Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India

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Abstract Background and objectives: Malnutrition is a silent emergency and it is one of the most common causes of morbidity and mortality among children and adolescent throughout the world. The present study was undertaken to investigate the prevalence of malnutrition among 10 to 17 years old adolescent and its association with socio-demographic factors.
Design and setting: This community based cross-sectional descriptive study was conducted between May 2014 to April 2015 on 839 subjects.
Subjects and methods: Anthropometric measures were measured in 560 adolescents in rural areas of West Bengal state, India, by using standard technique. Different socio-demographic variables were studied by questioner method.
Results: In the present investigation, about 54% of adolescents were stunted and 49% were thin. The adolescents belonged to lower social class were significantly more likely to be stunted (OR = 2.68) and thin (OR = 2.44). Other variables like father’s occupation, mother’s education, economic status and sanitation showed significant and negative association with undernutrition. However, mother’s working status showed significant and positive association with undernutrition. Adolescents of working mothers were more likely to be stunted and thin than those who do not worked outside of the home. Adolescents of women with higher education were less likely to be undernourished than adolescents of poor and uneducated women. Adolescents of nuclear families (family size <4) were more likely to be stunted and thin.
Conclusions: Poverty is found to be an important factor of undernutrition among the adolescents. So there is a require to implement well-thought poverty reduction actions along with...
1. Introduction

Malnutrition is a silent emergency, and it continues to be a major public health problem worldwide, especially in South-East Asia and sub-Saharan Africa. It is an indicator of poor nutrition, having a major consequence on human health as well as for the social and economic development of a population [1]. It is one of the most common causes of morbidity and mortality among children and adolescents throughout the world [2]. Every year, more than 10 million children worldwide die from preventable and treatable illnesses. At least half of these deaths are caused by malnutrition [3]. The health consequences of a prolonged state of malnutrition among children and adolescents include delayed physical growth and impaired motor and cognitive development, diminished cognitive performance, lower intellectual quotient (IQ), poor social skills, greater behavioral problems and vulnerability to contracting diseases [3,4]. Moreover, malnutrition also leads to important consequences in adult life in terms of physical growth, work capacity, reproductive performances and risk of chronic diseases [5]. The global scope of malnutrition is still unacceptably high, and the progress to reduce it is slow [6]. Malnutrition continues to be one of India’s major human development challenge. Despite enormous economic progress achieved in the past two to three decades, malnutrition among children and adolescents in both urban and rural India still claims many lives due to the immense population size, illiteracy, inadequate access to health facilities, and socioeconomic disparities in India. As a result, nutritional assessments among the adolescent and children play a potential role in formulating developmental strategies and programs in India.

The studies of malnutrition at national and local levels have focused predominantly on children under 5 years of age. There is little information available from adolescents, the age group, with the highest growth velocity after infancy. The adolescent period is a very important phase in the life span of an individual. It is defined as the transition period from childhood to adulthood and is characterized by an exceptionally rapid growth. During this stage of the life cycle, adolescents experience rapid growth and developmental changes such as physical growth, improved gross and fine motor skills and biological maturity. The nutritional status of adolescents requires close monitoring because they represent the next generation of parents. This heightened physical growth depends upon dieting behavior and socio-economic status. Several epidemiological studies have shown an association between physical developments in adolescent period with socio-economic status [7–15]. Such database is lacking at the moment in India. These types of database will enable the government and nongovernmental agencies to formulate policies for the well-being of the adolescents.

There is little information available on the nutritional status of adolescents in West Bengal, although some important scientific papers are mentioned here [16–20]. West Bengal is a state in eastern India that stretches from the Himalayas in the North to the Bay of Bengal in the South and is the fourth-most populated state in the nation, with over 91 million inhabitants (7.55% of India’s population) [21]. West Bengal’s climate varies from tropical Savanna in the southern portions to humid subtropical in the north. The main seasons are summer, the rainy season, a short autumn, and winter. Monsoons bring rain to the whole state from June to September. The predominant occupation is agriculture.

The aim of the present study was to investigate the prevalence of malnutrition among adolescents in the rural areas of West Bengal and examine the possible association of different sociodemographic factors with malnutrition.

2. Subjects and methods

2.1. Study participants

This cross-sectional descriptive study was conducted between May 2014 to April 2015 on 839 subjects, out of which 408 (48.63%) were boys and 431 were (51.37%) girls. Participants were selected from different villages of Howrah, Birbhum, and East and West Midnapore districts of West Bengal state, India. The eligibility criteria for recruitment of the participants for the present study were 10–17 years old; apparently, healthy and not suffering from any acute illness. Participants with background of acute (diarrhea, measles, mumps, chicken pox, etc.) or chronic (asthma, diabetes, cardio-vascular disease, epilepsy, tuberculosis, dermatitis, intestinal problems, etc.) diseases were excluded from the study. The authors disqualified 143 (17.04%) participants because they were not eligible based on these criteria. Among the 696 eligible participants, 79 were not interested to participate in the present study. Among the remaining 617 participants, 57 participants were excluded from the study due to missing or incomplete data. Thus, a total of 560 (80.46% of eligible) adolescents participated in the present survey.

2.2. Sample design

A stratified two-stage random cluster sampling was utilized for selecting participants. At first, fifteen clusters (village)
were selected from each district. Then, a systematic random sampling method was used to identify 15 participants per cluster. To obtain the sampling interval, all the households in the cluster were listed and divided by the required number of participants. The first household was randomly selected by using the lottery method, and subsequent households were identified by adding the sampling interval to the random number. The selected households were approached during field visits and the protocol of the study was explained verbally in the local language (Bengali). Informed consent was obtained from the parents. Ethical approval and prior permission were obtained from the institutional Ethics Committee before the commencement of the study, and the study was conducted in accordance with the ethical standards of the committee and with the Helsinki Declaration.

2.3. Sociodemographic factors

A pre-structured schedule questionnaire containing different sociodemographic variables was used to determine sociodemographic status of the study participants. The type of house was determined by considering the type of its walls and roof and divided into three categories: kutch, mud walls with a thatched roof; semi-pucca, brick walls with a thatched or tiled roof; and pucca, brick walls with a roof made of concrete.

2.4. Age

Assessment of age is most essential for conducting growth studies. The accurate age of the participants was recorded from their birth certificate.

2.5. Measurement of anthropometric dimensions

Height and weight of the participants were measured by following standard technique and appropriate landmarks. Height was measured to the nearest of 0.1 cm using an anthropometer (Hindustan Minerals) and weight to the nearest of 0.1 kg using a portable weighing machine (Libra). From measuring the height and weight of the participants, the body mass index (BMI) was computed. WHO classification was used for the assessment of malnutrition. Stunting was defined as the height-for-age z-score less than 2 standard deviations below the median of reference population [22,23]. Thinness was defined as BMI below the 5th percentile for age and overweight-obese was defined as BMI above the 85th percentile for age using the NHANES I reference population [22,23].

2.6. Statistical analysis

The sample size was determined by using the standard formula \( n = \frac{z^2pq}{d^2} \) [24]. The minimum estimated sample size was 556 \((1.96^2 \times 0.3649 \times 0.6351)/0.04^2\). The calculation was based on 36.49% prevalence \((p)\) of undernutrition among the Bengalee adolescent [17] with desired precision \((d)\) of 4%, where, \( q = p-1\) and \( z = 1.96\). Before data collection, all measurements were taken twice for 40 participants (20 boys; 20 girls) to calculate the technical error of measurement (TEM), relative technical error of measurement (%TEM) and coefficient of reliability (R) [25].

In the present study, the relative TEM of measurements was low and below the acceptable relative TEM [26]. This implied that the observed error for measurements in the present study was small and reproducible without significant technical error. Data were presented by sex. Different anthropometric measures were described by their means and standard deviation. To test the significance differences in different parameters, a Student t-test was performed. Chi-square analysis was performed to determine the differences in the prevalence of thinness, overweight-obese and stunting across the sex, age groups and different sociodemographic factors. One-way ANOVA was employed to test age variation in height, weight and BMI. Odd ratio (OR) and 95% confidence interval (CI) were calculated to determine the risk of thinness and stunting with respect to different age groups and different sociodemographic factors. Statistical analyses were performed using the statistical software IBM SPSS version 20. Statistical significance was set at \( P < .05 \).

3. Results

The details of socio-demographic status of the participants are presented in Table 1. Approximately 79% of the adolescents belonged to the Hindu religion. More than 15% of the adolescents belonged to the socioeconomically vulnerable sections of lower social class i.e., scheduled tribe and scheduled caste. Approximately 42% of the fathers and 50% of the mothers were illiterate or just able to sign. Occupations of the fathers were diverse. Approximately 32% of the fathers were laborers, 59% were marginal farmers, and 7% ran small sized business or in administrative position. Most of the mothers did not work outside the home (66.79%). Housing conditions were of poor standard. Fifty-eight percent of the houses were semi-pucca, 30.36% were kutcha houses, and only 11.25% were pucca houses. Almost all of the houses had no water supply, and families used untreated water. A large proportion of the houses (24%) did not have a bathroom, and excrement was disposed of in the area surrounding the houses. The mean size of each household was 5.85 persons, and, in general, 65% of the families were large \((\geq 5)\) members. The mean per capita income per month was about Rs. 1768/- (US $ 27.6). It was interesting to note that, for approximately 32% of the household, per capita income was less than Rs. 1000/-, and approximately 14% of the household had a monthly per capita income of more than Rs. 4000/month. This indicates a wide variation in the socio-economic status of the households.

The weight, height and body mass index (BMI) for different ages and sex are presented in Table 2. It was observed that the mean weight and height were significantly \((P < .001)\) increased with the advancement of age. The mean BMI also significantly \((P < .001)\) increased when boys and girls approached higher ages, except at the ages of 11 and 15 years among girls. The overall mean BMI of the boys \(16.83(3.34)\) kg/m\(^2\) was slightly higher than girls \(16.35(2.71)\) kg/m\(^2\).

The age-specific mean values of height, weight and BMI of the adolescents was plotted in relation to the WHO
The age-specific mean values of height, weight and BMI for both sexes at all ages were below the median reference values of WHO.

The age and sex specific nutritional status of the adolescents are presented in Table 3. The overall prevalence of stunting and thinness among the adolescents were 53.57% and 48.75%, respectively, when both sexes were considered together. The prevalence of overall overweight-obesity was low (4.64%). Stratifying the prevalence of stunting by age revealed that the highest prevalence was observed among 17-year-old adolescents (63.64%). The prevalence of stunting among the three nutritional groups showed a significantly higher prevalence of stunting (P < .001) in early adolescents than the late adolescents.

The adolescents of the present study were divided into three nutritional categories, thinness, normal and overweight-obese, according to the WHO recommended BMI cutoff value for adolescents, as mentioned above. The prevalence of stunting among the girls (58.36%) was significantly (P < .001) higher than boys (48.75%).

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| Table 1 Socio-demographic characteristics of the participants. |
|---------------------------------------------------------------|
| Boys and girls | Boys (n = 560) | Girls (n = 281) | |
| Religious | Hindu | 443 | 79.11 | 214 | 76.70 | 229 | 81.49 |
| | Muslim | 117 | 20.89 | 65 | 23.30 | 52 | 18.51 |
| Caste | Lower (SC and ST) | 85 | 15.18 | 44 | 15.77 | 41 | 14.59 |
| | Other | 475 | 84.82 | 235 | 84.23 | 240 | 85.41 |
| Occupational status of father | Laborer | 178 | 31.79 | 91 | 32.62 | 87 | 30.96 |
| | Cultivator | 331 | 59.11 | 163 | 58.42 | 168 | 59.79 |
| | Business/Service | 38 | 6.79 | 19 | 6.81 | 19 | 6.76 |
| | Other | 13 | 2.32 | 6 | 2.15 | 7 | 2.49 |
| Educational status of father | Illiterate or just able to sign | 234 | 41.79 | 115 | 41.22 | 119 | 42.35 |
| | Up to primary | 210 | 37.50 | 102 | 36.56 | 108 | 38.43 |
| | Secondary or above | 116 | 20.71 | 62 | 22.22 | 54 | 19.22 |
| Occupational status of mother | Housewife | 374 | 66.79 | 188 | 67.38 | 186 | 66.19 |
| | Laborer | 69 | 12.32 | 34 | 12.19 | 35 | 12.46 |
| | Cultivator | 103 | 18.39 | 48 | 17.20 | 55 | 19.57 |
| | Business/Service | 14 | 2.50 | 9 | 3.23 | 5 | 1.78 |

| Table 2 Mean (SD) of physical characteristics of the participants. |
|---------------------------------------------------------------|
| Age | Height (Mean (SD)) | Weight (Mean (SD)) | BMI (Mean (SD)) |
|---------------------------------------------------------------|
| Boy | 10 | 128.32 (5.41) | 23.58 (5.81) | 14.12 (2.28) |
| 11 | 132.87 (8.38) | 27.79 (8.74) | 15.38 (3.01) |
| 12 | 138.56 (9.13) | 30.64 (6.96) | 15.95 (3.27) |
| 13 | 145.08 (9.01) | 34.41 (8.04) | 16.27 (3.37) |
| 14 | 149.91 (9.23) | 38.61 (6.86) | 17.34 (3.71) |
| 15 | 155.47 (6.28) | 42.85 (8.15) | 17.76 (3.47) |
| 16 | 157.53 (7.29) | 44.21 (8.69) | 17.75 (2.86) |
| 17 | 158.61 (6.35) | 47.19 (5.95) | 18.81 (2.49) |
| All | 279 | 147.04 (13.23) | 37.1 (10.87) | 16.83 (3.34) |
| F ratio | 78.279 | 44.636 | 8.575 |
| | (P < .001) | (P < .001) | (P < .001) |
| Girl | 10 | 130.75 (5.71) | 25.51 (5.96) | 14.78 (2.24) |
| 11 | 135.74 (7.0) | 27.4 (6.32) | 14.68 (2.1) |
| 12 | 139.41 (6.7) | 31.64 (6.71) | 16.17 (2.52) |
| 13 | 143.18 (6.22) | 34.06 (4.46) | 16.67 (2.44) |
| 14 | 147.23 (6.4) | 35.86 (5.91) | 16.93 (2.94) |
| 15 | 148.51 (7.39) | 37.32 (7.79) | 16.81 (2.83) |
| 16 | 150.66 (5.39) | 38.96 (5.37) | 17.19 (2.39) |
| 17 | 152.22 (5.72) | 41.29 (8.45) | 17.71 (2.77) |
| All | 281 | 143.43 (9.58) | 34.07 (8.31) | 16.35 (2.71) |
| F ratio | 53.123 | 27.697 | 7.133 |
| | (P < .001) | (P < .001) | (P < .001) |
was studied and is presented in Table 4. The results indicate that approximately 71% of the adolescents in the thinness category were stunted and that approximately 40% in the normal category were stunted. However, only 7.69% of the adolescents in the overweight-obese category were stunted.

As the bi-variate analysis shows only the gross differences, the logistic regression analysis was used to examine the association of sociodemographic factors with adolescent’s undernutrition (stunting and thinness). The results showed that the adolescents belonging to the lower social class (scheduled tribe and scheduled caste) were significantly more likely to be stunted (OR = 2.68, \( P < .001 \)) and thin (OR = 2.44, \( P < .001 \)) than the other social class (Table 5). Other variables such as father’s occupation, mother’s education, economic status and sanitation showed significant and negative association with undernutrition. However, mother’s working status showed a significant positive association. Notably, adolescents of working mothers were more likely to be stunted and thin than those with mothers who do not work outside of the home. The adolescents of women with higher education who belong to better-off households were less likely to be undernourished than adolescents of poor and uneducated women. These results suggest that adolescents of nuclear families (family size <4) were more likely to be stunted (OR = 1.46) and thin...

**Figure 1** Comparison of mean height, weight and BMI of the present study with WHO reference values.
Prevalence of stunting (Height for age z-score ≤2SD), thinness (<5th Percentile of BMI-for-age) and overweight-obese (>85th Percentile of BMI-for-age) among the adolescents.

| Age group (years) | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | All    |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Boys Stunting    | 10    | (33.33%) | 10    | (32.26%) | 13    | (40.63%) | 14    | (41.18%) | 17    | (54.84%) | 18    | (58.06%) | 18    | (57.45%) | 27    | (62.79%) | 27    | (48.75%) |
| OR (95% CI)      | 0.95  | 1.37  | 1.44  | 2.43  | 2.77  | 2.87  | 3.37  | 1.91  |        |
| Thinness         | 19    | (63.33%) | 17    | (54.84%) | 18    | (56.25%) | 16    | (47.06%) | 14    | (45.16%) | 13    | (41.94%) | 13    | (38.3%)  | 18    | (34.88%) | 15    | (46.59%) |
| OR (95% CI)      | 3.22  | 2.27  | 2.44  | 1.66  | 1.54  | 1.35  | 1.16  | 1.63  |        |
| (1.22–8.52)      | (0.88–5.83) | (0.94–6.13) | (0.66–4.16) | (0.59–3.96) | (0.52–3.48) | (0.49–2.74) | (0.83–3.18) |        |        |
| Overweight-Obese| 1     | (3.33%) | 3     | (9.68%) | 2     | (6.25%) | 3     | (8.82%) | 3     | (9.68%) | 3     | (9.68%) | 3     | (6.38%)  | 1     | (2.33%)  | 1     | (6.81%)  |
| OR (95% CI)      | 3.11  | 1.93  | 2.81  | 3.11  | 3.11  | 3.11  | 1.98  | 0.69  | 2.12   |
| (0.12–22.49)     | (0.16–22.49) | (0.28–28.53) | (0.3–31.68) | (0.3–31.68) | (0.19–19.94) | (0.04–11.49) | (0.27–16.4) |        |        |
| Girls Stunting   | 11    | (31.43%) | 17    | (42.5%)  | 23    | (62.86%) | 22    | (62.86%) | 16    | (57.14%) | 19    | (63.33%) | 17    | (70.73%) | 29    | (69.23%) | 27    | (58.36%) |
| OR (95% CI)      | 1.62  | 5.02  | 3.69  | 2.91  | 3.77  | 5.27  | 4.91  | 3.06  |        |
| (0.62–4.17)      | (1.79–14.05) | (1.37–9.93) | (1.03–8.18) | (1.34–10.55) | (1.98–14.06) | (1.83–13.55) | (1.44–6.49) |        |        |
| Thinness         | 18    | (51.4%)  | 23    | (57.5%)  | 19    | (57.6%)  | 18    | (51.4%)  | 15    | (53.6%)  | 14    | (46.67%) | 14    | (46.34%) | 19    | (43.59%) | 17    | (50.89%) |
| OR (95% CI)      | 1.37  | 1.75  | 1.76  | 1.49  | 1.13  | 1.12  | 1.34  | 1.07  |        |
| (0.55–3.43)      | (0.72–4.27) | (0.69–4.48) | (0.55–3.43) | (0.56–3.96) | (0.43–2.95) | (0.46–2.69) | (0.68–2.63) |        |        |
| Overweight-Obese| 1     | (2.9%)  | 0     | (0.0%)  | 1     | (3.0%)  | 0     | (0.0%)  | 2     | (7.1%)  | 1     | (3.3%)  | 1     | (2.4%)   | 1     | (2.6%)   | 1     | (2.5%)   |
| OR (95% CI)      | 0.28  | 1.06  | 0.32  | 2.61  | 1.17  | 0.85  | 0.89  | 0.87  |        |
| (0.01–7.19)      | (0.06–17.71) | (0.08–8.23) | (0.20–3.40) | (0.07–19.59) | (0.05–14.11) | (0.5–14.86) | (0.1–7.7) |        |        |
| Boys and Girls   | 21    | (32.31%) | 27    | (38.03%) | 23    | (55.38%) | 36    | (52.17%) | 33    | (55.93%) | 32    | (52.46%) | 31    | (60.66%) | 37    | (63.64%) | 54    | (53.57%) |
| Stunting (z-score ≤2SD) | 1     | (32.31%) | 1     | (32.31%) | 2     | (32.31%) | 3     | (32.31%) | 3     | (32.31%) | 3     | (32.31%) | 3     | (32.31%) | 3     | (32.31%) | 3     | (32.31%) |
| OR (95% CI)      | 1.28  | 2.60  | 2.28  | 2.66  | 3.23  | 3.67  | 4.04  | 2.42  |        |
| (0.63–2.61)      | (1.27–5.31) | (1.13–4.61) | (1.28–5.52) | (1.55–6.71) | (1.86–7.22) | (2.03–8.07) | (1.4–4.17) |        |        |
| Thinness         | 2.06  | 2.10  | 1.52  | 1.51  | 1.24  | 1.13  | 1.49  | 1.49  |        |
| (1.06–4.0)      | (1.06–3.84) | (0.79–2.9) | (0.77–2.97) | (0.63–2.43) | (0.61–2.09) | (0.92–2.39) |        |        |
| OR (95% CI)      | 2     | 3     | 3     | 5     | 4     | 4     | 2     | 2     |        |
| (3.08%)         | (4.23%) | (4.62%) | (4.35%) | (8.47%) | (6.56%) | (4.55%) | (2.44%) | (4.64%) |        |
| Overweight-Obese| 1     | (3.08%) | 1.39  | 1.52  | 1.52  | 2.92  | 2.21  | 1.5   | 1.53   |
| (0.22–8.59)     | (0.25–9.44) | (0.23–8.86) | (0.54–15.64) | (0.39–12.53) | (0.27–8.45) | (0.11–5.45) | (0.35–6.61) |        |        |
than those of Kenya [33]. According to de Onis et al [18] 52% severity malnutrition [23], the overall prevalence of 48.75%, respectively. Based on the WHO classification of prevalence of stunting and thinness were 53.57% and West Bengal state.

The nutritional status of adolescents from the rural areas of available on the nutritional status of adolescents from rural health of a population. However, very little information is Undernutrition is an indicator of poor nutrition and poor capacity of foods and unequal food sharing pattern in the table distribution of health resources, low purchasing ca-

The basic reasons behind undernutrition are long-term cu-
mulative inadequacies of health and nutrition and an insufficient intake of nutrients during the early stages of childhood. Pal et al [35] and Measham and Chatterjee [36] reported that one of the key causes of undernutrition among Indian communities was the lack of access to insufficient foods and resource amenities.

Dietary patterns, diarrhea episodes, prevalence of various parasitic infestation and other chronic illnesses were not studied in the present study. Moreover, it is likely that the rural populations have a nutritionally deficient diet and are also exposed to diseases due to the unsanitary conditions. They have to wash utensils and clothing in polluted pond water, which may make them more susceptible to parasitic infestations and other chronic infections, thus leading to a higher prevalence of undernutrition [35,37].

The prevalence of stunting was significantly higher among girls (58.4%) than boys (48.7%). The prevalence of thinness was also higher among girls than boys. According to the WHO Report on the Nutritional Status of Adolescents, the prevalence of stunting among girls is 45%, and that among boys is 20% [38]. The higher prevalence of undernutrition among girls is another well-known and accepted fact in almost every Indian community [39,40]. Several studies have already reported the discriminations made against the girls in India [20,41].

There are numerous and multifaceted causes of under-
nutrition. These causes are intertwining with each other and are hierarchically related. The most immediate determinants of undernutrition are poor diet and disease, which are caused by a set of underlying factors: household food security, education, income, nutritional situation of the parents, access to clean water and sanitation, access to primary health care, sex and age of child. In the present study, education of the mother was an important risk factor for stunting. Children of women with higher education were less likely to be undernourished. Education could be related to increased productivity, better methods of feeding and use of health-care facilities [7,42–44]. Women having higher education, owing to their exposure to the outside world, are more aware of personal hygiene and of promo-
tive and curative health care than that of uneducated or less educated women. Education can also enable women to make independent decisions and to have greater access to household resources that are vital for nutritional status [45]. Our results were also consistent with this study. With

| Table 4 Nutritional status classification of adolescents according to gender, BMI-for-age (percentiles) and height-for-age (Z-score). |
|---|---|---|
| Height for age | BMI-for-age | > 5th to < 85th Percentile | > 85th Percentile |
| | Classification n % | Classification n % | Classification n % |
| Boys | ≤ - 2 SD | W + S | 86 | 66.15 | S | 48 | 36.92 |
| | > - 2 SD | W | 44 | 33.8 | N | 82 | 63.1 |
| Girls | ≤ - 2 SD | W + S | 108 | 75.52 | S | 56 | 42.75 |
| | > - 2 SD | W | 35 | 24.5 | N | 75 | 57.3 |
| All | ≤ - 2 SD | W + S | 194 | 71.06 | S | 104 | 39.85 |
| | > - 2 SD | W | 79 | 28.9 | N | 157 | 60.2 |

W + S = wasting + stunting; W = wasting; S = stunting; N = normal; OW = overweight and stunting; OW = overweight.

(OR = 1.36). These results also showed that adolescents of large families (family size > 8) were more likely to be stunted (OR = 1.3) and thin (OR = 1.69).

4. Discussion

India has a unique opportunity to improve the health and nutritional status of its citizens as a result of its tremendous economic development in the past two to three decades. There have been impressive improvements in some health indicators in the past two decades, including a drop in the fertility rate and reduction in infant mortality rate, but improvements in nutritional status have been less impressive [27,28]. More than half of the world’s undernourished population lives in India [29]. Apart from overall poverty, the health status of the rural population reflects inequitable distribution of health resources, low purchasing capacity of foods and unequal food sharing pattern in the families making them socially and biologically vulnerable. Undernutrition is an indicator of poor nutrition and poor health of a population. However, very little information is available on the nutritional status of adolescents from rural areas of West Bengal. This lack of useful epidemiological data is the reason why we have attempted to investigate the nutritional status of adolescents from the rural areas of West Bengal state.

In the present study, overall (age and sex combined) prevalence of stunting and thinness were 53.57% and 48.75%, respectively. Based on the WHO classification of severity malnutrition [23], the overall prevalence of stunting and thinness among the studied population was very high. Comparing the results with global estimates show that, the prevalence of stunting and thinness among the adolescents in this area were higher than those reported for Nepal [30], Ethiopia [31], and Bangladesh [32] but lower than those of Kenya [33]. According to de Onis et al [18] 52% boys from Kolkata are stunted. A high prevalence of stunting (52.5%) has also been documented from West Bengal by Das et al [19] The exact figures of undernutrition among the adolescents vary from study to study [11,17,19,20,34], but there is no doubt that undernutrition is an extremely serious public health problem among the adolescents in India, especially among rural population. The basic reasons behind undernutrition are long-term cumulative inadequacies of health and nutrition and an
|                      | Stunting               |                         |                      |                      | Thinness                |                         |                      |                      |
|----------------------|------------------------|-------------------------|----------------------|----------------------|-------------------------|-------------------------|----------------------|----------------------|
|                      | %                      | $\chi^2$                | COR (95% CI)         | AOR (95% CI)         | %                      | $\chi^2$                | COR (95% CI)         | AOR (95% CI)         |
| **Sex**              |                        |                         |                      |                      |                        |                         |                      |                      |
| Male                 | 48.75                  | 5.21*                   | 1                    | 1                    | 46.59                   | 1.03                    | 1                    | 1                    |
| Female               | 58.36                  | 1.47*                   | (1.06–2.06)          | 1.71**               | (1.18–2.49)             | 50.89                   | 1.19                 | (0.85–1.65)          | 1.23                 | (0.86–1.77)          |
| **Religious**        |                        |                         |                      |                      |                        |                         |                      |                      |
| Hindu                | 54.63                  | 0.95                    | 1.22 (0.81–1.84)     | 0.98 (0.61–1.57)     | 49.89                   | 1.09                    | 1.24 (0.83–1.87)     | 1.07 (0.68–1.7)      |
| Muslim               | 49.57                  | 1                       | 1                    | 1                    | 44.44                   | 1                       | 1                    | 1                    |
| **Caste**            |                        |                         |                      |                      |                        |                         |                      |                      |
| Lower (SC and ST)    | 72.94                  | 15.12***                | 2.68*** (1.61–4.47)  | 2.57*** (1.45–4.56)  | 67.06                   | 13.44***                | 2.44*** (1.49–3.97)  | 2.16*** (1.26–3.71)  |
| Other                | 50.11                  | 1                       | 1                    | 1                    | 45.47                   | 1                       | 1                    | 1                    |
| **Occupational status of father** |              |                         |                      |                      |                        |                         |                      |                      |
| Laborer             | 61.8                   | 15.08**                 | 3.51*** (1.66–7.4)   | 5.29* (1.36–20.62)   | 59.55                   | 16.12**                 | 3.61*** (1.69–7.75)  | 5.18** (1.4–19.14)   |
| Cultivator          | 52.57                  | 2.4*                    | (1.17–4.92)          | 4.04* (1.1–14.87)    | 45.62                   | 2.06*                   | (0.99–4.29)          | 2.91 (0.84–10.08)    |
| Business/Service    | 31.58                  | 1                       | 1                    | 1                    | 28.95                   | 1                       | 1                    | 1                    |
| Other               | 30.77                  | 0.96                    | (0.25–3.76)          | 2.47 (0.45–13.71)    | 38.46                   | 1.53                    | (0.41–5.74)          | 3.65 (0.72–18.41)    |
| **Educational status of father** |            |                         |                      |                      |                        |                         |                      |                      |
| Up to primary       | 50.95                  | 1.11                    | (0.71–1.75)          | 0.87 (0.48–1.59)     | 44.76                   | 0.99                    | (0.63–1.57)          | 0.67 (0.38–1.2)      |
| Up to secondary     | 48.28                  | 1                       | 1                    | 1                    | 44.83                   | 1                       | 1                    | 1                    |
| Housewife           | 46.79                  | 20.88***                | 1                    | 1                    | 42.51                   | 19.58***                | 1                    | 1                    |
| **Occupational status of mother** |       |                         |                      |                      |                        |                         |                      |                      |
| Laborer             | 68.12                  | 2.43***                 | (1.41–4.19)          | 1.9 (0.95–3.8)       | 68.12                   | 2.89***                 | (1.67–4.99)          | 1.79 (0.91–3.53)     |
| Cultivator          | 66.99                  | 2.31***                 | (1.46–3.65)          | 2.66*** (1.51–4.67)  | 57.28                   | 1.81**                  | (1.17–2.82)          | 2.23** (1.31–3.79)   |
| Business/Service    | 64.29                  | 2.05                    | (0.67–6.22)          | 14.7** (3.06–70.73)  | 57.14                   | 1.8                     | (0.61–5.29)          | 6.98** (1.62–30.08)  |
| **Educational status of mother** |         |                         |                      |                      |                        |                         |                      |                      |
| Up to primary       | 52.11                  | 1.71*                   | (1.03–2.85)          | 1.82 (0.94–3.52)     | 47.37                   | 1.8*                    | (1.07–3.04)          | 2.19* (1.12–4.28)    |
| Up to secondary     | 38.89                  | 1                       | 1                    | 1                    | 33.33                   | 1                       | 1                    | 1                    |
| Housewife           | 46.79                  | 1                       | 1                    | 1                    | 38.27                   | 1                       | 1                    | 1                    |
| **Economic status** |                        |                         |                      |                      |                        |                         |                      |                      |
| Rs. ≤1000           | 60.61                  | 13.21**                 | 2.13* (1.29–3.5)     | 1.51 (0.6–3.78)      | 56.23                   | 14.35***                | 2.07** (1.25–3.43)   | 1.65 (0.67–4.05)     |
| Rs. 1001–4000       | 47.25                  | 1.24                    | (0.73–2.1)           | 1.15 (0.49–2.72)     | 41.21                   | 1.13                    | (0.66–1.93)          | 1.09 (0.47–2.54)     |
| Rs. > 4000          | 41.98                  | 1                       | 1                    | 1                    | 38.27                   | 1                       | 1                    | 1                    |
| **Family size**     |                        |                         |                      |                      |                        |                         |                      |                      |
| ≤4                  | 58.76                  | 6.67*                   | 1.48* (1.03–2.12)    | 1.46 (0.96–2.22)     | 53.09                   | 6.78*                   | 1.41 (0.99–2.02)     | 1.36 (0.91–2.05)     |
| ≥5–7                | 49.07                  | 1                       | 1                    | 1                    | 44.44                   | 1                       | 1                    | 1                    |
| ≥8                  | 64.29                  | 1.87                    | (0.96–3.64)          | 1.3 (0.62–2.74)      | 61.9                    | 2.03                    | (1.05–3.93)          | 1.69 (0.83–3.49)     |
| **Type of house**   |                        |                         |                      |                      |                        |                         |                      |                      |
| Kutchha             | 57.65                  | 1.66                    | 1.32 (0.74–2.35)     | 0.43 (0.17–1.11)     | 51.76                   | 1.16                    | 1.34 (0.75–2.39)     | 0.48 (0.19–1.17)     |
| Semi-pucca          | 51.99                  | 1.05                    | (0.61–1.79)          | 0.52 (0.22–1.19)     | 48.01                   | 1.15                    | (0.67–1.98)          | 0.63 (0.28–1.39)     |
| Pucca               | 50.79                  | 1                       | 1                    | 1                    | 44.44                   | 1                       | 1                    | 1                    |
| **Sanitation**      |                        |                         |                      |                      |                        |                         |                      |                      |
| Toilet Present      | 49.77                  | 9.41**                  | 1                    | 1                    | 44.84                   | 10.92***                | 1                    | 1                    |
| Toilet Absent       | 64.93                  | 1.93***                 | (1.29–2.89)          | 1.72* (0.98–3.02)    | 61.19                   | 1.94***                 | (1.3–2.88)          | 1.76* (1.01–3.04)    |

*P < .05; **P < .01; ***P < .001.
compared to working mothers. Mesfin et al. [46] also noted in their studies that the risk of stunting was greater for children born to working mothers than those born to housewives. Social class difference too had also found in child undernutrition. The risk of being undernourished was significantly higher among lower social class (Scheduled Tribe and Scheduled Caste) adolescent compared to the upper or middle social class. This may be because availability and accessibility of health care services in rural areas are not in par with urban areas. As the socially backward groups have little exposure to the outside world, they probably stick to their traditional beliefs related to food preparation methods, child care, feeding practices, etc. [47], which have important implications for child nutrition. In addition to this, they live in inaccessible remote areas and hence, there is an issue of availability and accessibility. After controlling the effect of other variables, differentials in adolescent undernutrition by economic status, family size and type of house were not in evidence, indicating that differentials in undernutrition were confounded by other socioeconomic factors. Adolescents reared in joint families were found less likely to be stunted than those in nuclear families. Sapkota and Gurung [8], reported that the children who were reared in nuclear families were more likely to be stunted than those raised in joint families. Studies conducted on prevalence and determination of malnutrition among children in Nigeria showed that malnutrition was significantly associated with gender and age of child, education of mother, calorie intake of the households, access to clean water and presence of toilet in the households [48]. Similar research conducted in Nepal showed that, poor socioeconomic status was found as the risk factors for both stunting and being underweight [8]. Malnutrition varies from country to country depending on ecological, social, economic, and other factors. In India, at present, the most serious nutritional problems are mainly due to poverty. Tesfaye [9] reported that the main predictors of children nutritional status were maternal education, occupation of mother, age of mothers, preceding birth interval, age of child, sex of child, source of water drinking and place of residence. India, with a population of more than 1 billion, has many challenges in improving the health of its citizens. Steady declines have been noted in the fertility rate, maternal mortality, infant and child mortalities and the prevalence of severe manifestations of nutritional deficiencies, but the pace has been slow. From the foregoing analysis, it is evident that undernutrition among adolescent shows a gloomy picture in West Bengal. In the present investigation, approximately 54% of adolescent were stunted, and 49% were thin. The present study showed that socially, economically and educationally weaker sections of this state were more likely to be undernourished. In addition to the existing universal education program, there is a need to provide mass education regarding health and child nutrition in the rural regions, particularly among the socioeconomic groups that are educationally lagging. In this endeavor, cooperation is necessary among the government, non-governmental organizations, medical personnel and the local people. The results of the present study will be useful for policy makers and programmers to formulate various developmental and health care programs. Nutritional intervention is also necessary to improve the nutritional status among the adolescents.

5. Study limitation
The current study has certain limitations. Different factors affecting adolescent nutritional status were studied; however, some potential confounders, such as the physical activity of the study participants, age of the mother at first birth, mother’s BMI, preceding birth interval, diarrhea episode, prevalence of various parasitic infestation, type of food consume and method of feeding, were not studied. There are limitations associated with using cross-sectional data, as in every cross sectional study, conclusions related to cause and effect cannot be drawn. A longitudinal dataset would be better suited to examine the influence of sociodemographic factors on nutritional status of adolescent. However, as far as we are aware, this is the only provincial study to define the relationship between sociodemographic factors and nutritional status of adolescent. This study was conducted among 10- to 17-year-old children. Additional study is needed for children under 10 years of age.

Ethical approval
Ethical approval and prior permission were obtained from the institutional Ethics Committee before commencement of the study.

Conflict of interest
The authors declare that there are no conflicts of interest.

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