±5.24 cm and 145.42±5.86 cm. C2 had a higher height than the C1 research group (p<0.001). The weight status of students of selected Government primary schools is depicted in (Table 2). Groups A1 and A2 had weights ranging from 20.00-31.00 kg and 18.00-39.00 kg, respectively, with mean (±SD) weights of 24.88±2.27 kg and 24.65±3.39 kg. There was no statistically significant difference in weight between the A1 and A2 research groups (p=0.635). B1 and B2 groups had weights ranging from 20.00-37.00 kg and 20.00-49.00 kg, respectively, with mean (±SD) weights of 26.14±3.57 kg and 29.49±5.78 kg. The weight of the B2 study group was higher than that of the B1 study group (p<0.001). C1 and C2 groups had weights ranging from 22.00-40.00 kg and 22.00-50.00 kg, with mean (±SD) weights of 28.39±3.54 kg and 32.90±6.04 kg, respectively. C2 had a higher weight than the C1 study group (p<0.001).

Table 1: Height status of government primary school students (n=400).

Group	Gender	N	Height in cm (Mean±SD)	P value
Group A1	Boys	68	135.01±3.70	0.088
Group A2	Girls	68	133.43±6.62	
Group B1	Boys	66	136.89±5.04	<0.001
Group B2	Girls	66	141.89±6.64	
Group C1	Boys	66	140.70±5.24	<0.001
Group C2	Girls	66	145.42±5.86	

Table 2: Weight status of government primary school students (n=400).

Group	Gender	N	Weight in kg (Mean±SD)	P value
Group A1	Boys	68	24.88±2.27	0.635
Group A2	Girls	68	24.65±3.39	
Group B1	Boys	66	26.14±3.57	<0.001
Group B2	Girls	66	29.49±5.78	
Group C1	Boys	66	28.39±3.54	<0.001
Group C2	Girls	66	32.90±6.04	

Biepicondylar breadth of humerus and femur of government primary school students

The biepicondylar breadth of humerus and femur of selected Government primary school students is depicted in (Table 3).

Table 3: Biepicondylar breadth of humerus and femur of boys and girls of government primary school (n=400).

Groups	Gender	N	Biepicondylar breadth (cm)	
			Humerus (Mean±SD)	Femur (Mean±SD)
Group A1	Boys	68	5.11±0.39	7.40±0.43
Group A2	Girls	68	4.93±0.52	7.30±0.52
P value			0.023	0.217
Group B1	Boys	66	5.12±0.40	7.72±0.53
Group B2	Girls	66	5.30±0.53	7.52±0.53
P value			0.032	0.035
Group C1	Boys	66	5.52±0.39	8.02±0.53
Group C2	Girls	66	5.46±0.61	7.83±0.56
P value			0.567	0.550

Biepicondylar humerus breadths of A1 and A2 groups varied from 4.20-7.10 cm and 3.80-6.20 cm, respectively, and the mean (±SD) biepicondylar humerus breadth were 5.11±0.39 cm and 4.93±0.52 cm. The biepicondylar breadth of the humerus in the A1 study group was higher than the A2 study group ($p<0.05$). Biepicondylar humerus breadths of B1 and B2 groups varied from 4.00-6.20 cm and 4.00-6.90 cm, respectively, and the mean (±SD) biepicondylar humerus width were 5.12±0.40 cm and 5.30±0.53 cm. The B2 study group's biepicondylar humerus width was higher than the B1 study group ($p<0.05$).

Table 4: Body mass index (BMI) of boys and girls of government primary school (n=400).

Group	Gender	N	Body mass index kg/m^2 (Mean±SD)	P value
Group A1	Boys	68	13.66±1.09	0.517
Group A2	Girls	68	13.80±1.34	
Group B1	Boys	66	13.92±1.51	0.033
Group B2	Girls	66	14.65±2.26	
Group C1	Boys	66	14.29±1.28	<0.001
Group C2	Girls	66	15.57±2.42	

The mean (±SD) biepicondylar width of the humerus in C1 and C2 groups were 5.52±0.39 cm and 5.46±0.61 cm respectively. Between the C1 and C2 study groups, there was no significant difference in biepicondylar humeral widths ($p=0.567$). Biepicondylar breadth of femur of A1 and A2 groups ranged from 6.30-8.20 cm and 6.20-8.50 cm, respectively. The mean (±SD) biepicondylar width of femur in A1 and A2 groups were 7.40±0.43 cm and 7.30±0.52 cm, respectively. The biepicondylar width of the femur between A1 and A2 groups was not significantly different ($p=0.217$). Biepicondylar femur breadths of B1 and B2 groups varied from 6.10-9.70 cm and 5.30-8.80 cm, respectively, and the mean (±SD) biepicondylar femur breadth were 7.72±0.53 cm and 7.52±0.53 cm. The B1 study group's biepicondylar femur width was higher than the B2 study group ($p<0.05$). The mean (±SD) biepicondylar breadth of femur in C1 and C2 groups were 8.02±0.53 cm and 7.83±0.56 cm, respectively. There was no significant difference in biepicondylar femur breadth between the C1 and C2 research groups ($p=0.55$).

Body mass index (BMI) of boys and girls of government primary school

Body mass index of A1 and A2 groups ranged from 11.60-16.60 kg/m^2 and 10.90-17.60 kg/m^2, respectively and the mean (±SD) BMI were 13.66±1.09 kg/m^2 and 13.80±1.34 kg/m^2, respectively. No significant difference in BMI was observed between A1 and A2 study groups ($p=0.517$). The BMI of B1 and B2 groups ranged from 10.40-18.30 kg/m^2 and 10.70-22.60 kg/m^2, respectively and the mean (±SD) body mass index were 13.92±1.51 kg/m^2 and 14.65±2.26 kg/m^2, respectively. Body mass index of B2 was greater than B1 study group ($p<0.05$). Body mass index of C1 and C2 groups ranged from 12.30-18.00 kg/m^2 and 11.10-23.10 kg/m^2, respectively and the mean (±SD) body mass index were 14.29±1.28 kg/m^2 and 15.57±2.42 kg/m^2, respectively. The BMI of C2 was greater than C1 study group ($p<0.001$).

Body surface area (BSA) of boys and girls of government primary school

Body surface area of A1 and A2 groups ranged from 0.87-1.13 m^2 and 0.84-1.31 m^2, respectively and the mean (±SD) body surface area were 0.99±0.05 m^2 and 0.97±0.08 m^2, respectively. No significant difference in body surface area was observed between A1 and A2 study groups ($p=0.264$). The BSA of B1 and B2 groups ranged from 0.89-1.25 m^2 and 0.89-1.41 m^2, respectively and the mean (±SD) body surface area were 1.02±0.08 m^2 and 1.10±0.12 m^2, respectively. Body surface area of B2 group was greater than B1 study group ($p<0.001$). The BSA of C1 and C2 was ranged from 0.91-1.30 m^2 and 0.97-1.47 m^2, respectively and the mean (±SD) body surface area were 1.07±0.08 m^2 and 1.17±0.11 m^2, respectively. Body surface area of C2 group was greater than C1 study group ($p<0.001$).

Table 5: Body surface area of boys and girls of Government primary school (n=400).

Group	Gender	N	Body surface area (m^2) (Mean±SD)	P value
Group A1	Boys	68	0.99±0.05	0.264
Group A2	Girls	68	0.97±0.08	
Group B1	Boys	66	1.02±0.08	<0.001
Group B2	Girls	66	1.10±0.12	
Group C1	Boys	66	1.07±0.08	<0.001
Group C2	Girls	66	1.17±0.11	

DISCUSSION

An anthropometric examination of nutritional status was done in the current study. A cohort of children (9-12 years old) from four public primary schools in the city of Dhaka that was diverse in terms of gender, family income, and age was specially chosen. Boys and girls between the ages of 9 and 10 had mean heights of 135.01±3.70 cm for boys and 133.43±6.62 cm for girls, respectively. Boys and girls between the ages of 9 and 10 differed in height. There was little to no height variation between the two research groups. Boys and girls between the ages of 10 and 11 had mean heights of 136.89±5.04 cm and 141.89±6.64 cm, respectively. Girls aged 10-11 were taller than males aged 10–11 in this age range. The two research groups' disparities in height were statistically different. Boys and girls between the ages of 11 and 12 had mean heights of 140.70±5.24 cm and 145.42±5.86 cm, respectively. Girls and boys between the ages of 11 and 12 were statistically significantly different in terms of height. Boys and girls between the ages of 9 and 10 had mean weights of 24.88±2.27 kg and 24.65±3.39 kg, respectively. The two groups did not differ significantly from one another. Boys and girls between the ages of 10 and 11 had mean weights of 26.14±3.57 kg and 29.49±5.78 kg, respectively. The average body weight of 10-11 years old girls was higher than that of 10–11–year-old boys. Boys and girls between the ages of 11 and 12 had mean weights of 28.39±3.54 kg and 32.90±6.04 kg, respectively. The average body weight of 11-12 years old girls was higher than that of 11-12 years old boys. Boys aged 9 to 10 had a mean biepicondylar humerus breadth of 5.11±0.39 cm, whereas females aged 9 to 10 had a mean value of 4.93±0.52 cm. Between the two groups, there was a significant difference. The mean biepicondylar humerus breadth for boys and girls aged 10 to 11 was 5.12±0.40 cm and 5.30±0.53 cm, respectively. Girls at 10-11 years had wider biepicondylar humerus than males aged 10–11 years. There was a statistically significant difference here. Between 11-12 years old boys and girls, there was no significant difference in biepicondylar humeral breadth.

Boys and girls between the ages of 9 and 10 had biepicondylar femur widths that were 7.40±0.43 cm and 7.30±0.52 cm, respectively, on average. This discrepancy wasn't significant. Boys and girls between the ages of 10 and 11 had mean biepicondylar femur breadths of 7.72±0.53 cm and 7.52±0.53 cm, respectively. The statistical significance of this discrepancy was discovered. Boys and girls aged 11 to 12 had mean biepicondylar breadths of the femur of 8.02±0.53 cm and 7.83±0.56 cm, respectively. This distinction was not determined to be significant. Body mass index values for boys and girls aged 9 to 10 were 13.66±1.09 and 13.80±1.34 kg/m^2, respectively, in the current study. There was no statistically significant difference between the two groups. Boys and girls aged 10 to 11 had mean body mass indices of 13.92±1.51 kg/m^2 and 14.65±2.26 kg/m^2, respectively. Statistics showed that this difference was not significant. Boys and girls between the ages of 11 and 12 had mean BMIs of 14.29±1.28 kg/m^2 and 15.57±2.42 kg/m^2, respectively. BMI values were higher in girls than boys and increased as the age of the participants increased.

The BMI values for different age categories in the present study were smaller than similar studies conducted in Bangladesh and India.[15,16] Observed results were found to be similar in a study conducted among vegetarian and non-vegetarian Nepalese children.[17] According to World Health Organization's (WHO) growth reference for 5-19 years, the students participated in the present study found to be underweight. Boys and girls aged 9 to 10 had computed mean body surface areas of 0.99±0.05 m^2 and 0.97±0.08 m^2, respectively. There was no connection between the two groups. Boys and girls between the ages of 10 and 11 had mean BSAs of 1.02±0.08 m^2 and 1.10±0.12 m^2, respectively. This variation was statistically noteworthy. Boys and girls between the ages of 11 and 12 had mean BSAs of 1.07±0.08 m^2 and 1.17±0.11 m^2, respectively. Additionally, this distinction was statistically significant.

Limitations

The present study has certain limitations. Firstly, no information was collected on parental education or income, and lifestyle-related variables. Hence, it was not possible to explore the socioeconomic status and dietary habits or physical activity behavior of children. Secondly, data were collected from students of four schools in the Dhaka district. Hence, the present results might not be generalizable to all schoolchildren in Bangladesh.

CONCLUSION

According to anthropometric measurements and analyses of body composition, the present study findings indicate that the nutritional status of children was below the reference criterion. It could be beneficial to conduct more research with a larger sample size and a proportionate number of samples from various categorical variables in order to comprehend the children's nutritional status and its predictive factors.

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