Growth and Nutritional Status among Pre-adolescent and adolescent Bengali boys and girls in North 24 Parganas, West Bengal, India

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ABSTRACT: *The aim of this paper is to examine the physical growth of the study population as well as to assess the level of malnutrition and to understand the influence of socio-economic and socio-demographic parameters on their nutritional status. In this cross sectional study, sample size consists of 1770 school going children (789 boys and 981 girls), aged 9 to 16 years collected from different educational institutions of North 24 Parganas district of West Bengal, India. Subjects who looked apparently healthy and active were included in the study. Efforts were made to exclude those with physical deformities. Anthropometric measurements were taken according to the method suggested by Weiner and Lourie (1981). Ages was calculated from the date of birth as recorded in the school diary. Out of 1770 study participants, 244 (13.8%) were overweight (128 {16.2%} boys and 116 {11.8%} girls), whereas 256 (14.5%) were obese (87 {11.0%} boys and 169 {17.2%} girls). 201 (11.4%) were underweight (83 {10.5%} boys and 118 {11.8%} girls). Underweight is more prevailing among boys at the age group 9. The highest percentage of underweight prevailed among mothers who are laborer or heavy worker. The studied children were compared with NCHS children. All the observations suggest that North 24 Parganas children have striking similarity with the NCHS children.*

INTRODUCTION

Nutrition is the most important contributory factor for human resource development in the country (Amirthaveni and Barikor, 2001). But still, undernourishment continued to be a major public health issue and cause of a substantial proportion of all child deaths every year specifically in developing countries like India (Black et al., 2003). Developing countries like India, accounts for about 40 percent of undernourished children in the World (James, 1998) and it is largely due to dietary inadequacy. In India, children living in the backward and drought–prone rural areas (Vijayaraghavan et al., 2003), urban slums and those belonging to the socially backward groups like scheduled castes and tribal communities, are highly susceptible to undernutrition (Martorell, 1984). To assess the nutritional status of an individual or population, anthropometry is widely recognized as one the useful techniques because it is highly effective for detection of undernutrition. Much of the global childhood stunting and wasting are the result of deficiencies in energy and protein intake, known as protein- energy malnutrition, which is mainly assessed by dietary intake in individual or household level (Patterson et al. 2005).

Growth studies among the children have always occupied a very prominent position in the scientific research curriculum and have always received serious attention of the researchers engaged in the field of both medical science and physical anthropology all over the world (Sharma, 1970). The assessment of pattern of growth during the adolescent period is based on a set of standard physical or anthropometric measurements. These measurements not only indicate the general pattern of growth during adolescent period, but also reflect a population specific growth pattern, which can serve as models for the nutritional assessment of the population (Banerjee, 2009).

The standard of living and nutritional status of a population may be measured through infant and child growth. This is not only a direct evaluation of the health and nutritional status of children, but it is also an indirect measure of quality of life of the entire society to which children belong (UN, 1985: Tanner, 1986; Monteiro, et al., 1992).

Cross-sectional and longitudinal anthropometric studies in families have established that different measures of physical growth and development in man during infancy, early childhood and adolescence and the stages of sexual maturation are strongly governed by genes though in a complex manner (Susanne, 1980a. 1984; Sharma, 1983). In the same way a large number of environmental variables, sometimes inter-correlated, are responsible for causing a significant variability in all measures of physical growth in man. Environmental factors are commonly categorized under: 1. Diet and nutrition, 2. Socio-economic factors including educational level and occupational status of parents, income and expenditure and standard of living, 3. Demographic factors like birth order, number of younger and older sibs, family size etc. 4. Psychosocial stress. 5. Environmental pollution, 6. Disease and illness, 7. Family size, 8. Sib ship size, 9. Trace elements in diet. Most of these factors have been discussed exhaustively by Eveleth and

Tanner (1976). The state of nutrition of any community or group of people depends considerably on the quality and quantity of food its members consume (ICMR, 1951). Hence the nutritional status is reflected by the dietary status, within certain ranges of variation. In view of the above present study is an attempt to examine the growth and nutritional status among Pre-adolescent and adolescent Bengali boys and girls.

METHODOLOGY

Materials for the present study have been collected from different educational institutions of North 24 Parganas. Sample size consists of 1770 Pre-adolescent and adolescent boys and girls, aged 9 to 16 years (789 boys and 981 girls). The schools have been randomly drawn from the list of all schools in the study area. On the other hand, the study adopted complete enumeration method in case of selection of students from each schools. Students who are absent in the class during measurements are excluded. Participants who look apparently healthy and active (but not on the basis of bodily structure or proportion) are included in the study. Efforts were made to exclude those with physical deformities. Anthropometric measurements were taken according to the method suggested by Weiner and Lourie (1981). Assessment of exact age is most essential for the conclusion of growth and nutritional studies. Age was calculated from the date of birth as recorded in the school diary.

The anthropometric measurements of Height, weight, sitting height, waist circumference, hip circumference, calf skinfold, triceps skinfold, systolic and diastolic blood pressure were taken for each boy and girl participant of the study as per the IBP recommendation (Weiner and Lourie, 1981). Portable weighing machine, Anthropometer, steel tape and Harpenden skinfold caliper were used for taking anthropometric measurements. All circumference measurements were taken using steel tape nearest to 0.1 cm. Body weight were recorded using a portable weighing machine nearest to 0.5 Kg. The other anthropometric measurements were also taken nearest to 0.1 cm except the skin fold measurements, where it was considered nearest to 0.1 mm. The measurer sits by the side of the subject and fits the tape snugly but not compressing soft tissues. To get the value of hip circumference the measurement is taken around the pelvis at the point of maximal profusion of the buttocks. Anthropometric measurements taken on each boy and girl aged 9 to 16 years are as follows: Stature (cm), weight (Kg), waist circumference (cm), Hip circumference (cm) Triceps skin fold (mm), calf skinfold (mm), Blood pressure (mmHg). The methods of measurements are explained hereinabove along with the details of instruments used and land marks consideration on the body.

Before the commencement of actual anthropometric survey in the school. The family data were taken in terms of (1) Date of birth of the subject with documentary evidence, (2) Educational background and occupational status of the parents, (3) size of the population, (4) Parity or birth order of the boy or girl, (5) Per month expenditure of the family (in rupees). All data were collected in schedule method.

However, due to the distribution of the families of the school boys and girls in the city, it took a considerable amount of time to collect socio-economic and demographic data using this procedure. Moreover, guardians were not always available in the house for interview. Those parents who did not mention the date of birth of their wards were left out for any further consideration and eventually their wards could not be included in the study.

Descriptive statistics like mean and standard deviation were used to study the age wise growth and nutritional status and t-test were used to see the significant differences between age groups and between traits. Logistic regression was also done.

RESULTS

Different nutritional anthropometric indices were examined to determine the nutritional status of children in the age group of 9-16 year.

Table 1 shows the mean anthropometric traits of height, weight, sitting height, waist circumference, hip circumference, calf skinfold, triceps skinfold, BMI, systolic and diastolic pressure of the adolescent Bengali boys and girls. The distance curve of height and weight showed a gradual increase with age (Figs 1 and 2). The rapid increase of height in the ages of 11-12 years among girls and 13-14 years among boys which correspond to the adolescent growth spurt. A maximum increase in weight was found in the 16-year group. The distance curve of sitting height, waist circumference, hip circumference also shows gradual increase with increasing age except at 16 years in boys, where it shows slight decreasing trend. Mean skinfold measurements (calf skinfold and triceps skinfold) show increasing tendency with age. Maximum increment in triceps skinfold was in between 13-14 years among girls. Systolic and diastolic pressures also increase with age.

Table 2 shows the state of underweight among the 9-16 year Bengali children through nutritional status of Body mass index. In our study the sample consists of 1770 children of which 789 (44.6%) are boys and 981 (55.1%) are girls. Among these children 201(11.36%) are underweight, 1068 (60.3%) are normal, 500 (28.2%) are overweight or obese. Underweight is more prevailing among the 9-year-old boys (26.66%). Obesity is more also among the 9-year-old girls (30.25%). Results show the double burden of

malnutrition which is characterized by the coexistence of undernutrition along with overweight and obesity.

Table 3 shows the relationship between children's underweight and their father's occupation. Father's occupation has been divided into four categories as not working (4.4%), service/Professional/salesman (35.7%), business (37.4%), skilled and unskilled laborer (22.6%). Percentage of underweight have been noticed maximum among the children of fathers who are laborer (16.2%) and in these families, underweight girls are more in comparison to boys (20.0% vs. 11.8%). Overweight and obesity have been noticed among the children of father's who are doing business (29.59%). On the average the percentage of overweight and obese girls (29.3%) are found to be more than that of boys (26.3%). When seen category wise, this differences are more pronounced among the children of fathers who are not working (24.0% boys as against 53.3% girls) and who are in the Service/Profession category (26.2% boys as against 32.0% girls).

Table 4 describes the same comparison with mother's occupation. Here 82.8% mothers are not working, 3.8% mothers are service holder or professionals, 2.1% mothers are doing business or self-employed, 9.7% mothers are manual laborer or heavy worker. Among these working categories of women the highest underweight (22.2%) children are found for mothers who are heavy workers or manual laborers. Overweight and obesity (28.89%) children are found among mothers who are not working. Here again, when looked category wise, girls are more underweight as well as overweight compared to boys.

Table 5 presents the relationship between father's educations with the nutritional status of their 9-16year children. It is seen that out of 1719 fathers,16.1% (285) are literate upto primary, 30% (531) are at secondary level educated, 31.6% (560) are educated up to HS and 19.4% (343) are highly educated. Highest percentage of underweight children (13.68%)were found among low educated fathers, i.e., educated up to primary level. Prevalence of overweight (28.98%)was high among the children whose father is educated up to HS. Except for children with low educated fathers, the girls are, percentage wise, more overweight and obese.

Table 6 shows the relationship between mother's education and the nutritional status of children. It has been seen that out of total 1737 mothers, 436 (24.6%) mothers are educated up to primarily, 653 (36.9%) mothers are educated up to secondary level, 434 (24.5%) mothers are educated up to HS level, 214 (12.1%) mothers are highly educated. There are 15.13% underweight among the children whose mothers are educated up to primary level. The feature is similar to the previous table, when the percentages are compared between boys and girls for each category.

Table 7 represents the relationship between nutritional status of 9-16 year children with their household size. It is found that out of 1770 families, 26.6% families' have1-3 members i.e nuclear family with possibly a single child, 48.0% having 4 members, having a chance of single child, two children or single child with either one grandparent, 20.7% having 5-6 members and rest are 4.7 % with atleast7 or more members. Here, 15.66% underweight children are found among families with 7 or more members. However, the sample size is very small in this category. If we take only three categories with household size 2-4, 5-6 and 7 or more members then we see that percentage of underweight is increasing with household size. Opposite is the case with overweight and obesity.

Table 8 gives the relationship between nutritional status of 9-16 year children with per capita expenditure of their family. As economy plays significant role for influencing the health status directly, we have considered per capita expenditure to assess the economic status of the families. The households have been divided into two categories according to per capita monthly expenditure namely (i) less than Rs. 15000 (84.8%), (ii) Rs. 15000 or more (15.2%). The result shows that underweight is directly related with per capita expenditure of the family. It has been observed that underweight is more in category (i) i.e., <RS 15000 (12.2% as against 6.7%). Overweight and obesity is more prevailed among category (ii), i.e., Rs. 15000 or more (30.9% as against 27.8%).

Table 9 represents the relationship between 9-16 year children's nutritional status with their birth order. It is found that among 1770 students, 64.9% children are first child of their parents, 31.1% children are second and only 4.1% are third child and above. Percentage of underweight has more or less an increasing trend with birth order (10.19% with birth order 1, 12.56% with birth order 2 and 20.83% with birth order 3 or more) whereas it is just the opposite when we take the category of overweight or obese (29.44% with birth order 1, 27.50% with birth order 2 and 15.27% with birth order 3 or more). It means that the prevalence of overweight and obesity is the most and the prevalence of underweight is the least among the single child families.

In table 10 we take all the anthropometric measures and test the differences between boys and girls for each age and sex. This is done through independent 't' test. The results show that anthropometric measurements of age group 9 waist circumference, hip circumference, triceps skinfold is significant at 1% level and weight, systolic pressure and BMI is significant at 5% level. At age group 10, hip circumference is significant at 1% level and sitting height and calf circumference is significant at 5% level, rest are insignificant. Age group 11 shows height and hip circumference is significant at 1% level and rest are insignificant. Age group 12 shows BMI, Waist circumference, Hip

circumference, calf circumference is significant at 1% level and rest are insignificant. Age group 13 shows that sitting height, hip circumference, calf circumference is significant at 1% level and weight is significant at 5% level, rest are insignificant. Age group 14 shows that hip circumference and calf circumference is significant at 1% level and waist circumference is significant at 5% level, rest are insignificant. Age group 15 shows that height, sitting height is significant at 1% level and rest are insignificant. Age group 16 shows height, weight, sitting height and diastolic pressure is significant at 1% level and rest are insignificant.

Table 11 summarizes the level of association between under nutrition of children with different categories of socio-economic and socio-demographic variables through categorical logistic regression analysis. Analysis reveals the relation between under nutrition and birth order. It shows the children having birth order 3 and above have the higher chance of being undernourished and it is significant at 1% level. Mother's occupation plays significant role in determining the relationship with children's nutritional status. Mothers belonging to laborer, household worker have the highest chance of giving birth to a undernourished children and it is highly significant at 1% level. To see the relationship between under nutrition and per capita expenditure of the family, it is seen that under nutrition among children was less in the households with income Rs. 15000 or more and it is significant at 5% level.

DISCUSSIONS

The purpose of this study is to examine secular changes in growth and nutritional status of Pre-adolescent and adolescent children of North 24 Parganas, West Bengal. Evaluations of growth and nutritional status are usually done with reference to height and weight. This may reflect changes in the general improvements of population in their life style, health and socio economic condition. From the present study, we observe that all anthropometric measurements show increase in order with increment of age in case of both boys and girls as shown in Table 1. Prevalence of underweight is more among boys in comparison to girls as shown in Table 2. We know that father's and mother's education play important role in growth and nutritional status of children. Poor nutritional status is associated with inadequate or unbalanced diets and it is among the determinants as well as the consequences of chronic illnesses. Obviously, the nutritional status of children is closely related to the economic conditions of their family, which are a determining factor for both food consumption and health care. From the present study we observe that incidences of underweight have been noticed to be more among the children of fathers, who are skilled and unskilled laborers (16.2%) and the girls are more affected

in comparison to the boys (20.0%). When we consider the working categories of mothers, the highest underweight children (22.2%) are found among the mothers, who are heavy workers or manual laborers. Women play multiple roles in the family that affect the health and wellbeing of all family members. In almost all societies around the world, they are assigned by custom to be the primary caregivers to infants and children (UNDP 1995). Activities carried out by women such as breastfeeding, preparing food, collecting water and fuel, and seeking preventative and curative medical care are crucial for child's healthy development. Women are gradually joining the laborer force more and more compared to previous time. Maternal employment influences child feeding practices, and, in turn, it affects child's nutritional status (Farhana and Naleena, 2012). Mothers exert strong influence over child feeding practices. This has been proven by a study done by Johannsen et al. (2006) which state that child's weight is found to be closely related to mother's BMI but not fathers. Feeding practices play a vital role in determining child health and food preferences in later life. Better child nutritional status is also associated with better educational achievement among children (Shariff et al., 2000). Underweight children are more prevalent among mothers who are less educated and among families with large family size.

To compare our results with those of National Child Health Survey (NCHS) data, we observe that there is a striking similarity of trend in height and weight boys and girls when plotted in the same graph (Figs. 3-6). Not only that there is an increasing trend for both the curves, but also the bends/slopes have similar pattern.

Results suggest that the effect of family size on the nutritional status is profound among children. Well-being depends upon the level of economic development and the extent to which parents, rather than extended family or state, bear the cost of rearing children. Here underweight (15.66%) is found to be more households with 7 or members and followed by 5-6 members (12.8%), 4 members (10.48%) and then 1-3 members (11.06%), successively. It is found from the logistic regression that children with higher income households are less undernourished and this is significant at 5% level.

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CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

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Table 1. Age and sex wise distribution of mean and SD of different anthropometric variables of 9-16 year Bengali children in North 24 Parganas

Age group (yrs)	N	Mean and ±SD									
		Height Cm.	Weight Kg	St Ht Cm.	Waist Circmf. Cm.	Hip Circmf. Cm.	CSF (SD)	TSF (SD)	BMI (SD)	Systolic BP mmHg	Diastolic BP mmHg
BOYS											
9	90	129.32 ±7.31	29.04 ±8.14	66.87 ±4.14	56.95 ±7.56	66.45 ±7.56	11.72 ±3.43	8.40 ±3.10	17.15 ±3.79	104.06 ±9.76	54.35 ±4.88
10	95	138.03 ±7.90	34.56 ±7.05	68.99 ±5.47	61.80 ±9.20	68.15 ±6.90	11.60 ±2.76	9.45 ±2.33	18.01 ±2.68	106.58 ±7.49	54.71 ±5.82
11	111	140.27 ±7.23	37.53 ±8.47	72.11 ±4.61	64.64 ±9.40	72.73 ±8.92	12.34 ±3.11	9.71 ±3.77	18.93 ±3.37	105.96 ±8.11	53.67 ±4.50
12	111	144.96 ±7.43	39.66 ±7.65	73.74 ±4.54	65.47 ±7.90	75.91 ±8.15	12.92 ±3.26	10.25 ±2.76	18.78 ±2.78	108.66 ±7.44	55.03 ±5.60
13	94	147.64 ±8.37	41.69 ±8.96	75.64 ±4.84	67.59 ±8.89	77.01 ±8.74	13.35 ±3.83	10.30 ±2.99	19.00 ±3.07	110.14 ±7.62	56.19 ±5.80
14	113	156.63 ±7.44	48.65 ±8.91	78.41 ±4.53	70.23 ±8.65	82.21 ±9.74	14.10 ±3.77	12.12 ±12.55	19.71 ±2.73	113.47 ±7.54	56.58 ±5.15
15	65	161.72 ±7.25	54.58 ±10.22	82.77 ±4.90	74.53 ±10.92	87.00 ±7.57	14.97 ±4.27	11.38 ±3.70	20.78 ±3.25	115.36 ±7.66	57.44 ±5.71
16	110	162.41 ±8.32	58.44 ±10.33	82.91 ±4.69	74.63 ±10.45	86.21 ±9.20	15.16 ±3.89	11.58 ±3.08	22.11 ±3.31	120.92 ±18.96	61.29 ±5.52
Total	789	147.49 ±13.22	42.91 ±12.72	75.07 ±7.12	66.90 ±10.61	76.83 ±10.96	13.24 ±3.74	10.42 ±5.66	19.31 ±3.43	110.63 ±11.50	56.15 ±5.83
GIRLS											
9	119	130.88 ±7.43	32.00 ±8.61	67.90 ±3.68	61.09 ±10.57	70.13 ±8.49	12.65 ±3.70	9.71 ±3.40	18.44 ±3.85	107.44 ±7.75	55.52 ±5.51
10	125	136.06 ±7.06	33.45 ±8.42	70.64 ±3.64	63.48 ±9.73	73.36 ±8.04	12.71 ±3.47	9.40 ±3.66	17.91 ±3.63	106.76 ±5.96	55.04 ±5.14
11	117	143.60 ±7.40	38.79 ±9.68	73.61 ±4.08	66.55 ±9.96	78.14 ±8.77	13.55 ±3.95	9.76 ±3.79	18.64 ±3.72	108.70 ±7.92	54.99 ±5.81
12	129	147.53 ±7.10	42.30 ±10.46	76.29 ±4.09	71.03 ±10.26	80.60 ±8.30	14.41 ±4.14	9.98 ±4.03	19.27 ±3.90	109.65 ±8.40	55.55 ±5.30
13	126	149.57 ±5.11	45.52 ±10.08	77.88 ±3.37	70.25 ±10.68	83.47 ±8.29	15.94 ±4.53	14.23 ±2.83	20.27 ±4.03	110.74 ±8.55	56.09 ±6.36
14	113	151.41 ±5.76	50.18 ±11.01	77.98 ±3.90	74.03 ±11.69	87.17 ±8.73	16.13 ±4.57	11.33 ±3.87	21.80 ±4.24	113.36 ±10.05	57.16 ±5.92
15	131	153.68 ±4.65	51.35 ±10.08	79.46 ±4.00	72.54 ±10.68	86.24 ±8.02	16.60 ±6.67	11.26 ±3.65	21.70 ±3.92	113.10 ±11.77	58.10 ±5.48
Total	121	153.98 ±5.68	54.55 ±9.53	80.55 ±4.38	75.56 ±9.62	88.74 ±7.15	16.42 ±4.25	11.51 ±3.16	22.97 ±3.55	116.46 ±6.09	58.27 ±3.28

CSF: Calf skin fold, TSF: Triceps skin fold

Table 2. Age and Sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri Age(yr)	Underweight			Normal			Overweight and obesity			All		
	M	F	T	M	F	T	M	F	T	M	F	T
9	24 (26.66)	18 (15.12)	42 (20.09)	39 (43.33)	50 (42.01)	89 (42.58)	27 (30.0)	51 (42.85)	78 (37.32)	90 (100.0)	119 (100.0)	209 (100.0)
10	7 (7.36)	19 (15.2)	26 (11.81)	50 (52.63)	71 (56.8)	121 (55.0)	38 (40.0)	35 (28.00)	73 (33.18)	95 (100.0)	125 (100.0)	220 (100.0)
11	8 (7.20)	19 (16.23)	27 (11.84)	64 (57.65)	63 (53.84)	127 (55.70)	39 (35.13)	35 (29.91)	74 (32.45)	111 (100.0)	117 (100.0)	228 (100.0)
12	8 (7.20)	17 (13.17)	25 (10.41)	78 (70.27)	81 (62.79)	159 (66.25)	25 (22.52)	31 (24.03)	56 (23.33)	111 (100.0)	129 (100.0)	240 (100.0)
13	12 (12.76)	17 (13.49)	29 (13.18)	59 (62.76)	79 (62.69)	138 (62.72)	23 (24.46)	30 (23.80)	53 (24.09)	94 (100.0)	126 (100.0)	220 (100.0)
14	13 (11.50)	11 (9.73)	24 (10.61)	80 (70.79)	69 (61.06)	149 (65.92)	20 (17.69)	33 (29.20)	53 (23.45)	113 (100.0)	113 (100.0)	226 (100.0)
15	4 (6.15)	12 (9.16)	16 (8.16)	48 (73.84)	85 (64.88)	133 (67.85)	13 (20.00)	34 (25.95)	47 (23.97)	65 (100.0)	131 (100.0)	196 (100.0)
16	7 (6.36)	5 (4.16)	12 (5.21)	73 (66.36)	79 (65.83)	152 (66.08)	26 (23.63)	36 (30.00)	62 (26.95)	110 (100.0)	120 (100.0)	230 (100.0)
Total	83 (10.51)	118 (12.04)	201 (11.36)	491 (62.23)	577 (58.87)	1068 (60.37)	215 (27.24)	285 (29.08)	500 (28.26)	789 (100.0)	980 (100.0)	1769 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese.

Table 3. Father's occupation and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri F Occu	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F	T	M	F	T	M	F	T
Not Working	1 (4.0)	7 (14.0)	8 (10.66)	18 (72.0)	27 (54.0)	45 (60.0)	6 (24.00)	16 (53.33)	22 (29.33)	25 (100.0)	50 (100.0)	75 (100.0)
Service/Professionals/ salesman	26 (9.09)	28 (8.61)	82 (13.42)	185 (64.68)	193 (59.38)	378 (61.86)	75 (26.22)	104 (32.0)	179 (29.29)	286 (100.0)	325 (100.0)	611 (100.0)
Business	33 (12.13)	36 (9.70)	69 (10.73)	161 (59.19)	223 (60.10)	384 (59.72)	78 (28.67)	112 (30.18)	190 (29.54)	272 (100.0)	371 (100.0)	643 (100.0)
Skilled and unskilled laborer	21 (11.79)	42 (20.0)	63 (16.23)	116 (65.16)	120 (57.14)	236 (81.94)	41 (23.03)	48 (22.85)	97 (25.00)	178 (100.0)	210 (100.0)	388 (100.0)
Total	81 (10.64)	113 (11.82)	194 (11.29)	480 (63.07)	563 (58.89)	1043 (60.74)	200 (26.28)	280 (29.28)	480 (13.39)	761 (27.95)	956 (100.0)	1717 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese.

Table 4. Mother's occupation and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri M Occu	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F	T	M	F	T	M	F	T
Not working	66 (10.04)	88 (10.90)	154 (10.51)	409 (62.25)	478 (59.23)	887 (60.58)	182 (27.70)	241 (29.86)	423 (28.89)	657 (100.0)	807 (100.0)	1464 (100.0)
Service/ Professions	1 (6.25)	5 (9.61)	6 (8.82)	14 (87.5)	29 (55.76)	43 (63.23)	1 (06.25)	18 (34.61)	19 (27.94)	16 (100.0)	52 (100.0)	68 (100.0)
Business	0 (0.00)	1 (4.16)	1 (2.70)	10 (76.92)	16 (66.66)	26 (70.27)	3 (23.07)	7 (29.16)	10 (27.02)	13 (100.0)	24 (100.0)	37 (100.0)
Laborer/ Household worker	16 (19.51)	22 (24.71)	38 (22.22)	51 (62.19)	49 (55.05)	100 (58.47)	15 (18.29)	18 (37.07)	33 (19.29)	82 (100.0)	89 (100.0)	171 (100.0)
Total	83 (10.80)	116 (11.93)	119 (6.83)	484 (63.02)	572 (58.84)	1056 (60.68)	201 (26.17)	284 (29.21)	485 (27.87)	768 (100.0)	972 (100.0)	1740 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese over all categories.

Table 5. Father's education and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri F Edu	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F		M	F	T	M	F	T
Up to Primary	20 (13.42)	19 (13.97)	39 (13.68)	84 (56.37)	82 (60.29)	166 (58.24)	45 (30.20)	35 (25.73)	80 (28.07)	149 (100.0)	136 (100.0)	285 (100.0)
Secondary	26 (10.27)	38 (13.66)	64 (12.05)	169 (66.79)	156 (56.11)	325 (61.20)	58 (22.92)	84 (30.21)	142 (26.74)	253 (100.0)	278 (100.0)	531 (100.0)
HS	26 (10.03)	37 (12.33)	63 (11.27)	158 (61.00)	176 (58.66)	334 (59.74)	75 (28.95)	87 (29.0)	162 (28.98)	259 (100.0)	300 (100.0)	559 (100.0)
Higher	9 (9.09)	20 (8.19)	29 (8.45)	69 (69.69)	150 (61.47)	219 (63.84)	21 (21.21)	74 (33.03)	95 (28.86)	99 (100.0)	244 (100.0)	343 (100.0)
Total	81 (10.65)	114 (11.89)	195 (11.35)	480 (63.15)	564 (58.87)	1044 (60.76)	199 (26.18)	280 (29.22)	479 (27.88)	760 (100.0)	958 (100.0)	1718 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese over all categories.

Table 6. Mother's education and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri M Edu	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F		M	F	T	M	F	T
Up to Primary	33 (16.5)	33 (13.98)	66 (15.13)	113 (56.5)	142 (60.16)	255 (58.48)	54 (27.0)	61 (25.84)	115 (26.37)	200 (100.0)	236 (100.0)	436 (100.0)
Secondary	26 (8.72)	51 (14.36)	77 (11.79)	200 (67.11)	208 (58.59)	408 (62.48)	72 (24.16)	96 (27.04)	168 (25.72)	298 (100.0)	355 (100.0)	653 (100.0)
HS	17 (8.13)	23 (10.22)	40 (9.21)	132 (63.15)	127 (56.44)	259 (59.67)	60 (28.70)	75 (33.33)	135 (31.10)	209 (100.0)	225 (100.0)	434 (100.0)
Higher	7 (11.86)	8 (5.19)	15 (7.04)	38 (64.40)	95 (61.68)	133 (62.44)	14 (23.72)	51 (33.11)	65 (30.51)	59 (100.0)	154 (100.0)	213 (100.0)
Total	83 (10.83)	115 (11.85)	198 (11.40)	483 (63.05)	572 (59.96)	1055 (60.77)	200 (26.10)	283 (29.17)	483 (27.82)	766 (100.0)	970 (100.0)	1736 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese over all categories.

Table 7. Household size and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri HH Size	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F		M	F	T	M	F	T
2-3	13 (8.72)	39 (12.14)	52 (11.06)	87 (58.38)	185 (57.63)	272 (57.87)	49 (32.8)	97 (30.21)	146 (31.06)	149 (100.0)	321 (100.0)	470 (100.0)
4	39 (9.62)	50 (11.26)	89 (10.48)	251 (61.97)	270 (60.81)	521 (61.36)	115 (28.39)	124 (27.92)	239 (28.15)	405 (100.0)	444 (100.0)	849 (100.0)
5-6	22 (12.42)	25 (13.15)	47 (12.80)	114 (64.40)	108 (56.84)	222 (60.49)	42 (23.72)	57 (30.00)	99 (26.97)	177 (100.0)	190 (100.0)	367 (100.0)
7 and above	9 (15.51)	4 (16.0)	13 (15.66)	39 (67.24)	14 (56.0)	53 (63.85)	10 (17.24)	7 (28.00)	17 (20.48)	58 (100.0)	25 (100.0)	83 (100.0)
Total	83 (10.51)	118 (12.04)	201 (11.36)	491 (62.23)	577 (58..87)	1068 (60.37)	215 (27.24)	285 (29.08)	500 (28.26)	789 (100.0)	980 (100.0)	1769 (100.0)

The values in parentheses () represent the percentages for each category i.e underweight, normal, overweight and obese over all categories.   HH: Household.

Table 8. per capita expenditure and sex-wise nutritional status of 9-16 year Bengali children in North 24 Parganas

Nutri PCE	Underweight			Normal			Overweight and Obesity			All		
	M	F	T	M	F	T	M	F	T	M	F	T
<15000	75 (11.1)	108 (13.1)	183 (12.2)	422 (62.3)	479 (58.1)	901 (60.1)	180 (26.6)	237 (28.8)	417 (27.8)	677 (100)	824 (100)	1501 (100)
15000 or more	08 (7.1)	10 (6.4)	18 (6.7)	69 (61.6)	99 (63.1)	168 (62.4)	35 (31.2)	48 (30.6)	83 (30.9)	112 (100)	157 (100)	269 (100)
Total	83 (10.5)	118 (12.0)	201 (11.4)	491 (62.2)	578 (58.9)	1069 (60.4)	215 (27.2)	285 (29.1)	500 (28.2)	789 (100)	981 (100)	1770 (100)

The values in parentheses () represent the percentages for each category i.e., underweight, normal, overweight and obese over all categories.   PCE: Per Capita Expenditure

Table 9. Birth order and sex-wise nutritional status of 9-16years Bengali children in North 24 Parganas

Nutri BO	Underweight			Normal			Overweight			All		
	M	F	T	M	F	T	M	F	T	M	F	T
1	46 (9.68)	71 (10.54)	117 (10.19)	301 (63.36)	392 (58.24)	693 (60.36)	128 (26.94)	210 (31.20)	338 (29.44)	475 (100.0)	673 (100.0)	1148 (100.0)
2	27 (9.74)	42 (15.44)	69 (12.56)	168 (60.64)	161 (59.19)	329 (59.92)	82 (29.60)	69 (25.36)	151 (27.50)	277 (100.0)	272 (100.0)	549 (100.0)
3 and above	10 (27.02)	5 (14.28)	15 (20.83)	22 (59.45)	24 (68.57)	46 (63.88)	5 (13.51)	6 (17.14)	11 (15.27)	37 (100.0)	35 (100.0)	72 (100.0)
Total	83 (10.51)	118 (14.95)	201 (11.36)	491 (62.23)	577 (73.13)	1068 (60.37)	215 (27.24)	285 (29.08)	500 (28.26)	789 (100.0)	980 (100.0)	1769 (100.0)

The values in parentheses () represent the percentages for each category i.e., underweight, normal, overweight and obese over all categories.   BO: Birth Order

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Table 10. Results of Independent t- test between boys and girls of different anthropometric variables

Age-groups (yrs.)	Anthropometric Variables	t-test for equality of means		
		t	df	p value
9	Height	1.513	207	.132
	Weight	2.156	207	.013*
	BMI	2.404	207	.017*
	Sitting height	1.899	207	.059
	Waist circumference	3.147	207	.002**
	Hip circumference	3.255	207	.001**
	Calf skin fold	1.849	207	.066
	Triceps skin fold	2.847	207	.005**
	Systolic pressure	2.788	207	.006*
	Diastolic pressure	1.599	207	.111
10	Height	-1.947	218	.053
	Weight	-1.234	218	.302
	BMI	-.222	218	.324
	Sitting height	2.670	218	.008*
	Waist circumference	1.293	218	.197
	Hip circumference	5.056	218	.000**
	Calf skin fold	2.547	218	.012*
	Triceps skin fold	-.115	218	.909
	Systolic pressure	.220	218	.826
	Diastolic pressure	.437	218	.662
11	Height	3.438	226	.001**
	Weight	1.041	226	.299
	BMI	-.613	226	.541
	Sitting height	2.606	226	.010
	Waist circumference	1.491	226	.137
	Hip circumference	4.618	226	.000**
	Calf skin fold	2.568	226	.011
	Triceps skin fold	.092	226	.927
	Systolic pressure	2.576	226	.011
	Diastolic pressure	1.903	226	.927
12	Height	2.742	238	.007*
	Weight	2.197	238	.029
	BMI	4.564	238	.000**
	Sitting height	1.088	238	.278
	Waist circumference	4.643	238	.000**
	Hip circumference	4.398	238	.000**
	Calf skin fold	3.065	238	.002**
	Triceps skin fold	-.601	238	.549
	Systolic pressure	.961	238	.338
	Diastolic pressure	.730	238	.466

13	Height	2.116	218	.030
	Weight	2.916	218	.004*
	BMI	2.550	218	.011
	Sitting height	4.043	218	.000**
	Waist circumference	1.958	218	.051
	Hip circumference	5.579	218	.000**
	Calf skin fold	4.472	218	.000**
	Triceps skin fold	10.011	218	.000**
	Systolic pressure	.536	218	.592
	Diastolic pressure	-.115	218	.908
14	Height	-5.893	224	.000**
	Weight	1.151	224	.201
	BMI	4.394	224	.000**
	Sitting height	-.766	224	.444
	Waist circumference	2.782	224	.006*
	Hip circumference	4.026	224	.000**
	Calf skin fold	3.635	224	.000**
	Triceps skin fold	-.643	224	.521
	Systolic pressure	-.091	224	.927
	Diastolic pressure	.791	224	.430
15	Height	-9.386	194	.000**
	Weight	-2.101	194	.037
	BMI	1.637	194	.103
	Sitting height	-5.051	194	.000**
	Waist circumference	-1.217	194	.225
	Hip circumference	-.641	194	.522
	Calf skin fold	.661	194	.075
	Triceps skin fold	-.219	194	.827
	Systolic pressure	-1.407	194	.161
	Diastolic pressure	.783	194	.435
16	Height	-9.057	229	.000**
	Weight	-2.975	229	.003**
	BMI	1.892	229	.060
	Sitting height	-3.953	229	.000**
	Waist circumference	.704	229	.482
	Hip circumference	2.343	229	.020
	Calf skin fold	2.335	229	.020
	Triceps skin fold	-.173	229	.863
	Systolic pressure	-2.454	229	.015
	Diastolic pressure	-5.096	229	.000**

*Significant at 5% level; **Significant at 1% level

Table 11. Categorical logistic regression of under nutrition of (9-16) year Bengali adolescent children in relation to different socio-economic variables

Name of the variables	Coefficient	p-value
Sex (Base = Female)		
Male	-.180	.247
Birth order (Base = 1)		.020
2	.243	.139
3 or more	.815	.009*
Mother's occupation (Base = Not working or Housewife)		.000**
Service/Professionals	-.167	.704
Business	-1.378	.176
Laborer/household worker	.850	.000**
Per capita income (Base = less than Rs. 15000)		
Rs 15000 or more	-.403	.035*
Constant	-2.091	.000

*Significant at 5% level; **Significant at 1% level

Fig 1
Mean height of 9-16 years boys and girls

Fig 2
Mean weight of 9-16 years boys and girls

Fig 3
Comparison of mean heights of present study with NCHS: Boys

Fig 4
Comparison of mean heights of present study with NCHS: Girls

Fig 5
Comparison mean weight of present study with NCHS standard girls

Fig 6
Comparison mean weight of present study with NCHS standard girls