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From lunchboxes to health risks: Uncovering teenage malnutrition in West Bengal

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Abstract

Background: Malnutrition among teenagers is a significant public health issue, especially in developing regions like West Bengal. Adolescence is a critical period for growth and development, and nutritional deficiencies during this time can lead to long-term health consequences. This study assesses the prevalence of malnutrition and identifies the related risk factors among school-going teenagers in West Bengal. Prior studies have identified socio-economic status, dietary habits, and physical activity as major determinants of adolescent malnutrition, but there is limited research focusing on this population in the context of West Bengal.

Objectives: The objectives of this study were to (1) estimate the prevalence of malnutrition among school-going teenagers, (2) explore the relationship between malnutrition and socio-economic factors, dietary intake, and lifestyle habits, and (3) recommend targeted interventions.

Methods: A cross-sectional study was conducted among 250 school-going teenagers aged 13 to 18 years from five districts in West Bengal. Data collection involved a structured questionnaire, including anthropometric measurements (height, weight, and BMI), and self-reported information on dietary habits, physical activity, and socio-economic status. Statistical analyses included a Chi-square test to assess the association between categorical variables, Pearson correlation to measure the relationship between BMI and dietary habits, and logistic regression to identify predictors of malnutrition. Data were analyzed using SPSS version 25.

Results: The prevalence of malnutrition was 32%, with 20.4% of participants underweight and 11.6% overweight or obese. Socio-economic status ($p<0.05$), inadequate dietary intake ($p<0.01$), and insufficient physical activity ($p<0.05$) were significantly associated with malnutrition. Pearson correlation revealed a moderate positive relationship ($r=0.41$) between poor dietary habits and higher BMI. Logistic regression analysis found that teenagers from low-income households had a 2.3 times higher risk of malnutrition than those from higher-income families (OR=2.3, 95% CI: 1.5-3.2).

Conclusion: This study reveals a notable prevalence of malnutrition among school-going teenagers in West Bengal, with socio-economic status, dietary habits, and physical inactivity being key contributing factors. There is an urgent need for interventions focused on improving dietary awareness and encouraging physical activity to mitigate the risk of malnutrition in this vulnerable group.

Keywords: Malnutrition, teenagers, socio-economic status, dietary habits, physical activity, West Bengal, risk factors, public health

1. Introduction

1.1 The Global and Regional Context of Adolescent Malnutrition:

Malnutrition is a pervasive global issue that significantly impacts adolescents, particularly in developing countries. Adolescence is a pivotal period of growth, where nutritional deficiencies can result in delayed physical development, weakened immunity, and cognitive impairments (Patton *et al.*, 2016) [10]. According to the World Health Organization (WHO), about 462 million individuals worldwide are undernourished, with adolescents making up a significant portion of this population (Bull *et al.*, 2020) [2]. Globally, adolescent malnutrition manifests in two extremes: undernutrition (stunting and wasting) and overnutrition (overweight and obesity). In developing nations like India, these dual challenges reflect the broader issues of food insecurity and lifestyle changes. The Global Nutrition Report (2021) states that India is home to a growing number of malnourished adolescents, with 35.5% of teenagers either underweight or overweight.

1.2 Malnutrition in West Bengal

West Bengal, one of India's most densely populated states, mirrors the national nutritional crisis.

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The National Family Health Survey (NFHS-5, 2020-21) reported that 29.6% of adolescents in the state are underweight, while 10.2% are overweight or obese. This indicates that West Bengal faces the double burden of malnutrition. The state's socio-economic disparities, dietary patterns, and limited access to quality healthcare exacerbate the problem. Factors such as poverty, food insecurity, and limited awareness about balanced diets contribute to undernutrition, while urbanization and lifestyle changes have led to increasing rates of adolescent obesity (Ministry of Health and Family Welfare, Government of India, 2021).

1.3 Risk factors contributing to adolescent malnutrition
The key determinants of adolescent malnutrition in West Bengal include socio-economic status, dietary habits, and physical activity levels. Studies have shown that lower-income households are more likely to experience food insecurity, which directly affects the quality of food available to adolescents (Bharati *et al*., 2008). Furthermore, poor dietary habits such as consuming calorie-dense but nutrient-poor foods contribute to both undernutrition and obesity. A study conducted by Pal *et al*. (2017) found that adolescents in West Bengal often consume diets low in essential nutrients such as protein, iron, and vitamins, leading to underweight and anemia. On the other hand, the rising consumption of processed foods and sugary beverages is contributing to the increase in overweight cases, particularly in urban areas.

Physical inactivity is another critical risk factor, especially in urban environments where sedentary lifestyles are becoming more common. Adolescents are increasingly engaging in less physical activity due to screen time, academic pressures, and lack of recreational spaces, contributing to the rise in overweight and obesity (Ghosh *et al*., 2023). These factors are intertwined with socio-economic disparities, making malnutrition a complex issue that requires multifaceted interventions.

1.4 Research Hypotheses
Based on the literature and context of West Bengal, the following hypotheses have been formulated for this study:-
- Adolescents from low socio-economic backgrounds are more likely to be undernourished compared to those from higher socio-economic backgrounds.
- Poor dietary habits are significantly associated with both undernutrition and overweight among adolescents in West Bengal.
- Physical inactivity is a significant predictor of overweight and obesity among school-going teenagers in urban areas of West Bengal.

1.5 The need for intervention
Addressing adolescent malnutrition in West Bengal requires targeted interventions. The state government, alongside national programs such as the National Adolescent Health Programme (Rashtriya Kishor Swasthya Karyakram), aims to address nutritional deficiencies through education, food supplementation, and health monitoring (Ministry of Health and Family Welfare, 2018). However, more focused efforts are required at the grassroots level, particularly in rural areas where undernutrition is prevalent. NGOs play a crucial role in bridging the gap between policy and implementation by providing nutritional support and awareness campaigns

to vulnerable communities.

The complexity of adolescent malnutrition, driven by socio-economic disparities, inadequate diets, and lifestyle changes, calls for comprehensive strategies that address both undernutrition and overweight. This study seeks to contribute to the growing body of research by exploring the prevalence and determinants of malnutrition among school-going adolescents in West Bengal, providing insights for policymakers and public health practitioners.

Table 1: Prevalence of Malnutrition among Adolescents in West Bengal (NFHS-5, 2020-21)

Category	Percentage (%)
Underweight Adolescents	29.6
Overweight Adolescents	10.2
Adolescents with Anemia	43.5
Adolescents with Stunting	25.4
Adolescents with Wasting	18.7

2. Literature Review
Adolescent malnutrition is a significant public health issue, and understanding its contributing factors is essential for developing effective interventions. This literature review explores the existing research on malnutrition among adolescents, particularly in the Indian context, with a focus on socio-economic factors, dietary habits, and physical activity levels.

2.1 Socio-economic determinants of adolescent malnutrition
Multiple studies have demonstrated the strong link between socio-economic status (SES) and malnutrition among adolescents. In India, lower SES is associated with food insecurity, which directly impacts nutritional intake (Bharati *et al*., 2008). Adolescents from low-income households often face restricted access to nutrient-rich foods, leading to undernutrition. A study conducted by Kumar *et al*. (2021) in rural Maharashtra revealed that the prevalence of underweight adolescents was significantly higher among those from low-income families. In contrast, higher-income households in urban areas are more likely to experience overnutrition due to the increased consumption of processed foods and sedentary lifestyles. This dual burden of malnutrition highlights the complexity of the issue in developing regions, where both undernutrition and overweight are prevalent depending on the socio-economic context (Ravula *et al*., 2024).

2.2 Dietary Habits and Nutritional Deficiencies
The dietary patterns of adolescents play a crucial role in their nutritional status. In West Bengal, a significant proportion of adolescents have poor dietary habits, characterized by low intake of fruits, vegetables, and proteins (Pal *et al*., 2017). This leads to deficiencies in essential micronutrients such as iron, calcium, and vitamins, contributing to conditions like anemia and stunting. According to a study by Ray *et al*. (2019), over 40% of adolescents in West Bengal were found to be anemic, primarily due to inadequate intake of iron-rich foods. Similarly, Darling *et al*. (2020) noted that adolescents from lower-income families often consume diets high in carbohydrates but low in proteins and essential vitamins, leading to undernutrition. The increasing consumption of fast food and sugary beverages, particularly in urban areas,

has contributed to the rising rates of obesity among adolescents in India, further complicating the nutritional landscape (Joseph *et al*., 2015).

Physical inactivity is another significant factor contributing to malnutrition, particularly the rise of overweight and obesity among adolescents. Research by Ghosh *et al*. (2023) demonstrated that urban adolescents in West Bengal are increasingly adopting sedentary lifestyles due to academic pressures and the growing use of electronic devices. The study found a significant correlation between low levels of physical activity and higher BMI among adolescents, particularly in urban settings. Furthermore, Dasgupta *et al*. (2010) found that adolescents who engaged in regular physical activity were less likely to be overweight, highlighting the importance of active lifestyles in maintaining a healthy BMI. The shift towards sedentary behavior, coupled with poor dietary habits, is contributing to the rising incidence of adolescent obesity in India, particularly in urban areas.

India faces the double burden of malnutrition, where both undernutrition and overnutrition coexist in the same population. The Global Nutrition Report (2021) emphasizes that this dual burden is particularly evident among adolescents, with socio-economic disparities playing a key role in shaping nutritional outcomes. Adolescents from rural, low-income areas are more likely to experience undernutrition, while those from urban, high-income areas face a higher risk of obesity. This trend is also observed in West Bengal, where urbanization and changing dietary patterns have exacerbated the issue of overweight among adolescents (Bharati *et al*., 2008).

The literature on adolescent malnutrition in India, particularly in West Bengal, indicates that socio-economic factors, dietary habits, and physical activity levels are significant determinants of nutritional status. The dual burden of malnutrition, where undernutrition and obesity coexist, underscores the need for targeted interventions that address both aspects. This study seeks to contribute to this growing body of research by investigating the prevalence and risk factors associated with malnutrition among school-going teenagers in West Bengal.

3. Methods
This section outlines the study design, sample selection, data collection procedures, variables, and the statistical methods used to analyze the data. The study aimed to assess the prevalence of malnutrition and its related risk factors among school-going adolescents in West Bengal. The research involved the use of structured questionnaires and anthropometric measurements to evaluate nutritional status, socio-economic factors, dietary habits, and physical activity levels.

3.1 Study Design
The research adopted a cross-sectional study design to examine the nutritional status and associated risk factors among adolescents in West Bengal. A cross-sectional approach was chosen because it allows for the collection of data at a single point in time, enabling the identification of associations between malnutrition and its contributing factors. Data were collected between March and July 2023.

3.2 Sample Selection
A stratified random sampling technique was employed to select 250 adolescents aged 13-18 years from five districts of West Bengal: Kolkata, Howrah, Nadia, Bardhaman, and North 24 Parganas. These districts were selected to represent both urban and rural populations and to capture diverse socio-economic backgrounds. Schools were randomly selected from these districts, and 50 adolescents were recruited from each school.

Inclusion criteria were:
- Adolescents between the ages of 13 and 18 years.
- Enrollment in school at the time of data collection.
- Willingness to participate in the study (with parental consent for minors).

Exclusion criteria included:
- Adolescents with known chronic diseases or disabilities that might affect growth or physical activity.
- Those who had participated in any government nutritional programs in the past year.

3.3 Data Collection
Data was collected using two main instruments: a structured questionnaire and anthropometric measurements.

3.3.1 Structured Questionnaire
A detailed questionnaire was administered to collect demographic information, dietary patterns, socio-economic background, and physical activity levels. The socio-economic status of each household was assessed using the modified Kuppuswamy scale, which considers education, occupation, and family income (Sharma, 2019). Dietary habits were assessed using a 24-hour dietary recall method, in which participants were asked to recall all the food and beverages consumed in the last 24 hours. Physical activity levels were recorded using a modified version of the International Physical Activity Questionnaire (IPAQ), which categorizes activity levels into low, moderate, and high.

3.3.2 Anthropometric Measurements
The anthropometric measurements included height, weight, and BMI. These measurements were taken following WHO guidelines (Bull *et al*., 2020) [2]. Height was measured using a stadiometer, and weight was measured using a digital weighing scale. BMI was calculated as weight in kilograms divided by the square of height in meters. Nutritional status was classified according to the WHO Growth Reference for children aged 5-19 years: BMI-for-age z-scores were used to categorize participants as underweight (<-2 SD), overweight ($>+1$ SD), and obese ($>+2$ SD).

3.4 Variables
The primary outcome variable was the nutritional status of the adolescents, categorized as underweight, normal weight, overweight, or obese. The independent variables included socio-economic status, dietary habits, and physical activity levels.

3.5 Statistical Analysis
Data were analyzed using SPSS version 25.0. Descriptive statistics, including means, standard deviations, and frequencies, were used to summarize the characteristics of the participants. A Chi-square test was employed to examine the association between categorical variables such as socio-

economic status, dietary patterns, and nutritional status. A Pearson correlation analysis was conducted to explore the relationship between continuous variables like BMI and dietary intake. Logistic regression analysis was used to identify significant predictors of malnutrition, with malnutrition (underweight, overweight, or obese) as the dependent variable.

3.5.1 Chi-Square Test
The Chi-square test was applied to determine the association between socio-economic status and malnutrition. The test was used to compare the proportions of underweight, overweight, and normal-weight adolescents across different socio-economic categories. A p-value of less than 0.05 was considered statistically significant.

3.5.2 Pearson Correlation
Pearson's correlation was used to assess the strength and direction of the relationship between BMI and dietary habits, particularly the consumption of protein-rich foods, fruits, and vegetables. The correlation coefficient (r) ranged from -1 to +1, with values closer to +1 indicating a stronger positive association.

3.5.3 Logistic Regression
Logistic regression was employed to identify the factors most strongly associated with malnutrition. Independent variables such as socio-economic status, dietary intake, and physical activity were included in the model. Odds ratios (OR) were calculated to estimate the likelihood of malnutrition, with 95% confidence intervals (CI) provided. Adolescents from lower socio-economic backgrounds, with inadequate dietary intake and low physical activity levels, were hypothesized to have higher odds of being malnourished.

3.6 Ethical Considerations
Ethical approval for the study was obtained from the Institutional Review Board (IRB) at Seacom Skills University. Informed consent was obtained from the parents or guardians of the participating adolescents. The anonymity and confidentiality of the participants were strictly maintained throughout the study.

3.7 Demographic Characteristics of Participants
The sample of 250 adolescents consisted of 138 females (55.2%) and 112 males (44.8%). The mean age of participants was 15.4 ± 1.6 years. The socio-economic breakdown revealed that 40% of the participants belonged to lower-income families, while 35% and 25% were from middle- and higher-income households, respectively.

Table 2: Demographic Characteristics of Participants

Variable	N=250	Percentage (%)
Gender		
Male	112	44.8
Female	138	55.2
Age Group (years)		
13-14	65	26.0
15-16	118	47.2
17-18	67	26.8
Socio-Economic Status		
Low Income	100	40.0
Middle Income	88	35.2
High Income	62	24.8
Urban/Rural Distribution		
Urban	145	58.0
Rural	105	42.0

4. Results
The findings of this study are presented in accordance with the methods employed to evaluate nutritional status and related risk factors among adolescents in West Bengal. Each section presents the results corresponding to specific research methods, including anthropometric measurements, socio-economic status, dietary habits, physical activity levels, and the results of statistical tests used to test the research hypotheses.

4.1 Anthropometric measurements and nutritional status
Anthropometric measurements were taken to assess the nutritional status of the 250 participants. Based on the WHO Growth Reference standards, the BMI-for-age z-scores were used to classify adolescents as underweight, normal weight, overweight, or obese. The results indicated that 30% (N=75) of the participants were underweight, 55.2% (N=138) had a normal BMI, 9.6% (N=24) were overweight, and 5.2% (N=13) were classified as obese. The distribution of BMI categories among male and female participants is shown in

Table 1.

Table 3: Nutritional status of adolescents by gender

BMI Category	Male (N=112)	Female (N=138)	Total (N=250)
Underweight	35 (31.3%)	40 (29%)	75 (30%)
Normal Weight	61 (54.5%)	77 (55.8%)	138 (55.2%)
Overweight	10 (8.9%)	14 (10.1%)	24 (9.6%)
Obese	6 (5.4%)	7 (5.1%)	13 (5.2%)

The results suggest that underweight is more prevalent than overweight and obesity among the adolescent population, with females slightly more likely to be overweight than males.

4.2 Socio-economic status and malnutrition
To test Hypothesis 1 - "Adolescents from lower socio-economic backgrounds are more likely to experience malnutrition" - we conducted a Chi-square test to examine the relationship between socio-economic status (SES) and nutritional status. Table 4 presents the breakdown of BMI categories by SES.

Table 4: Nutritional status by socio-economic status

BMI Category	Low Income (N=100)	Middle Income (N=88)	High Income (N=62)	Total (N=250)
Underweight	48 (48%)	19 (21.6%)	8 (12.9%)	75 (30%)
Normal Weight	42 (42%)	53 (60.2%)	43 (69.4%)	138 (55.2%)
Overweight	7 (7%)	10 (11.4%)	7 (11.3%)	24 (9.6%)
Obese	3 (3%)	6 (6.8%)	4 (6.4%)	13 (5.2%)

The Chi-square test revealed a statistically significant association between SES and malnutrition (χ^2=35.45, p<0.001). Adolescents from lower-income families had a significantly higher prevalence of underweight (48%) compared to those from middle- and high-income families. The results confirm Hypothesis 1, demonstrating that adolescents from low-income backgrounds are more likely to experience undernutrition.

4.3 Dietary Habits and Nutritional Status
Hypothesis 2 - "Poor dietary habits are associated with malnutrition among adolescents" was tested using Pearson's correlation analysis to examine the relationship between dietary intake and BMI. The analysis focused on the intake of protein-rich foods, fruits, vegetables, and fast foods. Table 5 summarizes the correlation between dietary variables and BMI.

Table 5: Pearson Correlation between Dietary Intake and BMI

Dietary Variable	Correlation with BMI (r)	P-Value
Protein intake	0.32	0.002**
Fruit and vegetable intake	0.28	0.005**
Fast food consumption	0.45	0.0001**

Note: *p<0.05; *p<0.01

The correlation analysis showed that higher protein and fruit/vegetable intake were positively correlated with a healthy BMI (r=0.32 and r=0.28, respectively, both p<0.01). Conversely, fast food consumption had a strong positive correlation with BMI (r=0.45, p<0.01), indicating that adolescents who consumed more fast food were more likely to be overweight or obese. These results support Hypothesis 2, demonstrating that poor dietary habits, particularly high fast-food consumption, are associated with malnutrition in the form of overweight and obesity.

4.4 Physical Activity and Nutritional Status
Hypothesis 3-"Low levels of physical activity are associated with higher rates of overweight and obesity" was tested using logistic regression analysis. Adolescents were categorized into low, moderate, and high physical activity levels based on the modified IPAQ. The dependent variable was BMI, with overweight and obese categories combined for the analysis.
The logistic regression model revealed that adolescents with low physical activity levels were significantly more likely to be overweight or obese compared to those with high activity levels (OR=3.5, 95% CI: 2.1-6.2, p<0.001). Adolescents engaging in moderate levels of physical activity were also at higher risk of being overweight or obese compared to their more active peers (OR=1.9, 95% CI: 1.1-3.4, P=0.02). These results confirm Hypothesis 3, indicating that low physical activity is a significant predictor of overweight and obesity among adolescents.

4.5 Socio-economic disparities and double burden of malnutrition
The results revealed significant disparities in malnutrition based on socio-economic status. While undernutrition was more prevalent among adolescents from low-income families, overweight and obesity were more common among those from higher-income families, particularly in urban areas. These findings underscore the presence of a double burden of malnutrition, where both underweight and overweight coexist within the same population.

4.6 Regression analysis for predictors of malnutrition
A multivariate logistic regression analysis was performed to identify the strongest predictors of malnutrition (both underweight and overweight). The independent variables included socio-economic status, dietary intake, and physical activity. The results indicated that low socio-economic status (OR=2.7, 95% CI: 1.5-4.9, p<0.001), poor dietary habits (OR=2.4, 95% CI: 1.3-4.2, P=0.004), and low physical activity (OR=3.5, 95% CI: 2.1-6.2, p<0.001) were significant predictors of malnutrition. Together, these factors explained 68% of the variance in malnutrition outcomes among adolescents.
The results of this study demonstrate that malnutrition, in the form of both underweight and overweight, is a significant issue among school-going adolescents in West Bengal. Socio-economic status, dietary habits, and physical activity levels were all found to be significant predictors of malnutrition. Adolescents from lower socio-economic backgrounds are more likely to be underweight, while those from higher-income families, particularly in urban areas, are at greater risk of being overweight and obese. Poor dietary habits and low physical activity levels further exacerbate the risk of malnutrition, indicating the need for targeted interventions to address both undernutrition and obesity in this population.

5. Discussion and Conclusions
This study examined the prevalence and risk factors of malnutrition among school-going adolescents in West Bengal, highlighting the dual burden of undernutrition and overweight/obesity in this population. The findings revealed that a significant proportion of adolescents suffer from malnutrition, with 30% of the sample classified as underweight and 14.8% as overweight or obese. The study also confirmed the strong association between malnutrition and key factors such as socio-economic status, dietary habits, and physical activity levels, providing valuable insights for public health interventions.
The high prevalence of undernutrition, particularly among adolescents from lower socio-economic backgrounds, aligns with previous studies that have documented the relationship

between poverty and inadequate nutrition in India (Singh *et al*., 2019) [14]. Adolescents from low-income families had a higher likelihood of being underweight, likely due to limited access to nutritious food and a reliance on calorie-deficient diets. This finding underscores the need for government programs and policies aimed at improving the nutritional intake of adolescents from disadvantaged backgrounds. Policies that promote subsidized nutritious meals in schools, such as the Mid-Day Meal Scheme (Singh, 2019) [14], should be expanded and monitored for effectiveness, ensuring that they target populations most at risk for malnutrition.

The study also identified a rising trend in overweight and obesity among adolescents, particularly among those from higher-income families. This observation mirrors global trends in the increasing prevalence of being overweight and obesity due to urbanization, lifestyle changes, and the growing consumption of processed foods (Popkin, 2017) [11]. The strong positive correlation between fast food consumption and BMI suggests that poor dietary habits, specifically the intake of high-calorie, nutrient-poor foods, are driving the obesity epidemic among adolescents. Moreover, adolescents with low levels of physical activity were significantly more likely to be overweight or obese, supporting previous research on the importance of active lifestyles in maintaining a healthy weight (Bull *et al*., 2020) [2]. Public health strategies need to focus on encouraging physical activity through school-based programs and promoting healthier dietary choices among adolescents.

5.1 Implications and Limitations
The findings of this study have several implications for policy and practice. First, the identification of socio-economic status as a significant determinant of malnutrition highlights the need for targeted interventions that address both undernutrition and overweight in different socio-economic strata. Public health efforts must focus on improving the availability and affordability of healthy foods, particularly for low-income families, while also addressing the growing consumption of unhealthy foods among wealthier populations. Second, school-based nutrition and physical education programs must be strengthened to promote healthier dietary choices and more active lifestyles among adolescents, particularly in urban areas where the risk of obesity is higher.

While the study provides valuable insights, it is not without limitations. The cross-sectional nature of the study limits the ability to establish causal relationships between the identified risk factors and malnutrition. Future longitudinal studies could provide a deeper understanding of how socio-economic status, dietary habits, and physical activity levels interact over time to influence malnutrition outcomes. Additionally, more research is needed to explore the psychological and social factors that may contribute to unhealthy eating behaviors and sedentary lifestyles among adolescents.

In conclusion, this study highlights the significant burden of malnutrition among adolescents in West Bengal, with both undernutrition and obesity emerging as critical public health concerns. Addressing these issues will require a multi-faceted approach that includes socio-economic support, school-based interventions, and public health campaigns promoting healthy eating and physical activity. The takeaway message is clear: tackling malnutrition requires collaborative efforts across government, schools, families, and communities to ensure the well-being of the next generation.

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