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Gender Differences in Nutritional Status During Early Adolescence: A Comparative Study in Mohanpur Block, Paschim Medinipur, West Bengal

Prasenjit Chaudhuri, Debanjana Sen, Alak Kumar Syamal *

PG Department of Physiology, Hooghly Mohsin College, Chinsurah, West Bengal, 712101, India

*Corresponding Author: PG Department of Physiology, Hooghly Mohsin College, Chinsurah, West Bengal, 712101, India
E-mail Address: alaksyamal@gmail.com (Alak Kumar Syamal)

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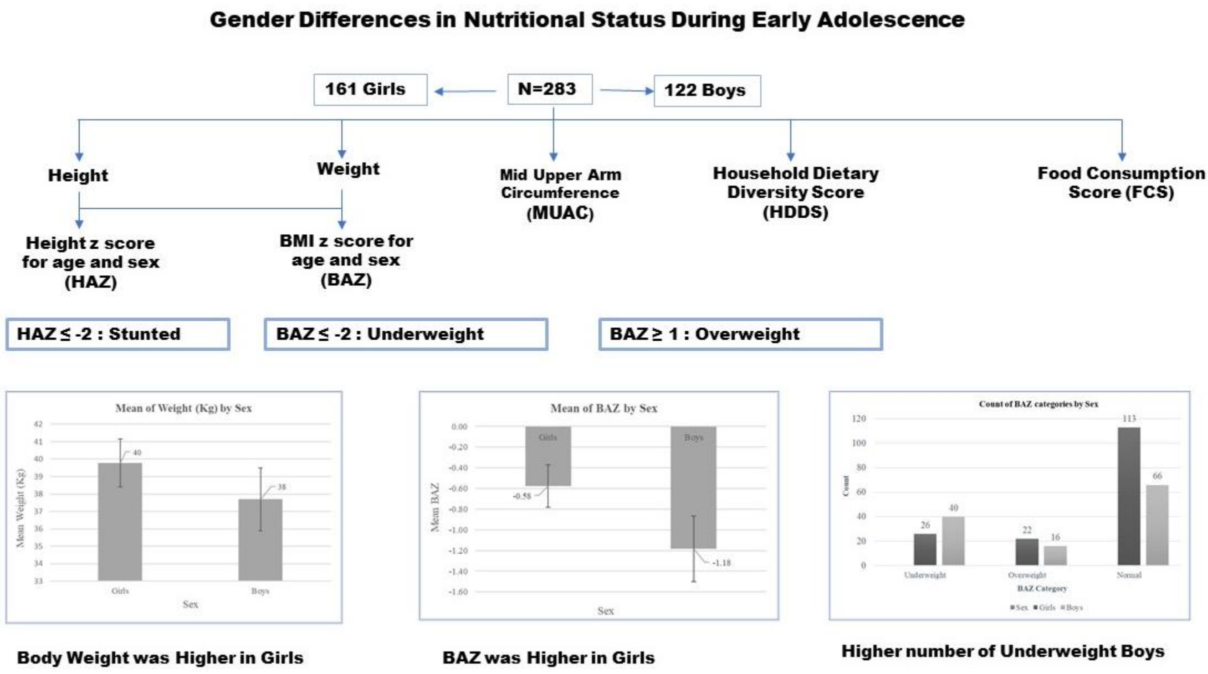
ABSTRACT

The aim of this study is to address the sex differences in nutritional status of rural West Bengal Indian adolescents. In 283 secondary school children (161 girls, 122 boys) of Mohanpur High School, a cross-sectional survey was undertaken. Anthropometric measures such as height, weight, mid-upper arm circumference (MUAC), and BMI-for-age z-scores (BAZ) and height-for-age z-scores (HAZ) were measured. Diet intake was estimated through Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS). Statistical tests such as t-tests, Mann- Whitney U tests, and chi-square tests were conducted in SPSS 25. Height was not significantly different by gender (p=0.836), nor HAZ (p=0.07). Girls weighed more compared to boys significantly (p=0.0118) and tended to have more BAZ (p=0.001). There were no significant differences in MUAC (p=0.105), HDDS (p=0.276), or FCS (p=0.757). BAZ categorization revealed that 32.8%of the boys were underweight as compared to 16.1% of girls (p=0.004). HAZ classification revealed no significant differences between sexes (p=0.986). These results indicate that adolescent girls and boys have comparable dietary consumption and height development, but differences in weight and BMI may be explained by earlier pubertal development and a tendency toward a more sedentary lifestyle in girls. Additional studies using biochemical markers are suggested to elucidate sex-specific nutritional differences.

Graphical Abstract:



1. Introduction

Adolescence is the period of life with rapid physical, physiological, and psychological changes. Puberty is a key event during adolescence, marked by a growth spurt and a series of physiological changes required for reproductive maturation, which in turn leads to numerous psychological changes. Both over and undernutrition during adolescence may be harmful to later life as those earlier problems may give rise to various chronic diseases like obesity, diabetes, cardiac problems, etc. [1-2].

According to WHO, globally, 54% of child deaths are due to malnutrition which results in the loss of 3 million young lives each year [3]. The double burden of malnutrition, that is the coexistence of obesity and undernutrition is one of the burning challenges in Southeast Asia and needs to be intervened effectively [4]. WHO and UNICEF have adopted revised prevalence thresholds for malnutrition indicators to improve identification and enable quicker action against malnutrition [5].

Various studies have shown the problem of undernutrition in different parts of rural India [6-7]. A study documented that, in rural India, 53.1% of boys and 39.5% of girls suffer from undernutrition [8]. The prevalence of stunting and thinness among adolescent boys and girls was found very high in many studies [9-11]. In northeast India, 40% of adolescents were found to be stunted [12].

In India, there are many conflicting observations regarding sex-based differences in malnutrition. In north India, one study found that 43.8% of boys were underweight while 30.1% of girls were underweight [13]. Many other studies also support that undernutrition is prevalent in adolescent boys [14-15]. Conversely, in another study malnutrition was observed among 60% of girls compared to 40% of boys. Girls were also found more anaemic than boys [16]. Similarly, boys were found to be socially privileged, consuming better quality food, and thus had better nutritional status than girls [9]. Therefore, in this respect, no conclusive study was found.

Thus, the objective of the present study is to examine sex-based disparities in the nutritional status of adolescents in rural West Bengal, India.

2. Methods

2.1 Study population

Two hundred eighty-three adolescent secondary school students from standard 5 to standard 8 participated in the present cross-sectional study. The study was conducted at Mohanpur High School, located in the Mohanpur block of Paschim Medinipur District, West Bengal, India. 161 girls with a mean age of 12.97± 0.81 years (range: 11.67 to 15.33 years) and 122 boys with a mean age of 12.92± 0.72 years (range: 11.75 to 14.50 years), participated in the study. Written consent and authorization from the school authority were taken before the study. Our study includes anthropometric measurement of height, weight, and mid upper arm circumference (MUAC), and a questionnaire containing questions regarding household dietary diversity score (HDDS) and food consumption score (FCS).

2.2 Anthropometric Measurement

Height and weight were measured using an anthropometer (accuracy of 1mm) and an electronic weight machine (accuracy of 0.1kg) [17] . MUAC was measured using measuring tape. From height and body weight BMI was calculated using the formula BMI= Body weight [kg]/(Body Height [m])2 [18]. WHO Anthro Plus software was used to convert BMI to BMI-for-age z-scores (BAZ) and height to height-for-age z-scores (HAZ). [19]. HAZ was divided into 2 categories: Normal and Stunted. Stunted was defined as HAZ ≤-2 (less than -2); others are considered Normal. BAZ was classified among 3 categories: Normal, Underweight, and Overweight. Underweight was defined as a BAZ score ≤ -2 whereas overweight was defined as a BAZ score ≥1; the remaining scores were called Normal [20].

2.3 Dietary Questionnaire

HDDS was used to measure dietary diversity and was calculated from the record of consumption of different food groups last day. The total number of groups was 12 and every group was assigned 1 mark; the addition of all marks constitutes the score. Thus, the highest possible score in HDDS is 12 [21]. FCS, on the other hand, is used to detect food security and dietary quality established by the World Food Programme (WFP). The FCS measured 3 important properties of a regular diet: food frequency, dietary diversity, and the nutritional significance of different food groups. A specific weight, assigned to a specific food group, represents the amount of nutrients in that food group. The questionnaire regarding FCS consists of dietary information for the last 7 days [22-23].

2.4 Statistical Analysis

In this cross-sectional study, at the beginning, Shapiro-Wilk normality tests were performed. All continuous variables were divided into two groups based on sex: girls and boys. The mean of the variables that were normally distributed, was compared between two groups using t-tests. If not distributed normally Mann-Whitney U tests were performed to find the differences. Categorical variables were represented as percentages and compared using chi-square tests. $p \leq 0.05$ was considered as significant. All the statistical analysis was performed using IBM SPSS Statistics version 25.

3. Result

Table 1 represents different parameters regarding nutritional status like height, weight, HAZ, BAZ, MUAC, HDDS, and FCS of adolescent boys and girls. Two groups were compared to find significant differences. Shapiro-Wilk tests were performed to check the normality of different variables. To explore differences between boys and girls, t-tests and Mann-Whitney U tests were used depending on the normality of the variables. Height, HAZ, BAZ, and FCG values between the two groups were compared using t-tests whereas the values of weight, MUAC, and HDDS were compared using Mann-Whitney tests. We found no significant difference in height between boys and girls (p=0.836). Similarly, HAZ of boys and girls were not significantly different (p=0.07). In contrast, boys had significantly lower body weight than girls (p=0.0118). Likewise, BAZ is considerably higher in girls than in boys (p=0.001). Conversely, no significant difference was observed in dietary diversity scores (HDDS) between the two groups (p=0.276). Similarly, food consumption scores were also found nonsignificant (p=0.757). However, no significant difference was identified in MUAC values between boys and girls (p= 0.105) (Figure 1 and Figure 2).

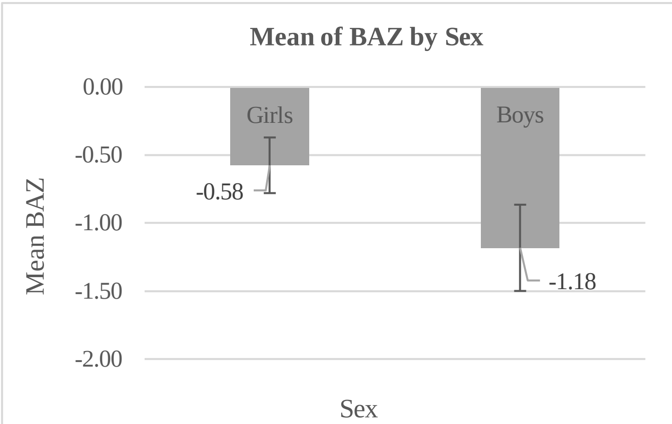


Figure 1 Mean of BAZ by Sex

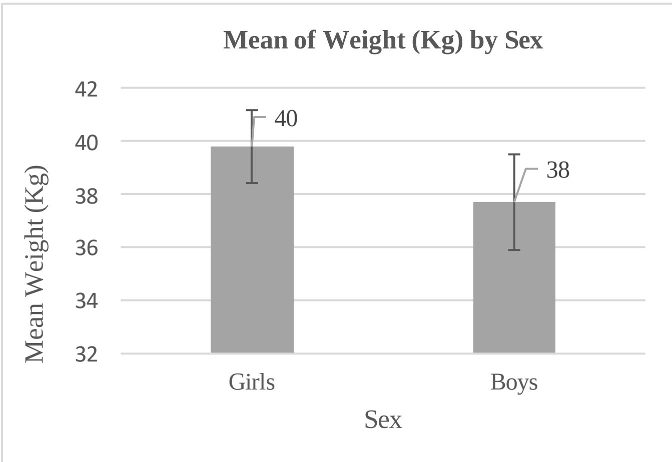


Figure 2 Mean of weight by sex

Table 2 highlights BAZ and HAZ categories for both sexes. According to BAZ, we classified both sexes among 3 categories: underweight, overweight, and normal. Additionally, we categorize them into 2 categories based on HAZ: stunting and normal. Chi-square tests were used to find differences in frequencies among the groups. In the BAZ category, we found a significant difference between boys and girls (p=0.004). Boys constituted a higher percentage (32.8%) of underweight children than girls (16.1%). Conversely, girls represented almost a similar portion of overweight (13.7%) compared to boys (13.1%). Additionally, according to BAZ, 70.2% of girls were normal, while only 54.1% of boys had normal BAZ. In HAZ categories, we identified no significant difference between boys and girls (p=0.986). (Fig 3)

Thus, although there is no difference in height or food intake patterns, the weight gain of boys is significantly lower than that of girls in the present population, considering their age and sex.

Table 1 Comparison of Physical and Nutritional variables by Sex

Variable	Sex (Mean±SD)		P*
	Girls (n= 161)	Boys (n=122)	
Height[1]	148.11± 6.511	147.848±14.565	0.836
HAZ[1]	-1.097±.89261	-0.8935±1.01235	0.07
BAZ[1]	-0.5760±1.314	-1.1826± 1.761	0.001*
FCS[1]	66.54±14.926	66.012±13.128	0.757
HDDS[2]	9.65± 2.104	10.04± 1.638	0.276
Weight[2]	39.79± 8.815	37.70± 10.048	0.0118*
MUAC[2]	20.873± 12.15	19.525± 2.8061	0.105

[1]T – Test, [2] Mann-Whitney-U Test, *significance

Table 2 Comparison of BAZ and HAZ categories by Sex (Mean ± SD)

Variable	Categories	Sex (Mean±SD)		P*
		Girls (n= 161)	Boys (n=122)	
BAZ	Underweight	26 (16.1%)	40 (32.8%)	0.004*
	Overweight	22 (13.7%)	16 (13.1%)	
	Normal	113 (70.2%)	66 (54.1%)	
HAZ	Stunting	21 (13.0%)	16 (13.1%)	0.986
	Normal	140 (87.0%)	106 (86.9%)	

Chi-Square Test, *significant at P<0.05

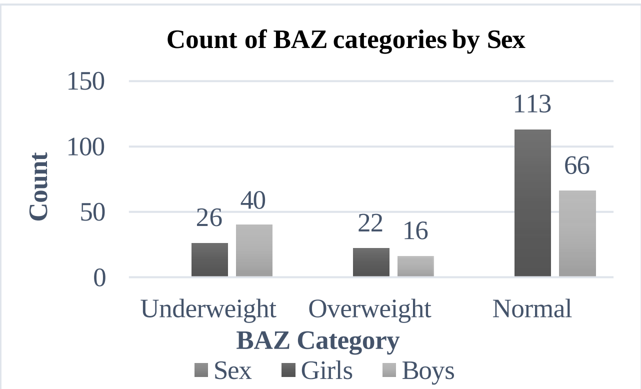


Figure 3 Count of BAZ categories by Sex

4. Discussion

In the present study, we observed no significant difference in height and HAZ scores between girls and boys, but BAZ was found higher in girls than boys. We found that the percentage of underweight boys was more than double that of girls. However, the percentage of stunting was found equal. A longitudinal study conducted in South India, which began with 5 to 7-year-old children and subsequently followed them up to the next 9 years, found that the rates of both undernutrition and stunting were higher in boys [14]. A similar result was found in the states of Uttar Pradesh and Bihar in India [24]. On the other hand, a study from Uttar Pradesh state of India noted higher malnutrition among adolescent girls [25]. In another study from Maharashtra state of India, we found the prevalence of both stunting and thinness in adolescent boys [15].

We found no significant difference in height and MUAC but body weight differed significantly between the two sexes. Pubertal growth starts earlier in girls; therefore, height and MUAC were similar between boys and girls, but HAZ was much lower in girls. As puberty occurs in girls earlier, girls may acquire increased fat and muscle mass earlier than boys. Many studies suggest that during puberty girls gain more fat mass compared to boys. During puberty, the concentration of blood estradiol increases which promotes the deposition of subcutaneous fat [27]. In addition, blood leptin levels increase with the beginning of puberty in girls and continue up to at least 15 years of age. Conversely, blood leptin levels initially increase in boys but after Tanner stage 2 it begin to decrease. At the end of puberty, the level of leptin in boys remains approximately one-third compared to girls [28]. Leptin is associated with the regulation of energy and fat mass. Thus, leptin may have a role in increasing fat mass in girls. On the other hand, testosterone inhibits fat deposition in pigs [29]. In humans, low testosterone is associated with obesity and high visceral fat deposition while high testosterone is linked with low fat % [30][31]. In addition, testosterone was reported to have a role in adipose tissue metabolism and the regulation of fat distribution within the body [32]. In a review article, Saad et al. wrote that testosterone replacement therapy may be beneficial for obese men with high visceral fat [33]. Moreover, it was also reported that increased testosterone is associated with weight loss in obese insulin-resistant men with type 2 diabetes [34]. According to a review by Kelly and Jones obesity and testosterone levels have a bidirectional relationship. Testosterone not only reduces fat deposition, but the accumulation of excess fat can also reduce the level of testosterone [35]. Testosterone and dihydrotestosterone were found to inhibit the differentiation of adipocytes [36] [37].

In our study, we found no significant disparity in food consumption patterns between the two sexes in early adolescence. Many studies found that during adolescence in rural India, both sexes faced similar challenges regarding nutrition [8] [38]. Some findings also contradict this result. In a longitudinal study from Andhra Pradesh and Telangana states of India, it was found that girls belonging to the mid-adolescent age, consume less amount of protein and vitamin-rich foods compared to boys [39]. Another study comprising married women noted that in rural India, women were more likely to be undernourished, which may have originated during adolescence [40]. Many other studies also supported this inequality [41].

As we found no difference in food intake diversity or patterns, other factors like socioeconomic and lifestyle factors may have come into play. Our study population belongs to the rural areas, and village boys are more engaged with outdoor games. The energy consumption from food may not be sufficient to meet the expenditure from their physical activity. Conversely, after puberty, girls tend to engage more in sedentary household work than in outdoor games. A study conducted in Brazil noticed that, in adolescents, particularly girls, the trend to a sedentary lifestyle is increasing [42]. This finding is further supported by other studies with high school girls [43]. Watching television and socially sedentary activities like talking on mobile phones were very common in the United Kingdom [44]. In a longitudinal prospective study, it was observed that as girls progress through puberty, their tendency to spend more time in sedentary activity increases [45]. A sedentary lifestyle in adolescent girls may be a cause behind their increased body weight[46]. Many studies reported that adolescent girls are found to be habituated to consume a high amount of junk food [47] [48]. Boylon et al observed an increased rate of junk food consumption in Australian children [49]. High junk food intake may also be linked with increased body weight and obesity [50].

Conclusion

In the present study, we did not find any gender-specific disparity regarding nutritional status. Whatever differences were found between the two groups were due to the earlier pubertal development and sedentary lifestyle of girls. However, further analysis involving blood samples for different nutrient contents is required to understand their nutritional status more precisely

Conflict of Interest

The author(s) declared no conflict of interest.

Ethical Compliance Standard

The present study was approved by the IEC-(Human) for Research, Hooghly Mohsin College, Government of West Bengal, India (Ref. No. HMC/IEC/DEPT/2024/5).

Credit author statement

DS: Conceptualization; PC: Methodology; AKS: Writing - Original Draft, Review & Editing

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