International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 8, Issue 12
December, 2025
Pages: 414-430

Double Burden of Malnutrition and Nutrition Knowledge Gaps Among Rural School Going Adolescent Girls: Evidence from Netrokona, Bangladesh

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http://dx.doi.org/10.47814/ijssrr.v8i12.3120

Abstract

Adolescence is a critical stage of physical and cognitive development, when adequate nutrition is essential for optimal growth and long-term health. The current study aims to assess the nutritional status, dietary practices and nutritional knowledge status of rural adolescent girls at Netrokona Bangladesh. A cross-sectional survey was conducted among 635 school-going girls to collect data on socio-demographic characteristics, dietary patterns and BMI-for-age using WHO standards distribution. There is a notable gap in comprehensive data regarding adolescent health and nutritional status in Netrokona Bangladesh, particularly for rural areas. The findings indicate a double burden of malnutrition among adolescents in Netrokona district, with 38.7% classified as thin, 48.5% as having normal BMI, 10.4% as overweight, and 2.4% as obese. Moreover, their daily dietary practice results showed that 28%, 46%, and 13.39% of adolescents do not intake vegetables, fruits and meat or fish respectively. In addition, 10.7% adolescents were skipping breakfast and 77.01% did not consume milk daily. Among the participants 54.8% washed vegetables after cutting indicating nutritional knowledge gap in daily dietary practices. Regarding to

address nutritional knowledge status present study found only 10.39% adolescents having better nutritional knowledge and the majority of adolescents had poor to average understanding of healthy nutritional practices. Nutritional knowledge analysis estimated strong positive correlation with maternal education, BMI for age and vegetable consumption but not with fruit, egg intake, or healthy practices. These findings suggest that better nutritional practices found specially when coupled with maternal education, might contribute to improve adolescents' nutritional status. However, these factors alone cannot overcome structural and socioeconomic barriers in rural Netrokona, Bangladesh. Therefore, for sustainable improvement an integrated approach including education, economic empowerment, and community-based nutritional interventions are crucial for Netrokona Bangladesh.

Keywords: *Adolescents; Malnutrition; Double Burden; Nutritional Knowledge; Bangladesh*

1. Introduction

Adolescence, which spans from ages 10 to 19, is a critical life stage between childhood and adulthood (World Health Organization, 2014). It is characterized by rapid physical growth, sexual maturation, and cognitive and emotional development, all of which increase nutritional requirements (Smith & Johnson, 2018). Adequate nutrition during this period is essential for supporting growth, reproductive maturity, brain development, and long-term health outcomes. Conversely, insufficient nutrition can delay puberty, hinder growth, and elevate the risk of chronic diseases particularly when combined with unfavorable lifestyle behaviors (Ghosh et al., 2020). For adolescent girls, the consequences are even more significant, as their nutritional status strongly influences future maternal health and pregnancy outcomes (Rahman & Biswas, 2017).

In Bangladesh, adolescents face major nutritional challenges, including underweight, stunting, micronutrient deficiencies, and an emerging rise in overweight and obesity (Begum et al., 2020). These issues are linked to multiple factors such as high population density, low literacy rates, economic inequity, and limited access to health services. Evidence from the Bangladesh Demographic and Health Survey (BDHS) 2017–2018 highlights that undernutrition among adolescent girls remains a serious concern (National Institute of Population Research and Training [NIPORT], 2019). Key determinants of nutritional status include household income, parental education, agricultural resources, cultural beliefs, poor dietary diversity, inadequate nutrient intake, and lack of healthy dietary practices often resulting in moderate to severe malnutrition that impairs physical development and adult stature (Islam et al., 2019; Kabir & Karim, 2020; Nasrin et al., 2021). Additionally, micronutrient deficiencies and the growing rates of overweight and obesity threaten adolescent well-being (Hossain et al., 2020). Different studies also indicated that over 60% of school-going adolescents in South Asia fail to meet recommended dietary requirements, suggesting widespread dietary inadequacy across the region (UNICEF, 2019). The World Health Organization (WHO) emphasizes nutritional status as an essential indicator of both individual and community health (WHO, 2015).

Dietary habits in rural and semi-urban areas of Bangladesh are typically carbohydrate-dense and low in micronutrient-rich foods such as fruits, vegetables, and protein sources due to economic constraints, cultural norms, and seasonal food availability (Ahmed et al., 2018). Netrokona a district of Bangladesh, a predominantly agrarian region marked by widespread poverty, food insecurity, and poor access to healthcare, places adolescents at a heightened risk of malnutrition (Lohman, Roche, & Martorell, 1988). While several studies have investigated adolescent malnutrition across Bangladesh, there remains insufficient evidence specifically focusing on dietary practices, nutrition knowledge, and nutritional status in remote districts such as Netrokona (Rahman et al., 2019; Sultana & Akter, 2020; Mahmud et al., 2021). The socioeconomic conditions in Netrokona including widespread poverty, food

insecurity, and inadequate health infrastructure create an environment where adolescents are particularly vulnerable to nutritional deficits (Hasan et al., 2022). Nutritional knowledge has been increasingly recognized as a significant determinant of dietary behavior and overall nutritional outcomes. In addition, higher levels of nutrition knowledge generally promote healthier food choices and improved dietary diversity (Patel & Das, 2018; Saha et al., 2020; Mistry et al., 2021). However, such knowledge may not necessarily translate into improved dietary practices when structural barriers such as financial constraints, cultural restrictions, and limited access to nutritious foods hinder adolescents' ability to adopt healthier behaviors (Khan & Siddique, 2020; Roy et al., 2021).

Therefore, this study seeks to assess the nutritional status, dietary diversity, and nutritional knowledge of rural school-going adolescent girls in Netrokona, Bangladesh. Furthermore, current evidence does not adequately explain how nutritional knowledge interacts with socio-demographic characteristics, dietary habits, and anthropometric outcomes in rural contexts. This study aims to fill this gap by providing a comprehensive assessment of the double burden of malnutrition and existing knowledge deficits among rural adolescents. The findings are expected to inform culturally sensitive and context-specific interventions that address structural barriers and promote healthier dietary practices, ultimately contributing to the overall well-being of adolescents in rural Bangladesh.

2. Materials and Methods

2.1 Study Area

A descriptive cross-sectional study was conducted among adolescent girls in the rural area of Netrokona district. The study area included semi-urban and predominantly rural regions with high rates of poverty, limited access to healthcare, and food insecurity, factors that substantially influence adolescent nutrition (FAO, 2013). This research was approved by the authorities of selected rural schools. The purpose and nature of the study were explained to each participant, and verbal consent was obtained prior to inclusion. To conduct this study, its objectives, methodology, and importance were clearly explained to the respondents. Data were collected using a pretested structured questionnaire through face-to-face interviews. School-going respondents who were willing to participate were included.

2.2 Sample Size

The sample size was calculated to estimate key prevalence indicators with 95% confidence and ±5% precision, assuming maximum variability (p = 0.50). The base size under simple random sampling was $n_0 = 384$. Allowing for a design effect of 1.5 due to clustering and 10% non-response yielded a target of approximately 640 participants (Rutterford, Copas, & Eldridge, 2015). A total of 635 adolescent girls aged 13–19 years were selected using a systematic sampling method.

2.3 Data Collection

The 635 participants were interviewed using the pretested questionnaire. Standard validated tools were used to collect information on anthropometry, socioeconomic conditions, dietary diversity, and nutritional knowledge. Nutritional status was assessed through height, weight, and BMI-for-age following standardized procedures. Weight was measured using a digital scale to the nearest 0.1 kg, and height was measured using an anthropometer to the nearest 0.1 cm. BMI for age was calculated as: BMI = Weight (kg) / Height (m^2). BMI-for-age were assessed following overweight: >+1SD (equivalent to BMI 25 kg/m2 at 19 years), obesity: >+2SD (equivalent to BMI 30 kg/m2 at 19 years), thinness: <-2SD and severe thinness: <-3SD (de Onis et al., 2007). Socioeconomic and demographic information (family size,

parental education, farm size, household income, and expenditures) were collected by interviewing adolescents and their families. Information on dietary habits and nutritional knowledge was also collected (Bhargava et al., 2003).

A structured nutritional knowledge questionnaire was used to assess awareness of food consumption habits among adolescent girls. Variations in dietary habits across age groups reflected differences in basic nutritional knowledge. Dietary knowledge is vital for ensuring nutrient adequacy (Alam, Roy, Ahmed, et al., 2010). The questionnaire contained 15 items on daily food habits and dietary diversity. Nutritional knowledge was assessed using 15 mixed-type questions (open- and closed-ended). Closed-ended items used yes/no responses, while open-ended questions allowed additional comments. Dietary information was collected using a seven-day recall method. Enumerators were trained to conduct pilot data collection, resolve technical issues, and make necessary adjustments before the main study to ensure adherence to the study protocol and ethical standards (Redwan, Sutradhar, Rahman, et al., 2025; Ghosh et al., 2017).

2.4 Knowledge Score Group

Nutritional knowledge was measured with a 15-item questionnaire focused on food, eating habits, and health-related behaviors. Each correct answer received a score of 1, while incorrect answers received 0, giving a maximum score 15. Based on total scores, adolescents were classified into three groups: poor knowledge (fewer than 7 points, <50% of total), moderate knowledge (7–10 points, 50–75% of total), or good knowledge (more than 10 points, >75% of total).

2.5 Data Analysis Instruments

All data were analyzed using SPSS version 25.0 (IBM Corp., 2017). Descriptive statistics (percentages, frequencies, mean, standard deviation) and inferential statistics (chi-square test, p-value) were applied, with significance set at $p < 0.05$. Initial analysis summarized demographic and anthropometric characteristics. Nutritional status was classified using WHO Anthro Plus software, which generated BMI-for-age Z-scores based on WHO growth reference standards (WHO, 2009).

3. Results

3.1 Socio-demographic Status

A total of 635 adolescents were participated in this study. Among them, 103 (16.22%) were in the early adolescence stage (13–15 years), 338 (53.23%) in the mid-adolescence stage (15–17 years), and 194 (30.55%) in the late adolescence stage (17–19 years) (Figure 1).

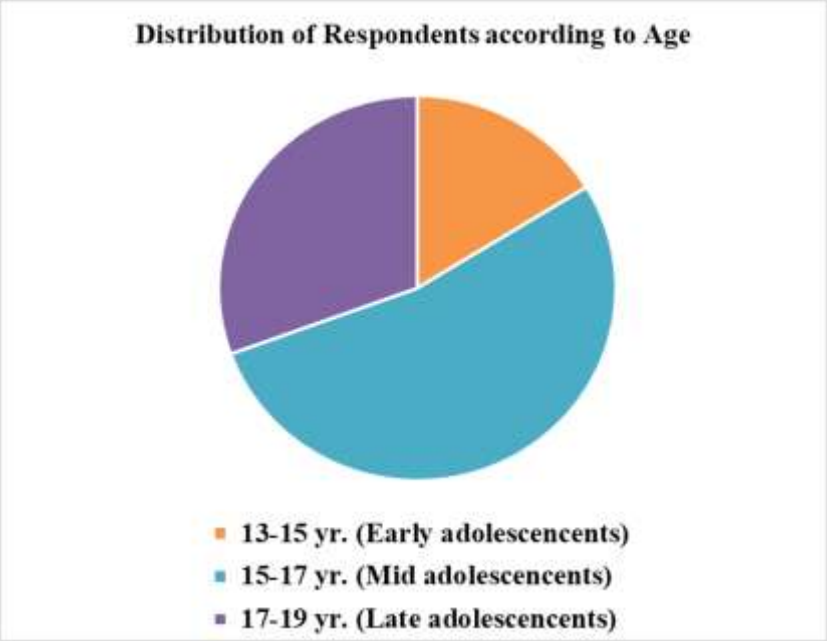

Figure 1: Pie Chart Showing Distribution of Respondents by Age Group

The sociodemographic information of the participants has been summarized in Table 1. Results from this study showed that the educational qualifications of the respondents' fathers and mothers were analyzed and classified into four categories: illiterate, primary, secondary, and above secondary (Table. 1).

Table 1. Socio-Demographic Information of the Respondents (n=635)

Characteristics	Categories	Number	Percentage (%)
Father's educational qualification (years of schooling)	Illiterate (0)	142	22.36
	Primary (1–5)	131	20.63
	Secondary (6–10)	254	40.00
	Above secondary (>10)	108	17.01
Mother's educational qualification (years of schooling)	Illiterate (0)	167	26.30
	Primary (1–5)	178	28.03
	Secondary (6–10)	192	30.24
	Above secondary (>10)	98	15.43
Family size (no. of members)	Small (≤4)	184	28.98
	Medium (5–6)	238	37.48
	Large (>6)	213	33.54
Farm size (hectare)	Landless (<0.02 ha)	118	18.58
	Marginal (0.021–0.20 ha)	420	61.26
	Small (0.21–1.00 ha)	88	13.86
	Medium (1.1–3.0 ha)	29	4.57

Characteristics	Categories	Number	Percentage (%)
	Large (>3.0 ha)	11	1.73
Annual household income ('000' BDT)	Low (<200)	106	16.69
	Medium (200–300)	387	60.94
	High (>300)	142	22.36
Annual household expenditure ('000' BDT)	Low (<100)	81	12.76
	Medium (100–300)	418	65.83
	High (>300)	136	21.42

Among the participants (635), the highest proportion of fathers (40.0%) had completed secondary education, followed by those who were illiterate (22.36%) and those with primary education (20.63%). The smallest group comprised fathers with education above the secondary level (17.01%). Similarly, among the mothers, 167 (26.30%) were illiterate, while 178 (28.03%) had completed primary education (1–5 years of schooling). A total of 192 (30.24%) had attained secondary education (6–10 years of schooling), and 98 (15.43%) had education above the secondary level (>10 years of schooling) (Table 1). Economic perspectives of the respondent's parent's annual family income showed diversity with low income (<100,000 BDT) were 106 (16.69%) and medium income (100000-300000 BDT) were 387 (60.94%) and high income (>300000 BDT) were observed 142 (22.36%) (Table.1). Similarly, annual household expenditure was observed categorically. About 81 (12.76%) households had annual low expenditure (<100,000 BDT), 418 (65.83%) had medium expenditure (100,000–300,000 BDT), and 136 (21.42%) households were in the high-income category (>300,000 BDT) (WHO, 2009 and UNICEF. (2017). Considering farm size of the respondents' families, about 118 (18.58%) were landless, 389 (61.26%) were marginal, 88 (13.86%) had small farms, followed by 29 (4.52%) with medium farms, and 11 (1.73%) with large farms (Table 1).

3.2 Nutritional Status

To assess the nutritional status BMI-for-age of the respondents were analyzed (Figure.2)

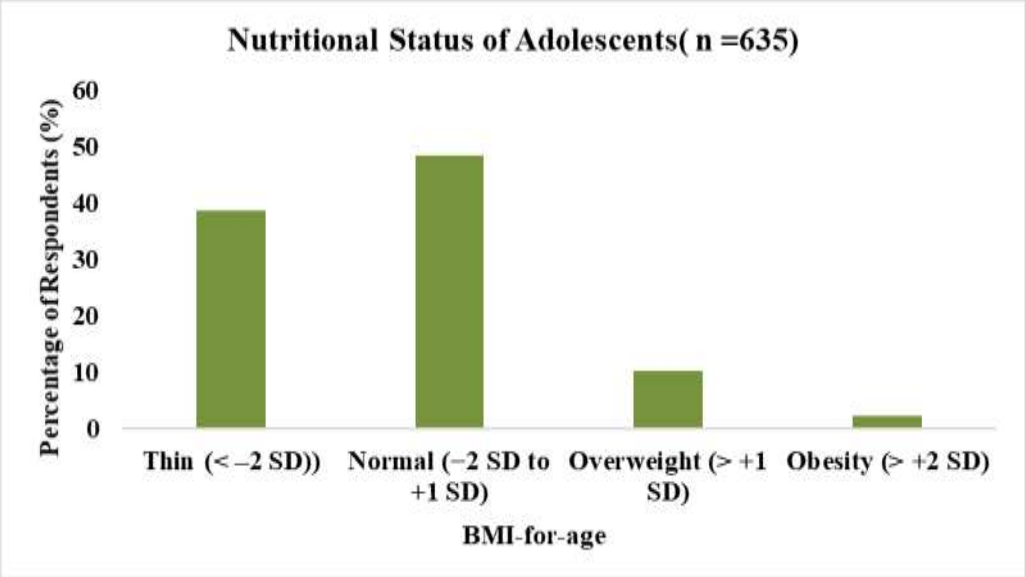

Figure 2: Distribution of Adolescents by BMI-for-age Status (n=635)

Nutritional status was assessed using BMI-for-age (5–19 years) Z-score classification**,** following WHO growth reference standards. The analysis revealed that 246 adolescents (38.74%) were classified as thin (BMI-for-age Z-score < –2 SD**)**, indicating a high prevalence of chronic energy deficiency. A total of 308 participants (48.50%) were within the normal BMI-for-age range (−2 SD to +1 SD)**.** Additionally, 66 adolescents (10.39%) were overweight (BMI-for-age Z-score > +1 SD) and 15 (2.36%) were obese (BMI-for-age Z-score > +2 SD)**.** This distribution indicates the coexistence of undernutrition and overnutrition a double burden of malnutrition suggesting an emerging nutrition transition in the Netrokona region of Bangladesh (Figure. 2).

3.3 Daily Dietary Habit of the Respondents:

Daily food consumption habit has a big impact on whether adolescents are likely to be underweight, overweight, or have normal BMI by diversified food intake and healthy practices. Therefore, this section represents daily dietary practices that will also reflect the nutritional knowledge of the respondents.

Table 2: Daily Dietary Habit of the Respondents (Nutritional Knowledge)

Question / Category	Response Options	Frequency (n)	Percentage (%)
1. How many times do you take main meals in a day?	One	82	14.01
	Two	150	23.62
	Three	403	63.46
	Four	32	5.03
2. Do you eat fermented rice?	Yes	129	20.31
	No	390	61.42
	Sometimes	116	18.27
3. How does your family usually prepare rice at home?	With starch	179	28.19
	Without starch	456	71.81
4. Which meal is the most important for you in a day?	Breakfast	184	28.98
	Lunch	354	55.75
	Dinner	97	15.28
5. Do you take breakfast every day?	Yes	442	69.61
	No	114	17.95
	Sometimes	79	12.44
6. What do you usually eat for breakfast?	Fermented rice	214	33.70
	Fresh rice	207	32.60
	Bread	98	15.43
	Cake	20	3.15
	Rice flakes / Puffed rice	28	4.41
	No breakfast	68	10.71
7. How many eggs do you eat in a week?	None	8	1.26
	One	167	26.30
	Two	264	41.57
	Three	140	22.05
	Four	53	8.35

Question / Category	Response Options	Frequency (n)	Percentage (%)
	Five	3	0.47
8. Do you eat vegetables every day?	No	178	28.03
	One time	202	31.81
	Two times	156	24.57
	Three times	99	15.59
9. Do you eat fruit every day?	None	292	45.98
	One time	189	29.76
	Two times	110	17.32
	Three times	44	6.93
10.At what stage of cooking do you wash vegetables?	Before cutting	287	45.20
	After cutting	348	54.80
11. Do you eat meat or fish every day?	No	126	19.84
	One time	213	33.54
	Two times	198	31.18
	Three times	98	15.43
12. How many times do you eat pulse soup in a day?	None	85	13.39
	One time	189	29.76
	Two times	219	34.49
	Three times	142	22.36
13. How many times is food cooked in your household daily?	One time	225	35.43
	Two times	243	38.27
	Three times	167	26.30
14. How many glasses of water do you drink every day?	3–4	278	43.78
	5–6	256	40.31
	7–8	101	15.91
15. Do you take milk every day?	No	489	77.01
	Yes	146	22.99

Table 2. Showed a detailed overview of the daily food consumption patterns of adolescents in the study area of Bangladesh. The majority of adolescents (63.46%) take three times main meal in a day compare to two times (23.62%) and one times (14.1%) which might suggest food insecurity. Around 61.42% of adolescents consume fermented rice every day in breakfast while 20.31% do not take it daily. Moreover 18.27% take fermented rice periodically in morning indication lack of balanced diet. Considering protein-rich foods egg consumption varied a lot. About 41.6% ate two eggs each week, 26.3% one egg, 22.0% three eggs, and 8.3% four eggs. Only 0.5% consumed five eggs weekly, while 1.3% reported no egg intake at all. Every day 28.03% adolescents do not take vegetables in comparison with 31.81% take once, 24.57% take twice and 15.59% take three times in a day. (Table.2) In case of fruit consumption 45.98% adolescents do not take fruit daily whereas 29.76% take once a day, 17.32% take twice a day and 6.93% take three times in a day. It was also found that 33.54% adolescents take meat or fish at least once a day, whereas 31.18% take twice, 15.43% take three times and 19.84 % do not consume meat or fish in a day at all.

Daily cooking frequency and food processing habit results showed that, more than half 54.8% respondents were washed vegetables after cutting, while 45.2% washed before. This result suggesting that nutritional knowledge gap in healthy food preparation practices. Daily consumption of pulse soup, an important source of plant protein was consumed twice by 34.5% and once by 29.8%. of the respondents. Household daily cooking frequency results showed that, main meal was cooked twice in 38.3% of households, once in 35.4%, and three times in 26.3% of the respondents. This result indicates variations in how household's food security and managing system. The majority of the adolescents 43.8%, drank 3-4 glasses of water daily whereas 40.3% take 5–6 glasses of water and only 15.9% consumed 8–9 glasses of water daily A significant portion 77.01% do not consume milk at least once daily, while 22.99% take regularly. (Table.2)

Overall, the findings suggest that, while most adolescents consumed rice regularly and followed a two-to three-meal pattern, their dietary diversity was inadequate, particularly for fruits, vegetables, and milk. Protein sources like eggs, pulses, and fish or meat were present but they consumed inconsistently. Additionally, unhealthy cooking practices, daily cooking frequency, plant or animal protein consumption frequency, water consumption rate with limited breakfast focus on nutritional knowledge gaps (Hossain et al., 2021; Rahman et al., 2020). These results indicate both nutritional inadequacies and unhealthy practices, underscoring the need for nutrition education and dietary interventions targeted toward adolescents at Netrokona Bangladesh.

3.4 Nutritional Knowledge Score of the Respondents

Nutrition knowledge score showed that 51.65% of the adolescents had poor knowledge, 37.95% had average knowledge, and 10.39% had better knowledge (Figure 3). These findings indicating an urgent need for nutrition education interventions in that community.

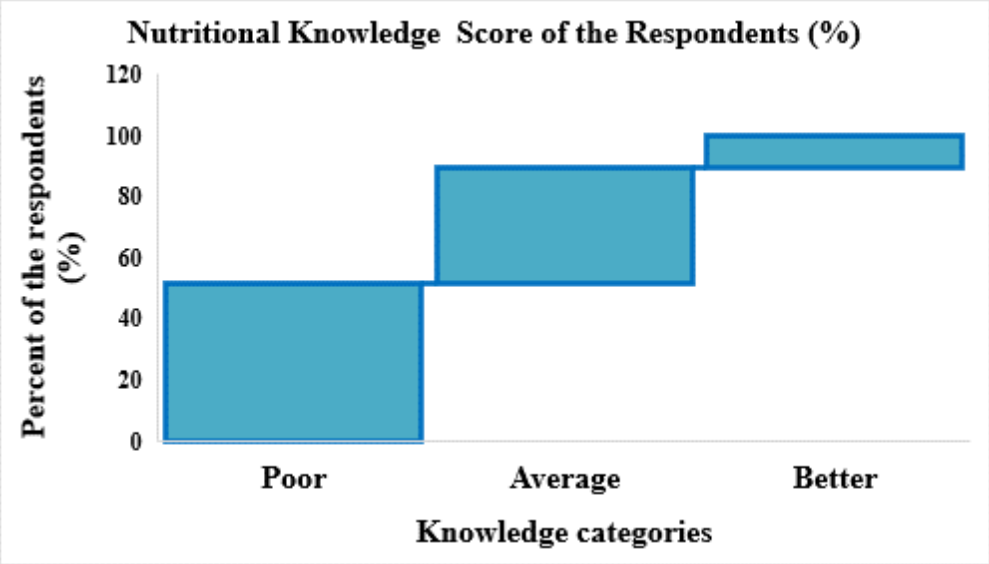

Figure 3: Nutritional Knowledge Score of the Respondents

The chart demonstrated that, the majority of the adolescents have deficiency in sufficient nutritional knowledge while only a small group achieving better nutritional knowledge**.** About 51.65% of adolescents fall into poor knowledge group, meaning half of the respondents showed limited understanding of nutritional practices. Approximately 37.95% of respondents had average knowledge level of nutrition. This indicates some awareness but remaining gaps in understanding. Only 10.39% of

the respondents had better nutritional knowledge score. (Figure.3) This suggests a small proportion had strong awareness of nutritional issues. This imbalance focuses the urgent need for nutrition education and awareness programs to improve dietary practices at Netrokona Bangladesh.

3.5 Correlation Analysis

To examine the relationship between socio-demographic, BMI for age and nutritional knowledge variables, Spearman's rank correlation coefficients were estimated and showed in Table 3. The analysis looked for a relationship between age, nutritional knowledge, BMI, and farm size. The correlation analysis was required to determine whether nutritional knowledge and household-level resources influence BMI and diet outcomes among adolescents.

Table. 3: Relationships between Age, BMI-for-age, Nutritional Knowledge, and Farm Size

		Respondents Age	Nutrition Knowledge Score	BMI Respondent	Farm Size (Decimal)
Spearman's rho	Respondents Age	--			
	Nutrition Knowledge Score	.715**	--		
	BMI for age of the Respondent	.604**	.535**	--	
	Farm Size (Decimal)	0.033	0.074	0.051	--

**. Correlation is significant at the 0.01 level (2-tailed).

The results showed, statistically significant strong positive correlation between respondents age and nutritional knowledge ($\rho = 0.715$, $p < 0.01$). It also representing older adolescents are more exposed to education, social interactions, which enhances their nutrition-related awareness. Similarly, moderate strong positive correlation ($\rho = 0.604$, $p < 0.01$) between respondents age and BMI were found supporting better nutritional knowledge tend to have healthier BMI. A moderate but significant positive correlation was observed between nutrition knowledge score and BMI ($\rho = 0.535$, $p < 0.01$), which suggests that respondents who knew more about nutrition were more likely to have a good nutritional status. On the other hand, no significant correlation observed between farm size, age and nutritional knowledge (Table.3). It also showed that the better firm size does not significantly influence their nutritional knowledge, status, or BMI for age (Choudhury et al., 2019; Hasan et al., 2019).

Moreover, this study analyzed the association between nutritional knowledge levels and selected variables (mother's education, daily vegetable intake, BMI category, daily fruit intake, vegetable washing methods, and egg consumption) among adolescent girls (Table.4).

3.6 Correlation between Nutritional Knowledge and Selected Variables

Table 4 shows the connection between mothers' education, dietary habits, knowledge levels (better, poor, and average), and participants' BMI. Mothers' education had a strong link ($\chi^2 = 64.96$, $p < 0.001$). A significant number of adolescents with poor knowledge (48.1%) came from families where mothers had no education. In contrast, participants whose mothers had secondary or higher education showed better nutritional knowledge, with over half in the average or better knowledge groups. Nutritional knowledge

was also significantly tied to vegetable consumption ($\chi^2 = 47.76$, $p < 0.001$). Among adolescents who had vegetables three times a day, 57.6% had average knowledge and 22.2% had better knowledge, while those who ate vegetables rarely mostly showed poor knowledge (48.3%).

Table 4. Correlation between Nutritional Knowledge and other Socio-Demographic and Dietary Variables

Variable	Category	Poor knowledge n (%)	Average knowledge n (%)	Better knowledge n (%)
Mother's education	No education	97 (48.1)	48 (28.7)	22 (13.2)
	Primary	54 (30.3)	79 (44.4)	45 (25.3)
	Secondary	37 (19.3)	99 (51.6)	56 (29.2)
	Higher	30 (30.6)	49 (50.0)	19 (19.4)
Daily vegetable intake	None	86 (48.3)	63 (35.4)	29 (16.3)
	Once/day	103 (51.0)	56 (27.7)	43 (21.3)
	Twice/day	48 (30.8)	84 (53.8)	24 (15.4)
	≥ Three times/day	20 (20.2)	57 (57.6)	22 (22.2)
BMI category	Underweight	149 (60.6)	72 (29.3)	25 (10.2)
	Normal	89 (28.9)	169 (54.9)	50 (16.2)
	Overweight	39 (59.1)	23 (34.8)	4 (6.1)
	Obese	8 (53.3)	4 (26.7)	3 (20.0)
Daily fruit intake	None	71 (38.8)	78 (42.6)	34 (18.6)
	Once/day	116 (39.9)	120 (41.2)	55 (18.9)
	Twice/day	45 (40.9)	44 (40.0)	21 (19.1)
	≥ Three times/day	21 (42.0)	24 (48.0)	5 (10.0)
Vegetable washing method	Wash before cutting	138 (39.7)	146 (42.0)	64 (18.4)
	Wash after cutting	120 (42.0)	113 (39.5)	54 (18.5)
Eggs consumed per week	None	4 (42.9)	1 (14.3)	3 (42.9)
	One	70 (41.9)	67 (40.1)	30 (18.0)
	Two	107 (40.5)	113 (42.8)	44 (16.7)
	Three	58 (41.4)	52 (37.1)	30 (21.4)
	Four	19 (35.8)	25 (47.2)	9 (17.0)
	Five	1 (33.3)	1 (33.3)	1 (33.3)

A strong association was also found between nutritional awareness and BMI ($\chi^2 = 64.45$, $p < 0.001$). Low awareness was more common among underweight (60.6%) and overweight (59.1%) adolescents, while normal-weight participants had the highest rates of medium (54.9%) and high (16.2%) awareness. There was no notable link between knowledge score and daily fruit consumption ($\chi^2 = 2.72$, $p = 0.843$). Knowledge scores were similar for individuals who washed vegetables before or after cutting them ($\chi^2 = 0.44$, $p = 0.804$). Similarly, egg consumption per week showed no significant relationship with nutritional knowledge ($\chi^2 = 6.77$, $p = 0.747$). Overall, these findings show that nutritional knowledge is closely linked to mothers' education, frequency of daily vegetable intake, and adolescents' BMI-for-age. However, there was no relationship with fruit or egg consumption or vegetable washing practices. This suggests that healthy eating habits and parental education greatly impact on adolescents' nutritional awareness. On the other hand, nutritional information may not always result in better dietary practices, which can be influenced by food availability, price, and cultural views (Dewey et al., 2002; World Health Organization [WHO, 2017).

4. Discussion

This study provides important insights into nutritional status and food habits of 635 school-going adolescent girls in the rural areas of Netrokona**.** The Present research findings also focus a double burden of malnutrition problem among respondents of that part of rural Bangladesh. The prevalence of thinness observed (39%) in this study is considerably higher than that reported in earlier studies from rural Bangladesh (23.7%), highlighting the persistent and escalating burden of undernutrition as a critical public health concern. Conversely, combined prevalence of overweight (10.39%) and obesity (2.36%) is notably higher than earlier urban studies suggesting a shifting food pattern in nutritional challenges facing rural adolescents. The predominance of thinness in adolescents reflect chronic food insecurity and limited dietary diversity in Netrokona rural areas, while the presence of overweight and obese adolescents signals a gradual dietary shifting. This transition is likely influenced by several factors, including rapid urbanization, insufficient physical activity such as a lack of regular outdoor play, the availability of low-cost unhealthy foods, and limited awareness regarding the risks associated with elevated BMI (Ahmed et al., 2020; Chowdhury et al., 2019).

This study also revealed that, about 17.95% of participants skipped breakfast regularly while (12.44%) periodically. This pattern is consistent with findings from other urban studies in different district areas of Bangladesh. Dietary habits of the respondents expressing critical nutritional gaps. A large proportion of the adolescents have failed to meet daily recommendations for fruits and vegetables intake, and the vast majority (77%) did not consume milk daily. Skipping breakfast and poor food safety practices, such as washing vegetables after cutting, further indicated behavioral inadequacies. Similar trends have been reported in other South Asian contexts, where monotonous rice-based diets and limited protein intake dominate adolescent nutrition (Sarker et al., 2018). These deficiencies during adolescence increase risks of stunting, delayed puberty, anemia, and long-term metabolic complications. The high consumption of cereals (100% daily) reflects traditional Bangladeshi dietary patterns. However, the relatively low consumptions of fruits and dairy products indicates potential micronutrient deficiency risks, a concern highlighted in other regional studies (Choudhury et al., 2019). Several studies reported that 30% of participants regularly skip breakfast, with breakfast being most commonly skipped meal (23.3%). This pattern is consistent with findings from other urban studies in developing countries and is particularly concerning given established relationship between breakfast skipping and poor academic performance (Choudhury et al., 2019). The results emphasize the strong role of maternal education in shaping adolescent nutritional knowledge. Respondents whose mothers had higher education levels were significantly more likely to achieve medium to high knowledge scores. This is consistent with previous studies showing that maternal education often exerts a stronger influence on child and adolescent nutrition

than household income or adolescent's own awareness (Hossain et al., 2020; Rahman et al., 2019. Importantly, higher vegetable intake was linked to greater nutritional knowledge, suggesting that informed households may prioritize healthier food choices. However, knowledge did not significantly influence on fruit or egg consumption, indicating that economic and cultural barriers often constrain the ability to practice healthier behaviors despite awareness.

Analysis of this study showed that, BMI-for-age was significantly associated with nutritional knowledge, because thinness, overweight and obese adolescents were more likely to have low nutritional scores, while those with normal BMI tended to demonstrate higher awareness. This supports the idea that knowledge contributes to healthier weight status, though it is insufficient alone without supportive food environments. Spearman's correlation further confirmed that nutritional knowledge was strongly related to age and moderately associated with BMI, but not with farm size, underscoring the importance of education rather than land ownership in determining dietary outcomes (Mahfuz et al., 2018). These findings suggested the need for multifaceted interventions. School-based nutrition education can raise awareness, but must be coupled with policies that address food insecurity and improve availability, food processing and preservation of diverse foods. In public health programs adolescent girls should be prioritized, as their nutritional status directly impacts future maternal and child health. In disaster-vulnerable rural areas like Netrokona, special attention must be given to strengthening household resilience and access to affordable nutritious foods. This study provides novel evidence on how nutritional knowledge and socioeconomic context jointly influence adolescent nutrition in a rural Netrokona Bangladesh.

5. Conclusions

The present study focused the coexistence of undernutrition which include underweight and emerging overweight among school-going adolescent girls in rural Netrokona, Bangladesh, reflecting a growing double burden problem of malnutrition. Despite moderate awareness, many adolescents demonstrated poor dietary practices, characterized by inadequate intake of fruits, vegetables, and milk, and inconsistent protein consumption. The strong associations between nutritional knowledge, maternal education, and BMI suggest that family-level education plays a critical role in shaping adolescent nutrition outcomes. However, the lack of association between knowledge and certain dietary behaviors indicates that awareness alone cannot overcome structural barriers such as food insecurity, poverty, and cultural food preferences.

Therefore, improving adolescent nutrition requires a multidimensional approach that integrates nutrition education with socioeconomic support and food system interventions. School-based programs emphasizing practical nutrition education, along with efforts to enhance household access to affordable and diverse foods, are essential. Additionally, empowering mothers through literacy and nutrition-focused community initiatives can create a supportive environment for sustainable behavioral change. Strengthening adolescent nutrition in rural areas like Netrokona is not only vital for reducing malnutrition but also a strategic investment in the future health, productivity, and resilience of Bangladesh's next generation and sustainable development.

Acknowledgement

The authors would like to thank Bangladesh Institute of Research and Training on Applied Nutrition, Ministry of Agriculture, authorities for providing financial support to do this research. We also would like to express our heartfelt gratitude to the students, school teachers, and staff of the selected schools at Netrokona Bangladesh for their cooperation and support during data collection.

Conflict of Interest

The author(s) do not have any conflict of interest.

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