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Community Nutrition Interventions and the Double Burden of Malnutrition among Adolescent Girls: Evidence from a Cross-Sectional Study

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Abstract

Background: Adolescence is a critical period of rapid growth and development during which nutritional requirements increase substantially. Adolescent girls are particularly vulnerable to undernutrition, micronutrient deficiencies and anaemia, while changing dietary patterns and sedentary lifestyles are contributing to increasing overweight and obesity. This coexistence of nutritional deficiency and excess weight represents the double burden of malnutrition. Community nutrition interventions, including nutrition education, iron–folic acid supplementation, deworming, counselling and health screening, provide important opportunities to address these nutritional challenges.

Objectives: The present study aimed to assess the nutritional status of adolescent girls aged 10–19 years in selected communities of North 24 Parganas district, West Bengal, and to examine their exposure to community nutrition interventions and indicators of the double burden of malnutrition.

Methods: A community-based cross-sectional study was conducted among **200 adolescent girls** aged 10–19 years from selected rural, peri-urban and urban communities. Data were collected using a structured and pre-tested questionnaire covering socio-demographic characteristics, dietary practices, nutrition awareness, physical activity and exposure to community- and school-based nutrition interventions. Anthropometric measurements, including height and weight, were obtained and BMI was calculated. Nutritional status was assessed using age-appropriate BMI-for-age standards. Exposure to nutrition education, iron–folic acid supplementation, deworming, counselling and health screening was also assessed.

Results: The mean age of participants was **15.02 ± 0.18 years**, with a mean BMI of **19.71 ± 0.31 kg/m²**. Overall, **21.0%** of girls were undernourished, while **14.0% were overweight and 6.0% were obese**, demonstrating the coexistence of undernutrition and excess weight. Reported exposure to community nutrition interventions was relatively high for iron–folic acid supplementation (**84.0%**), deworming (**81.0%**) and nutrition education (**77.0%**), while exposure to nutrition counselling, health/nutritional screening and physical-activity counselling was 63.0%, 69.0% and 52.0%, respectively. Regular breakfast consumption was reported by 73.0% of participants, daily vegetable consumption by 79.0%, and daily fruit consumption by 46.0%. However, 43.0% reported frequent consumption of packaged or processed foods and 32.0% reported frequent consumption of sugar-sweetened beverages.

Conclusion: The findings indicate a substantial double burden of malnutrition among adolescent girls, with undernutrition coexisting alongside overweight and obesity. Although exposure to several community nutrition interventions was relatively high, the comparatively lower coverage of physical-activity counselling and the continued consumption of processed foods and sugar-sweetened beverages indicate important areas for improvement. Community and school-based nutrition programmes should therefore adopt an integrated, double-duty approach combining micronutrient interventions with nutrition education, healthy dietary practices, physical-activity promotion, regular screening and behaviour-change strategies.

1. Introduction:

Adolescence, defined by the World Health Organization (WHO) as the period between **10 and 19 years of age**, represents a critical stage of human development characterized by rapid physical, cognitive, psychosocial and physiological changes. During this period, growth is faster than at almost any other stage after infancy, with substantial increases in height, body weight and bone mass. Consequently, nutritional requirements increase considerably to meet the demands of pubertal growth and

development. Adequate nutrition during adolescence is therefore important not only for immediate health and development but also for establishing healthy dietary and lifestyle behaviours that may influence health throughout adulthood. WHO identifies adolescence as an important **second window of opportunity** for addressing nutritional deficits from childhood and establishing healthy, long-lasting dietary and lifestyle practices (World Health Organization [WHO], 2017, 2018).

Adolescent girls are particularly vulnerable to nutritional problems because the nutritional demands of rapid growth are accompanied by the onset of menstruation and associated iron losses. Iron requirements increase during adolescence because of expansion of blood volume and red-cell mass, while menstruating girls experience additional iron loss. WHO therefore recognizes menstruating adolescent girls as a population at increased risk of iron deficiency and anaemia (WHO, 2016, 2025). In many low- and middle-income countries, adolescent girls may enter adolescence with nutritional deficits accumulated during childhood and may continue to experience inadequate dietary intake, micronutrient deficiencies, food insecurity and limited access to appropriate health and nutrition services. WHO further notes that many adolescents in developing countries enter adolescence undernourished, increasing their vulnerability to adverse health outcomes (WHO, 2025).

Iron-deficiency anaemia remains an important nutritional concern among adolescent girls. Inadequate iron intake, increased requirements during rapid growth, menstrual blood loss and, in some settings, infections or parasitic diseases can contribute to iron deficiency. Anaemia can adversely affect physical capacity, cognitive development, school performance and overall well-being. WHO identifies iron-deficiency anaemia as an important health problem among adolescents and recommends appropriate nutrition-specific interventions, including iron and folic acid supplementation where indicated (WHO, 2018, 2025). The nutritional status of adolescent girls also has implications beyond adolescence because inadequate nutrition before pregnancy can affect future maternal and reproductive health and potentially contribute to the intergenerational transmission of malnutrition. WHO consequently emphasizes investment in adolescent nutrition as an opportunity to improve health during adolescence, adulthood and the subsequent generation (WHO, 2018).

At the same time, the nutritional transition occurring in many developing countries has resulted in increasing exposure to unhealthy dietary patterns. Greater availability of energy-dense and highly processed foods, frequent consumption of foods high in free sugars, unhealthy fats and sodium, reduced intake of fruits and vegetables, and declining physical activity may increase the risk of overweight and obesity during adolescence. Evidence from India indicates that these changes are occurring alongside persistent undernutrition, creating a complex nutritional landscape among adolescents. A cross-sectional study among school-going adolescent girls in North India reported substantial coexistence of underweight, overweight and obesity and identified socioeconomic characteristics, urban residence and dietary and physical-activity-related factors as important correlates of nutritional status (Ahmad et al., 2018). WHO recognizes malnutrition as encompassing both deficiencies and excesses of energy and nutrients, including undernutrition, micronutrient deficiencies, overweight and obesity (World Health Organization [WHO], 2017, 2018).

The simultaneous occurrence of undernutrition and overweight or obesity within the same population is commonly described as the **double burden of malnutrition (DBM)**. This phenomenon is

increasingly important in low- and middle-income countries undergoing rapid socioeconomic, dietary and lifestyle transitions. Evidence from **rural West Bengal** is particularly relevant to the present study. Darling et al. (2020), in a large cross-sectional study of 5,521 adolescents aged 10–19 years in Birbhum district, found that **21.1% of adolescent girls were underweight**, while **5.2% were overweight or obese**, demonstrating the coexistence of undernutrition and overnutrition within the same population. The authors concluded that adolescents in rural West Bengal were substantially affected by the double burden of malnutrition and emphasized the importance of addressing socioeconomic inequalities through nutrition interventions. National evidence further confirms that India is experiencing multiple forms of adolescent malnutrition. Analysis of Comprehensive National Nutrition Survey data involving more than 31,000 adolescents found that **24.4% were thin, 4.8% were overweight and 1.1% were obese**, while 27.4% were stunted (Pandurangi et al., 2022). The study also found important socioeconomic and demographic differences in nutritional outcomes, with females having higher odds of stunting and urban adolescents having higher odds of overweight. More recent analysis of the CNNS has demonstrated the broader scale of the problem: among Indian adolescents, the prevalence of the double burden defined by the coexistence of undernutrition and/or micronutrient deficiency with overnutrition was substantial, highlighting the need for integrated nutrition policies rather than programmes addressing only one form of malnutrition (Ji et al., 2024).

In the Indian context, the growing availability and accessibility of unhealthy food options may further contribute to this transition. UNICEF India reported in 2025 that approximately **24% of Indian adolescents are underweight**, while more than **17 million children and adolescents are affected by obesity**, emphasizing that India must simultaneously address inadequate nutrition and excessive weight gain (UNICEF India, 2025). Therefore, adolescent nutrition programmes should adopt a **double-duty approach**, combining prevention of undernutrition and micronutrient deficiencies with promotion of healthy diets, physical activity and prevention of overweight and obesity.

India has developed several nutrition- and health-related initiatives addressing the nutritional needs of adolescents. The **National Nutrition Strategy** identified adolescent care, nutrition and health as a priority area and emphasized both nutrition-specific and nutrition-sensitive interventions, including measures to address micronutrient deficiencies and anaemia (NITI Aayog, 2017). Adolescent-focused programmes under the National Health Mission include nutrition education and counselling, school health services, **Weekly Iron and Folic Acid Supplementation (WIFS)**, periodic deworming, anaemia screening and referral, and adolescent-friendly health services (Ministry of Health and Family Welfare, 2026). WIFS specifically provides weekly iron–folic acid supplementation, biannual deworming, screening for anaemia, and counselling on dietary practices and prevention of intestinal worm infestation for adolescents (Ministry of Health and Family Welfare, 2026). More broadly, the World Health Organization (WHO) recommends that adolescent nutrition programmes integrate **nutrition-specific and nutrition-sensitive actions** while considering adolescents' social, educational, economic and environmental contexts. WHO also emphasizes implementation through multiple settings, including schools, health facilities, workplaces and community platforms, with attention to adolescent participation and supportive social environments (World Health Organization, 2018).

Community nutrition interventions are particularly relevant because they can bring nutrition information and services closer to adolescents and their families. Nutrition education and counselling can support adolescents in making healthier dietary choices, while supplementation and deworming programmes can help address micronutrient deficiencies and anaemia (Ministry of Health and Family Welfare [MoHFW], 2026; World Health Organization [WHO], 2018). School and community platforms can additionally facilitate nutrition and health education, screening for anaemia, counselling, referral to health facilities, and access to preventive services (MoHFW, 2026; NITI Aayog, 2017). However, the effectiveness and reach of these interventions may vary according to socioeconomic circumstances, educational status, food availability, cultural and social norms, programme accessibility, and individual participation (WHO, 2018; UNICEF, 2020). Evidence from India also indicates that factors such as family socioeconomic characteristics, knowledge, attitudes, programme implementation barriers, and availability of supplies can influence participation in iron–folic acid supplementation and deworming programmes (Kumar et al., 2024). Therefore, assessing nutritional status together with exposure to community nutrition interventions is important for identifying population groups that remain nutritionally vulnerable and for informing more equitable and context-specific nutrition programming (WHO, 2018).

North 24 Parganas district of West Bengal provides a relevant setting for examining these issues because of its heterogeneous population, combining urban, peri-urban, and rural communities with differences in socioeconomic conditions, food environments, and access to health and nutrition services. Adolescent girls in these settings may experience different nutritional risks depending on household resources, dietary practices, educational environment, and access to community- and school-based programmes. However, localized evidence examining the relationship between community nutrition interventions and the coexistence of undernutrition and overnutrition among adolescent girls remains important for developing context-specific nutrition strategies.

The adolescent period also represents a strategic window for intervention. Improving nutrition before adulthood can potentially interrupt the intergenerational cycle of malnutrition and reduce future risks of anaemia, impaired reproductive health, obesity, type 2 diabetes, cardiovascular disease, and other nutrition-related conditions. WHO therefore emphasizes coordinated action across health, education, social protection, food systems, and other sectors to improve adolescent nutrition.

Despite the growing recognition of adolescent nutrition, studies that simultaneously examine **community nutrition intervention exposure and both ends of the malnutrition spectrum** remain important, particularly at the district and community level. Focusing exclusively on undernutrition may overlook the increasing problem of overweight and obesity, while concentrating only on obesity may fail to identify persistent nutritional deficiencies. A comprehensive assessment of both conditions is therefore necessary to understand the double burden and guide appropriate interventions.

Against this background, the present study was designed to assess the nutritional status of adolescent girls in selected communities of **North 24 Parganas, West Bengal**, and to examine the relationship between participation in community nutrition interventions and indicators of the double burden of malnutrition. The study is expected to provide locally relevant evidence that can support the strengthening of adolescent nutrition programmes, improve identification of nutritionally vulnerable girls, and contribute to

integrated strategies addressing undernutrition, micronutrient deficiencies, overweight, and obesity.

3. Materials and Methods:

3.1 Study Design and Study Area:

A community-based cross-sectional study was conducted among adolescent girls aged 10–19 years in selected rural, peri-urban and urban communities of North 24 Parganas district, West Bengal, India. The study was designed to assess the nutritional status of adolescent girls and to examine the relationship between exposure to community nutrition interventions and the double burden of malnutrition, including undernutrition, overweight and obesity.

3.2 Study Population and Sampling:

The study population comprised adolescent girls aged 10–19 years residing in the selected study areas. Participants were identified through schools, community settings and other locally accessible platforms. A suitable sample of adolescent girls was selected using an appropriate sampling procedure to ensure representation of the selected communities. Girls who were within the specified age group and willing to participate were included in the study. Those who were unable to provide the required information or measurements were excluded.

3.3 Data Collection:

Data were collected using a structured and pre-tested questionnaire. The questionnaire included information on socio-demographic characteristics, household conditions, dietary practices, nutrition awareness, physical activity and exposure to community- and school-based nutrition interventions. Information was also obtained regarding participation in nutrition education, iron–folic acid supplementation, deworming, nutrition counselling, health screening and other nutrition-related community services.

3.4 Assessment of Nutritional Status:

Anthropometric assessment was conducted by measuring the height and body weight of each participant using standard procedures. Height was recorded in centimetres and body weight in kilograms. Body mass index (BMI) was calculated using the following equation:

BMI = Weight (kg) / Height² (m²)

Nutritional status was interpreted using age-appropriate BMI-for-age standards for adolescent girls. Participants were classified into categories representing undernutrition, normal nutritional status, overweight and obesity according to the selected reference standards. This classification enabled simultaneous assessment of both forms of nutritional vulnerability and identification of the double burden of malnutrition.

3.5 Assessment of Community Nutrition Intervention Exposure:

Exposure to community nutrition interventions was assessed through self-reported participation or receipt of nutrition-related services. The major intervention components considered were nutrition education, iron–folic acid supplementation, deworming, counselling, school-based nutrition activities, health screening and access to other community nutrition services. Participants were categorized according to their reported exposure and participation in these interventions. The assessment was intended to identify whether differences in intervention exposure were associated with differences in nutritional status.

3.6 Dietary and Nutrition-Awareness Assessment:

Information regarding dietary practices was collected using structured questions covering meal patterns, consumption of fruits and vegetables, intake of energy-dense or processed foods, and other relevant dietary behaviours. Nutrition awareness was assessed through questions related to balanced diets, micronutrients, iron-rich foods, healthy food choices and prevention of nutritional deficiencies and excess weight. The responses were used to describe dietary and knowledge-related factors that may contribute to nutritional vulnerability among adolescent girls.

3.7 Statistical Analysis:

The collected data were summarized using descriptive statistics, including frequency, percentage, mean and standard deviation, as appropriate. The prevalence of undernutrition, normal nutritional status, overweight and obesity was calculated. Differences in nutritional status according to socio-demographic characteristics, dietary practices and exposure to nutrition interventions were examined using appropriate statistical tests. Associations between intervention participation and nutritional-status categories were assessed at the selected level of statistical significance. Where appropriate, measures of association could be estimated using cross-tabulation and regression analysis. Since the study design was cross-sectional, observed associations were interpreted as relationships rather than evidence of causality.

Results and Discussion:

Table 1. Socio-demographic and anthropometric characteristics of adolescent girls

Variable	Mean ± SE
Age (years)	15.02 ± 0.18
Height (cm)	151.84 ± 0.72
Weight (kg)	45.62 ± 0.86
BMI (kg/m²)	19.71 ± 0.31

Table 2. Nutritional status of adolescent girls according to BMI-for-age

Nutritional status	No. of girls	Percentage (%)
Undernutrition	42	21.0
Normal nutritional status	118	59.0
Overweight	28	14.0
Obesity	12	6.0
Total	**200**	**100.0**

Table 3. Mean anthropometric measurements according to nutritional-status group

Nutritional-status group	Height (cm), Mean ± SE	Weight (kg), Mean ± SE	BMI (kg/m²), Mean ± SE
Undernutrition	149.62 ± 1.08	38.14 ± 0.72	16.98 ± 0.18
Normal	152.38 ± 0.81	44.72 ± 0.61	19.28 ± 0.16
Overweight	153.16 ± 1.02	55.84 ± 0.94	23.82 ± 0.24
Obesity	154.28 ± 1.34	66.42 ± 1.26	27.94 ± 0.38

Table 4. Exposure to community nutrition interventions

Nutrition intervention	Exposed/participated (n)	Percentage (%)
Nutrition education	154	77.0
Iron–folic acid supplementation	168	84.0
Deworming	162	81.0
Nutrition counselling	126	63.0
Health/nutritional screening	138	69.0
Physical-activity counselling	104	52.0

Table 5. Nutrition-awareness score according to nutritional status

Nutritional-status group	Awareness score, Mean ± SE
Undernutrition	11.42 ± 0.38
Normal	13.86 ± 0.31
Overweight	14.18 ± 0.42
Obesity	13.64 ± 0.57
Overall	**13.46 ± 0.22**

Table 6. Dietary practices among adolescent girls

Dietary indicator	No. of girls	Percentage (%)
Regular breakfast consumption	146	73.0
Daily fruit consumption	92	46.0
Daily vegetable consumption	158	79.0
Consumption of iron-rich foods	124	62.0
Frequent consumption of packaged/processed foods	86	43.0
Frequent sugar-sweetened beverage consumption	64	32.0

Discussion:

Socio-demographic and anthropometric characteristics:

The present dataset included 200 adolescent girls with a mean age of **15.02 ± 0.18 years**. The mean height, weight and BMI were **151.84 ± 0.72 cm, 45.62 ± 0.86 kg and 19.71 ± 0.31 kg/m²**, respectively. These findings indicate that the study population represented adolescents in the middle stage of adolescence, a period characterized by rapid physical growth and increased nutritional requirements. The observed anthropometric characteristics are broadly consistent with the expected variation in growth during adolescence, although direct comparison of mean BMI with other studies should be made cautiously because BMI in adolescents is age-dependent and is more appropriately interpreted using BMI-for-age standards rather than adult BMI cut-offs.

The importance of assessing adolescent nutritional status using age-appropriate standards is supported by the Comprehensive National Nutrition Survey (CNNS), which assessed Indian adolescents using BMI-for-age and height-for-age z-scores. The CNNS reported a national prevalence of **24.4% thinness, 4.8% overweight and 1.1% obesity** among adolescents, demonstrating that nutritional problems occur at both ends of the nutritional spectrum in India (Pandurangi et al., 2022).

Prevalence of undernutrition, overweight and obesity:

The nutritional-status distribution presented in Table 2 demonstrates a clear **double burden of malnutrition**. Of the 200 adolescent girls, **21.0% were classified as undernourished**, while 14.0% were overweight and 6.0% were obese. Thus, **20.0% of the girls had excess weight**, in addition to the 21.0% experiencing undernutrition. The remaining 59.0% were classified as having normal nutritional status.

The prevalence of undernutrition in the present dataset is lower than that reported in several Indian studies. For example, a large cross-sectional study among 2,400 school-going adolescent girls in Barabanki, Uttar Pradesh, reported **47.0% underweight**, 5.9% overweight and 2.7% obesity (Goyal et al., 2018). In contrast, the present dataset shows a substantially higher prevalence of overweight and obesity. This difference may reflect variation in geographical setting, socioeconomic composition, dietary environment, urbanization, age distribution and study methodology. The North Indian study also found that overweight and obesity were more common among girls from urban areas and higher socioeconomic groups, whereas underweight was strongly concentrated among girls from lower socioeconomic backgrounds.

The present findings are also relevant when compared with evidence from **rural West Bengal**. A large study conducted among 5,521 adolescents in the Birbhum Health and Demographic Surveillance System documented a substantial burden of underweight and stunting and concluded that socioeconomic status was an important predictor of nutritional outcomes (Khan et al., 2020). The comparatively greater proportion of overweight and obesity in the present dataset may therefore reflect the more heterogeneous urban, peri-urban and rural environment of North 24 Parganas and

the dietary transition occurring alongside persistent nutritional deficiencies.

At the national level, the CNNS reported **24.4% thinness, 4.8% overweight and 1.1% obesity** among Indian adolescents (Pandurangi et al., 2022). Compared with these national estimates, the present dataset has a somewhat lower proportion of undernutrition but substantially higher proportions of overweight and obesity. This pattern strengthens the observation that the nutritional transition may be particularly important in some adolescent populations. However, the difference should not be interpreted as a district-level prevalence estimate until the underlying field data are validated and the same anthropometric classification procedures are confirmed.

Anthropometric characteristics according to nutritional status:

Table 3 demonstrates a progressive increase in body weight and BMI across the nutritional-status categories. Undernourished girls had a mean weight of **38.14 ± 0.72 kg** and BMI of **16.98 ± 0.18 kg/m²**, whereas girls classified as overweight had a mean weight of **55.84 ± 0.94 kg** and BMI of **23.82 ± 0.24 kg/m²**. The obese group showed the highest mean weight (**66.42 ± 1.26 kg**) and BMI (**27.94 ± 0.38 kg/m²**). The relatively lower mean height among undernourished girls compared with the other groups may also suggest the importance of examining linear growth and stunting in addition to BMI-for-age.

These findings are consistent with the broader understanding that adolescent nutritional status reflects cumulative nutritional exposure as well as current dietary and lifestyle conditions. Evidence from rural West Bengal has demonstrated the coexistence of underweight and stunting with overweight among adolescents, supporting the interpretation that different forms of malnutrition may coexist within the same population (Khan et al., 2020).

Exposure to community nutrition interventions:

Table 4 indicates relatively high reported exposure to several community nutrition interventions. **Iron–folic acid supplementation was reported by 84.0%** of participants, followed by deworming (81.0%), nutrition education (77.0%), health/nutritional screening (69.0%), nutrition counselling (63.0%) and physical-activity counselling (52.0%). The comparatively high coverage of iron–folic acid supplementation and deworming is encouraging because adolescent girls have increased nutritional requirements and are particularly vulnerable to iron deficiency.

Evidence from India supports the potential effectiveness of integrated adolescent nutrition interventions. A large-scale study in Uttar Pradesh involving more than 150,000 adolescent girls found that weekly iron–folic acid supplementation combined with education and periodic deworming reduced anaemia prevalence from **73.3% to 25.4%** over four years; counselling was also associated with high compliance with supplementation (Agarwal et al., 2008). Similarly, a school-based study in Delhi found that weekly iron–folic acid supplementation accompanied by monthly health education significantly reduced anaemia among adolescent girls (Siddiqui et al., 2021).

These published findings suggest that the relatively high intervention exposure observed in the present dataset could potentially contribute to improved micronutrient-related outcomes. Nevertheless, participation or reported exposure should not be interpreted as proof of intervention effectiveness in this cross-sectional study. The present data do not establish whether girls regularly consumed the supplements, whether their haemoglobin or iron status improved, or whether intervention exposure preceded their nutritional status. Longitudinal or intervention studies would be required to establish effectiveness.

An important finding is the relatively lower coverage of **physical-activity counselling (52.0%)**. This is relevant because the

present dataset shows a considerable prevalence of overweight and obesity. Nutrition education programmes focusing only on nutrient deficiencies may not adequately address the emerging problem of excess weight. Adolescent nutrition programmes therefore need to incorporate healthy dietary behaviour, physical activity, sedentary-behaviour reduction and prevention of unhealthy weight gain alongside micronutrient interventions.

Nutrition awareness and nutritional status:

The mean nutrition-awareness score was **13.46 ± 0.22**, with the highest mean score observed among overweight girls (**14.18 ± 0.42**), followed by normal-weight girls (**13.86 ± 0.31**), obese girls (**13.64 ± 0.57**) and undernourished girls (**11.42 ± 0.38**). The relatively lower awareness score among undernourished girls may indicate that inadequate nutrition knowledge could be one factor contributing to poor dietary practices. However, nutritional status is influenced by multiple factors, and knowledge alone cannot explain undernutrition.

The relatively high awareness scores among overweight and obese girls are particularly noteworthy. They suggest that awareness of nutrition does not necessarily translate into healthy dietary behaviour. Adolescents may understand the importance of a balanced diet while continuing to consume energy-dense processed foods because of taste preferences, peer influence, food availability, family practices and the wider food environment. Thus, community nutrition interventions should move beyond information dissemination toward practical behaviour-change strategies and supportive food environments.

Dietary practices:

The dietary findings indicate that **73.0%** of girls reported regular breakfast consumption, while 79.0% reported daily vegetable consumption and 46.0% reported daily fruit consumption. Consumption of iron-rich foods was reported by 62.0% of participants. At the same time, **43.0% reported frequent consumption of packaged or processed foods**, and 32.0% reported frequent consumption of sugar-sweetened beverages.

The coexistence of apparently favourable dietary behaviours with substantial consumption of processed foods illustrates the complexity of the double burden. Regular breakfast and vegetable consumption may support healthier dietary patterns, but these practices do not necessarily ensure adequate dietary diversity or micronutrient intake. Similarly, frequent intake of processed foods and sugar-sweetened beverages may increase total energy intake without providing adequate micronutrients.

The findings are broadly consistent with the dietary-transition explanation proposed in studies of adolescent malnutrition in India. The North Indian study of 2,400 adolescent girls found that dietary and physical-activity characteristics were associated with the nutritional-status spectrum and highlighted the importance of socioeconomic and environmental determinants of overweight and obesity (Goyal et al., 2018). National CNNS evidence likewise demonstrates that adolescent malnutrition is associated with socioeconomic and demographic characteristics, with urban residence being associated with greater odds of overweight among younger adolescents.

Implications for the double burden of malnutrition:

Taken together, the results illustrate the complexity of adolescent nutrition in North 24 Parganas. The simultaneous presence of **21.0% undernutrition and 20.0% overweight/obesity** indicates that community nutrition programmes must address both nutritional deficiency and excess weight. A programme focused exclusively on iron supplementation or undernutrition would not adequately respond to the increasing burden of overweight and obesity. Conversely, an obesity-focused programme could overlook

persistent undernutrition and micronutrient deficiencies.

The findings support an integrated approach combining **iron–folic acid supplementation, deworming, nutrition education, dietary counselling, regular anthropometric screening, physical-activity promotion and healthy food-environment interventions**. The evidence from Indian intervention studies demonstrates that supplementation combined with education and counselling can improve micronutrient-related outcomes, while epidemiological studies demonstrate the need to address socioeconomic, dietary and environmental determinants of excess weight.

The results should nevertheless be interpreted with caution. Because the study is cross-sectional, temporal relationships between intervention participation, dietary behaviour and nutritional status cannot be established. Self-reported intervention participation and dietary practices may also be affected by recall or reporting bias. Furthermore, BMI-for-age identifies nutritional status but does not directly measure body composition or micronutrient status. Therefore, future studies should incorporate haemoglobin and, where feasible, biochemical indicators of micronutrient status, dietary diversity measures, physical-activity assessment and longitudinal follow-up.

Overall, comparison with published Indian evidence indicates that the present dataset reflects the broader **double burden of adolescent malnutrition**, but with a comparatively prominent component of overweight and obesity. The findings reinforce the need to strengthen community and school nutrition programmes so that they simultaneously prevent undernutrition and micronutrient deficiencies while addressing unhealthy dietary patterns, sedentary behaviour and excess weight. Such an integrated approach is particularly important during adolescence because nutritional and behavioural patterns established during this period may influence health and disease risk later in adulthood.

Conclusion:

The present study demonstrates that adolescent girls in the selected communities of North 24 Parganas, West Bengal, experience a **substantial double burden of malnutrition**. Among the 200 participants, **21.0% were undernourished, whereas 14.0% were overweight and 6.0% were obese**, indicating that nutritional deficiency and excess weight coexist within the same adolescent population.

The study also found relatively high reported exposure to several community nutrition interventions, particularly **iron–folic acid supplementation (84.0%), deworming (81.0%) and nutrition education (77.0%)**. However, physical-activity counselling had comparatively lower coverage (52.0%). The dietary findings further suggest that, despite relatively favourable practices such as regular breakfast and vegetable consumption, a considerable proportion of girls frequently consumed packaged or processed foods and sugar-sweetened beverages.

These findings highlight the need to move beyond programmes focused solely on undernutrition, anaemia or micronutrient deficiencies. Adolescent nutrition programmes should adopt an **integrated double-duty approach** that combines iron–folic acid supplementation and deworming with nutrition education, dietary counselling, regular anthropometric screening, physical-activity promotion and interventions that encourage healthier food environments. Such an approach is particularly important because nutrition knowledge alone may not necessarily translate into healthy dietary behaviour.

The study provides locally relevant evidence for strengthening community and school-based adolescent nutrition programmes in North 24 Parganas. However, because the study was cross-sectional, the findings demonstrate

associations rather than causality. Self-reported intervention exposure and dietary practices may also be affected by recall or reporting bias. Future studies should therefore include longitudinal follow-up, haemoglobin and other biochemical indicators of micronutrient status, dietary-diversity assessment and more detailed measures of physical activity.

Overall, the findings reinforce the importance of **context-specific, comprehensive and equitable adolescent nutrition interventions** that simultaneously address undernutrition, micronutrient deficiencies, overweight and obesity. Strengthening these interventions during adolescence may contribute to healthier dietary and lifestyle behaviours and reduce the longer-term health consequences associated with malnutrition.

Ethical Statement:

The study was conducted in accordance with ethical principles for research involving human participants. Participation was voluntary, and informed consent was obtained from the participants and, where applicable, their parents or legal guardians before data collection. Participants were informed about the purpose and procedures of the study, their right to participate or withdraw at any time, and the confidentiality of the information provided. Personal identifiers were not disclosed, and the collected data were used solely for research purposes. Anthropometric measurements and questionnaire responses were collected respectfully, with due consideration for the privacy, dignity, safety and well-being of all participants.

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