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Nutritional status, knowledge, and associated socio-demographic factors among adolescent girls in the coastal region of Bangladesh: A cross-sectional study

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Abstract

Background: Adolescent girls in low- and middle-income countries are particularly vulnerable to malnutrition due to a combination of biological, socio-economic, and environmental factors. In the coastal regions of Bangladesh, these challenges are compounded by frequent natural disasters and pervasive poverty, influencing both undernutrition and overnutrition among this demographic.

Aim: This study aims to assess the nutritional status, knowledge, and associated socio-demographic factors among adolescent girls in Bangladesh's coastal regions, focusing on identifying key drivers of malnutrition and areas for intervention.

Methods: A descriptive cross-sectional study was conducted from April 2024 to July 2024 in Chattogram and Cox's Bazar. The sample consisted of 345 adolescent girls aged 10 to 19 years. Data were collected using structured face-to-face interviews and anthropometric measurements. Statistical analysis was performed using SPSS and Stata to explore correlations between nutritional status and socio-demographic factors.

Results: The study found a significant prevalence of both undernutrition and overnutrition among participants, with 10.14% underweight and 29.85% either overweight or obese. Nutritional knowledge was generally poor, with less than half of the respondents demonstrating a good understanding of dietary needs. Parental education, especially maternal, was significantly associated with better nutritional outcomes. Larger and joint family structures were correlated with higher rates of overweight and obesity.

Conclusion: The findings underscore the urgent need for targeted nutritional education programs in Bangladesh's coastal regions. Enhancing maternal education, strengthening family involvement in dietary practices, and addressing environmental challenges through sustainable agricultural initiatives are crucial for improving the nutritional health of adolescent girls in these areas

Keywords: Adolescent nutrition; Malnutrition in LMICs; Coastal Bangladesh; Family dynamics; Nutritional education.

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1. Introduction

Adolescence is a critical period for growth, cognitive development, and the establishment of healthy behaviors, making proper nutrition essential during this phase (Norris et al., 2022). Globally, 1.2 billion adolescents, representing about 16% of the world's population, are undergoing rapid physical and mental development, significantly increasing their nutritional needs (UNICEF, 2022). Among adolescents, girls are particularly vulnerable to malnutrition due to biological and cultural factors, especially in low- and middle-income countries (LMICs) such as Bangladesh (World Bank, 2021). According to the Bangladesh Demographic and Health Survey (BDHS), 26% of adolescents were stunted, 11% were underweight and 7% were overweight or obese reflecting a growing double burden of malnutrition (NIPORT, 2014). Inadequate nutrition during adolescence can result in stunted growth, reduced educational outcomes, and increased risks of non-communicable diseases (NCDs) later in life (Akseer et al., 2020). The coastal regions of Bangladesh, including Chattogram and Cox's Bazar, are particularly vulnerable to malnutrition due to high levels of poverty and environmental challenges (Rabby & Rabby, 2022). Over one-third of households in these regions experience food insecurity, leading to nutritional deficiencies among adolescent girls (Farzana et al., 2017). Environmental degradation, frequent cyclones, and salinity intrusion in these areas further exacerbate food insecurity, as agricultural productivity declines, limiting access to fresh and nutritious food (Gopalakrishnan et al., 2019). Moreover, social norms, including gender-based food distribution, often disadvantage adolescent girls regarding household nutritional intake (Mitra and Rao., 2017). Despite ongoing efforts to improve adolescent health and nutrition, coastal regions in Bangladesh continue to experience high rates of malnutrition among adolescent girls (Fariha & Banu., 2024). The Bangladesh Demographic and Health Survey data shows that about half of adolescent girls are undernourished whereas more than 20% of adolescent girls in Bangladesh are either overweight or obese (NIPORT and ICF, 2020). In addition, the prevalence of overweight among adolescent girls has nearly doubled in the last decade (NIPORT and ICF, 2021). Poor dietary diversity and a lack of nutritional knowledge and awareness further compound the issue (Ruiz et al., 2019). In Bangladesh, adolescent malnutrition is primarily driven by poor dietary diversity, with many lacking essential nutrients like vitamins and minerals due to the limited availability of micronutrient-rich foods (Wrottesley et al., 2023). Additionally, low nutrition knowledge among adolescents exacerbates the issue, as many are unaware of the importance of consuming nutrient-dense foods (Kombanda et al., 2022). This is further compounded by food insecurity, early marriage, and pregnancy, which increase nutritional demands without adequate support (Oforiwaa Essandoh., 2021). Adolescent malnutrition has both immediate and long-term consequences (Mwene-Batu et al., 2020). It impairs cognitive function, reduces school performance, and diminishes productivity in adulthood (Fiorentino., 2015). Furthermore, malnourished girls are more likely to give birth to low-birth-weight babies, perpetuating the cycle of intergenerational malnutrition (Arlinghaus et al., 2018). Given the alarming rates of malnutrition and low levels of nutritional knowledge, it is crucial to assess the current state of adolescent nutrition, particularly in coastal regions that face compounded socio-economic and environmental challenges (Freduah et al., 2017). This study seeks to address a critical gap in the understanding of the nutritional status of adolescent girls in the coastal belt of Bangladesh, with a focus on identifying the socio-demographic factors that influence nutritional outcomes. Coastal regions are disproportionately affected by climate-related disasters, which aggravate food insecurity and reduce access to healthcare, further elevating the risk of malnutrition (Rahman et al., 2024). Moreover, there is limited research that investigates the levels of nutritional knowledge and awareness among adolescents in these areas. Addressing this gap is vital for developing targeted public health interventions and educational programs that can improve dietary behaviors and reduce the prevalence of malnutrition. By examining the nutritional status, socio-demographic factors, and knowledge of adolescent girls in coastal regions in Bangladesh, this study provides important insights into the drivers of malnutrition in coastal Bangladesh. The findings will be crucial for informing policymakers, healthcare professionals, and non-governmental organizations about the specific needs of adolescent girls in these vulnerable regions. This research aims to contribute to the broader literature on adolescent nutrition and will provide evidence-based recommendations for improving nutrition education and intervention programs in LMICs.

2. Methodology

This study employed a descriptive cross-sectional design to assess the nutritional status and associated factors among adolescent girls in the coastal belt region of Bangladesh. This approach was chosen for its suitability in providing a snapshot of the population at a specific point in time, allowing the collection of prevalence data and insights into correlational relationships (Koh et al., 2000). The study was conducted between April 2024 and July 2024 in the districts of Chattogram and Cox's Bazar, regions well-known for their high exposure to environmental risks and socioeconomic vulnerabilities. The target population for this study consisted of adolescent girls aged 10 to 19 years residing in these coastal areas. The calculated sample size for this study was 345 participants. The sample size was determined using the standard statistical formula for sample size calculation, considering a 95% confidence interval and a 5% level of significance, ensuring sufficient power to detect statistically significant findings. A stratified cluster sampling method

was employed to ensure representative sampling from different strata of the population. The coastal region was divided into strata based on geographic location and socioeconomic status. Within each stratum, clusters such as villages or community blocks were randomly selected. Adolescent girls from these clusters were then included in the study, ensuring a diverse and representative sample. Eligible participants were adolescent girls aged between 10 and 19 years, while individuals were excluded if they had cognitive impairments or mental health conditions that impeded their ability to understand the study or provide informed consent. Data collection was conducted through structured, face-to-face interviews using a pre-tested questionnaire. The questionnaire covered a range of topics, including socio-demographic information, nutritional knowledge, and awareness. In addition to interviews, anthropometric measurements were collected to assess nutritional status. Standardized equipment was used to measure the height and weight of participants. Weight was measured using a calibrated digital scale and recorded in kilograms, while height was measured in centimeters using a stadiometer. These measurements were used to calculate Body Mass Index (BMI) for each participant. The questionnaire, initially developed in English, was translated into Bengali, the local language, and then again translated to ensure accuracy and consistency in meaning. During the data collection phase, several steps were taken to ensure the quality and accuracy of the data. After collection, an initial screening of the dataset was conducted to identify any apparent errors or inconsistencies. In cases where data were missing, strategies such as mean imputation for continuous variables and mode imputation for categorical variables were employed. If necessary, more sophisticated methods like multiple imputation were considered to handle missing data effectively. Outliers in the dataset were identified using statistical methods such as z-scores or the interquartile range (IQR) rule. These outliers were carefully examined to determine whether they represented genuine data points or errors. Depending on the findings, appropriate actions were taken, such as correcting or removing the outliers. Additionally, normalization techniques were applied where necessary to ensure the data met the assumptions required for the statistical tests used in the analysis. To further ensure data integrity, a double-data entry system was implemented for a subset of the data. Range checks were applied to numerical variables to confirm that all values fell within reasonable bounds. Any values outside these expected ranges were flagged for further review. Data analysis was conducted using SPSS (IBM SPSS Statistics, Version 26), Stata (Version 13), and R statistical software. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated to summarize the socio-demographic characteristics, anthropometric data, and knowledge scores of the participants. The nutritional knowledge score was calculated by assigning 1 point for each correct response and 0 points for each incorrect response to the questions related to nutritional awareness. Participants' nutritional knowledge was categorized as good if they scored 70% or higher on the assessment, while a score below 70% was categorized as poor. In addition to descriptive statistics, inferential statistical methods, such as correlation were used to explore the relationships between variables. Ethical approval for the study was obtained from the Ethical Review Committee of the Faculty of Allied Health Sciences at Daffodil International University, Bangladesh. All participants were fully informed about the study's purpose, procedures, and potential risks and benefits. Informed consent was obtained from each participant and their guardian, as many participants were minors under the age of 18. Confidentiality was strictly maintained, with all data anonymized or pseudonymized to protect the identities of participants. Only authorized research personnel had access to the data which were stored securely. Findings were reported in aggregate form to prevent the identification of individual participants. To minimize risks to participants, careful monitoring was conducted throughout the study to ensure that no adverse effects resulted from nutritional assessments or interventions. Special care was taken when involving vulnerable populations, such as younger adolescents, to ensure their protection and justify their inclusion in the study.

3. Results

The mean age of respondents was 14.35 years (SD ± 2.41). The majority (38.84%) were in the age group of 16–19 years, followed by 33.91% in the 13–15 age group, and 27.25% in the 10–12 age group. Regarding education, 37.10% of the respondents had received secondary education, 28.41% had attained primary education, and 27.83% had a higher secondary education or above. A small proportion (6.67%) had no formal education. Regarding the respondents' fathers' education, the majority (25.80%) had received graduate or above-level education, followed by 24.35% who had completed HSC and 22.90% who had completed SSC. A minority of fathers (1.74%) had no formal education. Concerning fathers' occupations, 25.80% were employed in the private sector, 20.58% held government jobs, and 18.84% were engaged in business, while others were self-employed (18.55%) or involved in various other occupations (16.23%). In terms of mothers' educational levels, 26.38% had completed HSC, and 24.06% had completed SSC. A smaller portion (14.78%) had achieved graduate-level education or higher, and 4.64% had no formal education. Most mothers (51.01%) were housewives, while 14.78% were employed in the private sector, 13.33% in government service, and 12.17% were self-employed. A smaller proportion (6.67%) were involved in business. Most respondents (67.25%) lived in joint families, while 32.75% lived in nuclear families. The average family size was 6.86 members (SD ± 2.55). The largest proportion of families (40.87%) had 7 to 9 members, followed by 25.51% with 4 to 6 members, and 20.58% with 10 or more members. Regarding monthly household income, the mean income was BDT 55,253.62 (SD ± 30,898.81). Nearly one-third of families (28.41%) had a monthly income of BDT 50,001–BDT 75,000, while 25.22% earned between BDT

25,001 and BDT 50,000. A smaller proportion (9.86%) earned more than BDT 100,000 per month, and 20.00% had a monthly income below BDT 25,000 (Table 1).

Table 1 Socio-demographic characteristics of the respondents (n=345)

Socio-demographic variables	No. of respondents	Percentage
Age group (Mean ± SD = 14.35 ± 2.41)		
10-12 years	94	27.25%
13-15 years	117	33.91%
16-19 years	134	38.84%
Level of education		
None	23	6.67%
Primary	98	28.41%
Secondary	128	37.10%
Higher secondary or above	96	27.83%
Father's level of education		
No formal education	6	1.74%
Primary level	35	10.14%
Secondary level	52	15.07%
SSC	79	22.90%
HSC	84	24.35%
Graduate or above	89	25.80%
Father's occupation		
Business	65	18.84%
Govt. service	71	20.58%
Private service	89	25.80%
Self-employed	64	18.55%
Others	56	16.23%
Mother's level of education		
No formal education	16	4.64%
Primary level	49	14.20%
Secondary level	55	15.94%
SSC	83	24.06%
HSC	91	26.38%
Graduate or above	51	14.78%
Mother's occupation		
Housewife	176	51.01%
Business	23	6.67%
Govt. service	46	13.33%
Private service	51	14.78%

Self-employed	42	12.17%
Others	7	2.03%
Family type		
Nuclear	113	32.75%
Joint	232	67.25%
Family size (Mean ± SD = 6.86 ± 2.55)		
1 to 3	45	13.04%
4 to 6	88	25.51%
7 to 9	141	40.87%
10 and more	71	20.58%
Monthly household income (Mean ± SD = 55253.62 ± 30898.81)		
<BDT 25000	69	20.00%
BDT 25001 – BDT 50000	87	25.22%
BDT 50001 – BDT 75000	98	28.41%
BDT 75001 – BDT 100000	57	16.52%
>BDT 100000	34	9.86%

Table 2 summarizes the nutritional knowledge and awareness of the respondents (n = 345). The majority (70.43%) believed that consuming a variety of foods is important for health, while 25.22% did not, and 4.35% were unsure. A significant portion of respondents (54.20%) reported never checking food labels for nutritional information when purchasing packaged food, with only 2.61% always doing so, and 18.84% checking sometimes. When asked if they could name the three most important nutrients for adolescent health, 40.29% of the respondents answered affirmatively, whereas 59.71% could not. Regarding knowledge about balanced diets, 38.84% rated their knowledge as "Good," 24.93% as "Excellent," and 32.46% as "Fair." A small proportion (3.77%) rated their knowledge as "Poor." Respondents reported obtaining information about healthy eating and nutrition from various sources, with 67.83% citing school or educational programs as a key source. Family members were a source for 18.84%, healthcare professionals for 22.61%, and the internet or social media for 29.28%. A smaller percentage obtained information from books or magazines (16.23%), and 12.46% indicated that they do not actively seek out nutritional information. Most respondents (77.39%) were unaware of what a food pyramid or plate model for healthy eating is, with only 22.61% demonstrating knowledge of these concepts. When asked about the importance of consuming foods rich in iron and calcium, 38.84% considered it somewhat important, 22.61% very important, and 28.12% not important, while 10.43% did not know. Participation in nutritional education programs or workshops was low, with only 18.26% having attended such programs. The majority (81.74%) did not participate in any. Furthermore, only 15.65% of respondents believed that their current diet met their nutritional needs, while 66.38% were unsure, and 17.97% felt that their diet did not meet their nutritional needs. In terms of confidence in making healthy food choices, 17.68% were somewhat confident, and 14.20% were very confident, while 10.72% were not confident. A significant number (57.39%) indicated that they did not know or lacked confidence in making healthy food choices.

Table 2 Nutritional knowledge and awareness of the respondents (n=345)

Question/Statement	**Answer options**	**No. of respondents**	**Percentage**
Believe eating a variety of foods is important for health	Yes	243	70.43%
	No	87	25.22%
	Not sure	15	4.35%
Check food labels for nutritional information when purchasing packaged food	Always	9	2.61%
	Sometimes	65	18.84%

	Rarely	84	24.35%
	Never	187	54.20%
Can you name the three most important nutrients for adolescent health	Yes	139	40.29%
	No	206	59.71%
Knowledge about balanced diets	Excellent	86	24.93%
	Good	134	38.84%
	Fair	112	32.46%
	Poor	13	3.77%
Get information about healthy eating and nutrition from – (Multiple responses)	School/Educational programs	234	67.83%
	Family members	65	18.84%
	Healthcare professionals	78	22.61%
	Internet/social media	101	29.28%
	Books/Magazines	56	16.23%
	I don’t seek out this information	43	12.46%
Know what a food pyramid or a plate model for healthy eating is	Yes	78	22.61%
	No	267	77.39%
Importance of consuming foods rich in iron and calcium	Very important	78	22.61%
	Somewhat important	134	38.84%
	Not important	97	28.12%
	I don’t know	36	10.43%
Participated in any nutritional education programs or workshops	Yes	63	18.26%
	No	282	81.74%
Think that current diet meets nutritional needs	Yes	54	15.65%
	No	62	17.97%
	Not sure	229	66.38%
Level of confidence in making healthy food choices	Very confident	49	14.20%
	Somewhat confident	61	17.68%
	Not confident	37	10.72%
	I don't know	198	57.39%

Figure 1 illustrates the level of nutritional knowledge and awareness among the respondents (n = 345). Overall, 48.12% of respondents demonstrated a "Good" level of nutritional knowledge, while 51.88% had a "Poor" level of knowledge.

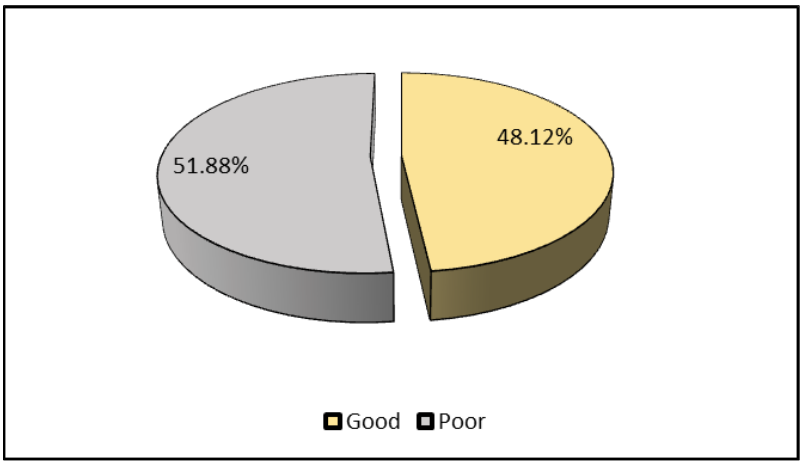

Figure 1 Level of nutritional knowledge and awareness of the respondents (n=345)

The anthropometric information of the respondents shows that the mean height of the respondents was 155.0 cm (SD ± 8.5), and the mean weight was 46.3 kg (SD ± 6.5). In terms of nutritional status, the majority (60.00%) of respondents were classified as having a normal weight. A smaller proportion were identified as underweight (10.14%), while 15.07% were overweight, and 14.78% were classified as obese (Table 3).

Table 3 Anthropometric information of the respondents (n=345)

Height (cm)	Mean ± SD	155.0 ± 8.5
Weight (Kg)	Mean ± SD	46.3 ± 6.5
Nutritional status	**No. of respondents**	**Percentage**
Underweight	35	10.14%
Normal	207	60.00%
Overweight	52	15.07%
Obese	51	14.78%
Total	345	100.00%

4. Discussion

The findings indicate a significant association between age and nutritional status (p = .034), with the highest proportion of overweight and obese respondents observed in the 16–19 years age group (15.67% and 16.42%, respectively), while the 10–12 years age group had a higher proportion of underweight individuals (12.77%). Educational attainment showed a marginal association with nutritional status (p = .056), with the highest percentage of normal-weight individuals observed among those with higher secondary education or above (62.50%). Similarly, respondents whose fathers had secondary-level education had the highest proportion of normal-weight individuals (67.31%), although the association was not statistically significant (p = .061). Father's occupation was also associated with nutritional status (p = .052), with respondents whose fathers were employed in private service showing the highest percentage of normal-weight individuals (73.03%), while those whose fathers were involved in business or government service had higher proportions of overweight and obese individuals. Mother's level of education demonstrated a significant association with nutritional status (p = .032). Respondents whose mothers had HSC or graduate-level education had the highest proportion of normal-weight individuals (82.42% and 82.35%, respectively), while overweight and obesity were more common among those with less educated mothers. Mother's occupation was significantly associated with nutritional status (p = .024), with overweight and obesity being more prevalent among respondents whose mothers were employed in business, government service, or private service. In contrast, those whose mothers were housewives had a higher percentage of normal-weight individuals (76.70%). Family type and family size were both significantly associated with nutritional status (p = .018 and p = .019, respectively). Respondents from nuclear families had a higher proportion of normal-weight individuals (61.95%), whereas joint-family respondents showed a slightly higher prevalence of

overweight and obesity. Larger family sizes (10 or more members) were associated with higher proportions of overweight (22.54%) and obese (19.72%) individuals. Monthly household income did not show a statistically significant association with nutritional status (p = .076), although respondents from higher-income families (>BDT 100,000) had a slightly higher prevalence of overweight and obesity (20.59% and 14.71%, respectively) compared to those with lower income levels. Finally, the level of nutritional knowledge and awareness was significantly associated with nutritional status (p = .016). Respondents with "Good" knowledge were more likely to be overweight (19.88%) or obese (21.69%), while those with "Poor" knowledge had a higher proportion of normal-weight individuals (68.72%) (Table 4).

Table 4 Association of respondents' nutritional status with their socio-demographic characteristics and level of nutritional knowledge and awareness

Variables	**Frequency (%)**	**Nutritional status**								**P-value**
		Underweight (35)		**Normal (207)**		**Overweight (52)**		**Obese (51)**		
Age group										
10-12 years	94 (27.25%)	12	12.77%	55	58.51%	15	15.96%	12	12.77%	.034
13-15 years	117 (33.91%)	13	11.11%	71	60.68%	16	13.68%	17	14.53%	
16-19 years	134 (38.84%)	10	7.46%	81	60.45%	21	15.67%	22	16.42%	
Level of education										
None	23 (6.67%)	3	13.04%	13	56.52%	4	17.39%	3	13.04%	.056
Primary	98 (28.41%)	10	10.20%	57	58.16%	15	15.31%	16	16.33%	
Secondary	128 (37.10%)	14	10.94%	77	60.16%	19	14.84%	18	14.06%	
Higher secondary or above	96 (27.83%)	8	8.33%	60	62.50%	14	14.58%	14	14.58%	
Father's level of education										
No formal education	6 (1.74%)	1	16.67%	3	50.00%	1	16.67%	1	16.67%	.061
Primary level	35 (10.14%)	3	8.57%	19	54.29%	8	22.86%	5	14.29%	
Secondary level	52 (15.07%)	6	11.54%	35	67.31%	9	17.31%	2	3.85%	
SSC	79 (22.90%)	8	10.13%	47	59.49%	11	13.92%	13	16.46%	
HSC	84 (24.35%)	9	10.71%	52	61.90%	12	14.29%	11	13.10%	
Graduate or above	89 (25.80%)	8	8.99%	51	57.30%	11	12.36%	19	21.35%	
Father's occupation										
Business	65 (18.84%)	5	7.69%	33	50.77%	12	18.46%	15	23.08%	.052
Govt. service	71 (20.58%)	6	8.45%	35	49.30%	13	18.31%	17	23.94%	
Private service	89 (25.80%)	10	11.24%	65	73.03%	12	13.48%	2	2.25%	
Self-employed	64 (18.55%)	6	9.38%	43	67.19%	8	12.50%	7	10.94%	
Others	56 (16.23%)	8	14.29%	31	55.36%	7	12.50%	10	17.86%	
Mother's level of education										
No formal education	16 (4.64%)	2	12.50%	9	56.25%	3	18.75%	2	12.50%	.032
Primary level	49 (14.20%)	5	10.20%	21	42.86%	12	24.49%	11	22.45%	
Secondary level	55 (15.94%)	6	10.91%	26	47.27%	10	18.18%	13	23.64%	

SSC	83 (24.06%)	7	8.43%	34	40.96%	20	24.10%	22	26.51%	
HSC	91 (26.38%)	10	10.99%	75	82.42%	5	5.49%	1	1.10%	
Graduate or above	51 (14.78%)	5	9.80%	42	82.35%	2	3.92%	2	3.92%	
Mother's occupation										
Housewife	176 (51.01%)	12	6.82%	135	76.70%	13	7.39%	16	9.09%	.024
Business	23 (6.67%)	3	13.04%	10	43.48%	6	26.09%	4	17.39%	
Govt. service	46 (13.33%)	6	13.04%	20	43.48%	10	21.74%	10	21.74%	
Private service	51 (14.78%)	7	13.73%	21	41.18%	12	23.53%	11	21.57%	
Self-employed	42 (12.17%)	6	14.29%	18	42.86%	9	21.43%	9	21.43%	
Others	7 (2.03%)	1	14.29%	3	42.86%	2	28.57%	1	14.29%	
Family type										
Nuclear	113 (32.75%)	11	9.73%	70	61.95%	17	15.04%	15	13.27%	.018
Joint	232 (67.25%)	24	10.34%	137	59.05%	35	15.09%	36	15.52%	
Family size										
1 to 3	45 (13.04%)	8	17.78%	18	40.00%	9	20.00%	10	22.22%	.019
4 to 6	88 (25.51%)	9	10.23%	65	73.86%	8	9.09%	6	6.82%	
7 to 9	141 (40.87%)	13	9.22%	88	62.41%	19	13.48%	21	14.89%	
10 and more	71 (20.58%)	5	7.04%	36	50.70%	16	22.54%	14	19.72%	
Monthly HH income										
<BDT 25000	69 (20.00%)	8	11.59%	36	52.17%	13	18.84%	12	17.39%	.076
BDT 25001 – BDT 50000	87 (25.22%)	9	10.34%	55	63.22%	11	12.64%	12	13.79%	
BDT 50001 – BDT 75000	98 (28.41%)	8	8.16%	69	70.41%	12	12.24%	9	9.18%	
BDT 75001 – BDT 100000	57 (16.52%)	6	10.53%	29	50.88%	9	15.79%	13	22.81%	
>BDT 100000	34 (9.86%)	4	11.76%	18	52.94%	7	20.59%	5	14.71%	
Level of knowledge and awareness										
Good	166 (48.12%)	13	7.83%	84	50.60%	33	19.88%	36	21.69%	.016
Poor	179 (51.88%)	22	12.29%	123	68.72%	19	10.61%	15	8.38%	

The prevalence of malnutrition among adolescent girls in this study was manifested in both undernutrition and overnutrition. Approximately 10.14% of the participants were underweight, while 29.85% were either overweight or obese. These findings align with global trends indicating a dual burden of malnutrition among adolescents in low- and middle-income countries (LMICs). For example, Popkin et al. (2020) discuss the global shift towards increased rates of both undernutrition and obesity in adolescent populations, particularly in South Asia (Popkin et al., 2020). Similar trends have been observed in other South Asian studies, where rapid urbanization and economic changes have led to a rise in obesity alongside persistent undernutrition (Gupta et al., 2012). The results indicate a significant association between age and nutritional status, with older adolescents (16–19 years) exhibiting higher rates of overweight and obesity compared to their younger counterparts. This trend could reflect changes in dietary habits as adolescents gain more autonomy in food choices, aligning with findings from Stok et al. (2018), who noted that older adolescents tend to adopt less healthy eating behaviors as they transition toward adulthood. The findings also indicate that higher educational levels of parents, particularly mothers, were significantly associated with better nutritional outcomes in adolescent girls. This finding aligns with existing literature that emphasizes the role of maternal education in improving

the health behaviors and nutritional status of children (Bhutta et al., 2013). Such educational effects are particularly pronounced in LMICs, where maternal education significantly influences household health practices and dietary choices (Abarca-Gómez et al., 2017). Another study in Cox's Bazar, Bangladesh also showed that parent's education plays a significant role in the health behavior of the children (Banik et al., 2024). The analysis also highlighted the influence of family structure on nutritional status. Adolescents from joint families and larger households exhibited a higher prevalence of overweight and obesity. This could be linked to dietary patterns where food quantity, rather than quality, is emphasized in larger family settings. Similar observations were made by Moore et al. (2017), who found that children in larger families often receive less individual attention in dietary monitoring, potentially leading to unbalanced food intake. Despite a general awareness of the importance of dietary diversity, this study revealed significant gaps in specific knowledge about nutrient requirements and food choices among adolescents. This issue is not isolated to Bangladesh but is also evident in other countries such as Nepal, where adolescents show a limited understanding of micronutrient needs and balanced diets (Cunningham et al., 2020; Giri et al., 2023). This discrepancy underscores the need for comprehensive education programs that delve into the specifics of dietary components and their health impacts. Additionally, the environmental challenges unique to the coastal regions of Bangladesh, such as frequent cyclones and salinity intrusion, further exacerbate food insecurity and malnutrition, compounding the nutritional challenges faced by these communities (Baten et al., 2015; Hanifi et al., 2022). In response to these multifaceted issues, targeted public health interventions are essential. Strategies should focus on delivering age-specific nutritional education, enhancing maternal education to improve household dietary practices, and developing robust agricultural systems resilient to environmental challenges. Moreover, interventions must also consider the dynamics of larger or joint family settings, promoting dietary quality over quantity to enhance overall nutritional outcomes.

5. Conclusion

This study highlights the complex nutritional challenges faced by adolescent girls in the coastal regions of Bangladesh, marked by a dual burden of malnutrition. Significant factors influencing nutritional status include socio-demographic variables like parental education, with maternal education showing a strong association with better nutritional outcomes, and family structure, where larger and joint families tend to exhibit higher rates of overweight and obesity. The study also identifies a critical gap in nutritional knowledge among adolescents, contributing to poor dietary choices. To address these issues, it is recommended to enhance nutritional education programs that are culturally tailored and accessible through schools and community centers, increase parental, especially maternal, involvement in nutritional education, and implement community-based sustainable agricultural practices to combat the adverse effects of environmental challenges. Strengthening these areas can significantly improve the nutritional health of adolescent girls in these vulnerable regions, supporting better health outcomes across the community.

Compliance with ethical standards

Acknowledgments

Moshfequa Rahman Khan, Kazi Jannatul Wakeya, Md Shihab-ul-Islam Rafi, and Salina Canadi conceptualized and designed the study. Zubaida Iftekhar and Abu Ansar Md Rizwan were responsible for data analysis and interpreting the results. The initial draft of the manuscript was written by Moshfequa Rahman Khan, Kazi Jannatul Wakeya and Md Shihab-ul-Islam Rafi, with significant revisions and contributions from Salina Canadi, Zubaida Iftekhar and Abu Ansar Md Rizwan to finalize the document. All authors have read and approved the final manuscript. We extend our gratitude to W A N Research & Consultancy for their expert consultancy in designing the study and evaluating the outcomes.

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Regarding this work, the authors disclosed no conflicts of interest.

Consent for publication

The permission of each author to publish this article has been obtained

Statement of ethical approval

The present research work does not contain any studies performed on animal/human subjects by any of the authors.

Statement of informed consent

Every individual participant participating in the study gave informed consent.

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