ORIGINAL ARTICLE

Nutritional Status, Dietary Diversity, and Health Complications Among Geriatric People in the Rural Areas of Bangladesh

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ABSTRACT

Introduction: Elderly populations worldwide are particularly vulnerable to malnutrition, influenced by a complex interplay of socioeconomic, health, and dietary factors. **Methods and materials:** A cross-sectional study was conducted in rural areas of Bangladesh among male and female individuals aged 60 and above. The Mini Nutritional Assessment (MNI) tool was used to assess nutritional status. Food insecurity was measured based on the United States Department of Agriculture (USDA) guidelines, and diet variety was described by calculating the Individual Dietary Diversity Score (IDDS). Data were analyzed using R studio.**Results:** The participant's mean age was 67.9 (SD ±7.98) years. About 13.0% were malnourished, and 51.8% were at risk of malnutrition. Low-income individuals faced a substantially increased malnutrition risk (AOR = 11.271, 95% CI = 2.296–55.322) than their counterparts. Dementia (AOR = 6.33, 95% CI = 2.47–16.20) and anorexia (AOR = 6.10, 95% CI = 2.58–14.40) were major contributors, with severe Activity in Daily Living (ADL) impairment further elevating malnutrition risk (AOR = 8.58, 95% CI = 0.63–116.59). Almost 58.9% had high IDDS, with a higher score among males than females. Among respondents, 17.4% experienced low and 9.9% had very low food security. Dietary patterns showed a reliance on starchy staples, with decreased consumption of vegetables, proteins, and dairy with age.**Conclusion:** Over half of the participants were at malnutrition risk, highlighting significant associations with age, health status, and socioeconomic factors. Targeted interventions are essential to mitigate malnutrition and improve nutritional health among geriatrics.
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INTRODUCTION

The physiological process of aging begins at birth, continues throughout a person's life, and culminates in death [1]. Old age, generally considered to begin after sixty years of age, marks one of the most vulnerable phases of life [2]. During this stage, individuals often experience health deterioration and a decline in physical strength, making them more susceptible to age-related diseases [3]. Globally, population aging is an emerging phenomenon, and Bangladesh is facing this demographic transition as well [4]. Between 2015 and 2050, the global elderly population is projected to grow by 900 million, increasing from 12% to 22% of the total population [5]. The elderly population is the fastest-growing demographic segment worldwide, with the majority of this growth concentrated in developing countries [5]. Bangladesh is expected to have 42.2 million older adults by 2050 [3]. This rapid demographic shift poses significant health, social, and economic challenges, particularly for aging populations in developing countries like Bangladesh.

Literature reveals that elderly people in Bangladesh confront a range of social, mental, medical, and economic challenges exacerbated by their advanced age [6]. The health and nutritional status of elderly individuals depend on access to adequate food, clean water, proper sanitation, and hygienic practices. The World Health Organization reports that malnutrition among the elderly in community settings has a global

prevalence ranging between 1.3% and 47.8% [7]. Undernutrition affects approximately one-third of the Bangladeshi population, equating to over 42 million individuals. Despite the growing significance of geriatric health in Bangladesh, it remains a largely neglected area of public health concern [8]. Many older adults in Bangladesh face poor socio-economic conditions due to poverty, wage disparities, lack of essential resources, inadequate shelter, and forced retirement upon reaching the age limit [9]. The prevalence of health problems among the elderly has a more detrimental effect on their nutritional status than chronological aging [10]. In low-income countries, malnutrition is strongly linked to food insecurity, resulting in a portion of the population with insufficient food intake [11]. In rural areas, the situation is further exacerbated by structural barriers that limit access to nutritious foods, contributing to widespread food insecurity among older adults.

Food insecurity in rural areas is also influenced by factors such as low household income, limited access to quality grocery stores, and higher food prices [12]. There is a strong correlation between food insecurity and health, especially for families living in poverty, due to the frequent incidence of poor health, limited access to healthcare in rural regions, and an increased risk of physical and mental illness [13]. Older adults experiencing food insecurity are more likely to report fair or poor health and are frequently burdened by comorbidities such as diabetes, depression, hypertension, cardiovascular disease, and gingivitis [14,15]. A meta-analysis reveals a strong association between food insecurity and increased levels of depression and stress [16]. Food-insecure older people also face more limitations in activities of daily living [15,17].

Given these complex interrelationships, it is essential to consider not only food security but also dietary diversity when assessing the nutritional risks faced by the elderly. Dietary diversity refers to the variety of foods consumed by an individual over a specific period [18]. It is a commonly used indicator for evaluating the nutritional quality of a diet and has been strongly associated with improvements in dietary adequacy [19]. A study conducted in China found that individuals with lower dietary diversity were more likely to experience higher levels of anxiety and depression [20]. Additionally, the positive association between nutritional status and dietary diversity scores highlights the potential of dietary diversity to support the achievement of optimal nutritional status, particularly among older adults [21].
Despite growing awareness of elderly malnutrition and its associated factors, most existing studies focus on urban populations or national-level data, overlooking the unique challenges faced by older adults in rural communities. This study, therefore, aimed to evaluate the nutritional status, health challenges, dietary diversity, and food insecurity among the elderly population living in rural settings.

METHODS

Study design, data collection tools, and techniques

A cross-sectional study was carried out in rural areas across four divisions of Bangladesh, namely Dhaka, Chittagong, Rangpur, and Barisal, selected from the country's eight divisions. A total of 384 elderly participants who met the specified inclusion criteria were included. Eligible participants were male and female individuals aged 60 years and above, residing in rural areas within the selected divisions, living with families, and willing to participate. Rural areas were identified based on the Bangladesh Bureau of Statistics report of Bangladesh's Population and Housing Census [22]. Exclusion criteria encompassed individuals unwilling to be interviewed, those hospitalized or residing in clinics or elder care facilities, and individuals with intellectual disabilities.

The data for this study were collected over the period from March 2023 to July 2023. A multistage sampling technique was employed. In the first stage, four divisions were randomly selected out of eight. In the second stage, rural areas within these divisions were identified. In the final stage, participants meeting the inclusion criteria were selected using convenience sampling within the chosen rural areas.

The sample size was determined using the formula for cross-sectional studies: n = Z pq/d [23,24]. Here, n represents the desired sample size, Z is the standard normal deviation (1.96 at 95% confidence interval), p denotes the assumed prevalence of malnutrition (50% or 0.5), and q was calculated as (1-p = 0.5). The study's margin of error was set at 5% (d = 0.05), resulting in a calculated sample size of n = 384.

A structured questionnaire was the primary data collection tool, initially developed in English and subsequently translated into the local language (Bengali) to ensure ease of access. All data were collected through face-to-face interviews.

Sociodemographic status assessment

Demographic variables included the respondent's age and sex, while socioeconomic status (SES) was assessed based on education level and monthly family income in Bangladeshi Taka (BDT). Income was further classified into three groups following the World Bank Atlas method: low income (less than 10,000 BDT), middle income (10,000 to 40,000 BDT), and high income (more than 40,000 BDT) [25].

Nutritional assessment

The Mini Nutritional Assessment (MNA) encompasses 18 items that assess four primary dimensions that indicate changes in dietary intake, recent weight loss, mobility, psychological stress or acute illness within the past three months, dementia, Body Mass Index

(BMI), lifestyle factors, and the presence of pressure scores [26]. Based on the MNA score, individuals were categorized into three categories: Malnutrition (MNA < 17), Risk of Malnutrition (MNA between 17 and 23.5), and Well-Nourished (MNA ≥ 24) [26]. Anthropometric measurements included height, weight, and mid-upper arm circumference. Weight was measured to the nearest 0.1 kg using a digital scale, with participants wearing light clothing and no shoes; the scale was positioned on a flat surface to ensure accuracy. A stadiometer was used to record height, measured without shoes to the nearest 0.1 cm. Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m^2). The Asian BMI cut-off points were applied to categorize participants' nutritional status as follows: underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23–24.9 kg/m^2), pre-obese (25–29.9 kg/m^2), and obese (≥30 kg/m^2) [27].

Dietary diversity and food insecurity assessments

The Individual Dietary Diversity Score (IDDS) was calculated in accordance with Food and Agriculture Organization (FAO) guidelines based on the frequency of consumption across nine distinct food groups within the previous 24 hours. Dietary information was collected through a food frequency questionnaire and recall method. A score of 1 was assigned if an individual consumed an item from a given food group, while a score of 0 was given if they did not. IDDS scores were then categorized into three levels: low (0-3), medium (4-6), and high (7-9) [18]. This study utilized seven questions to analyze food insecurity, focusing on households' experiences of food scarcity and associated behaviours over the preceding four weeks. Each question offered binary (yes/no) responses, with additional follow-up questions addressing frequency to gain more detailed insights. Topics covered included concerns about food adequacy, the inability to consume preferred or diverse foods, the necessity of consuming less desirable foods, reductions in meal frequency, and going to bed hungry due to limited resources. Responses captured both the occurrence and frequency of these challenges. Food security levels were categorized based on the United States Department of Agriculture (USDA) guidelines as follows: high food security (0-1), low food security (2-4), and very low food security (5-6) [28].

Health complications and functional status

The study examined the presence of health complications, including dementia, diabetes, anorexia, visual impairments, etc. Health conditions were verified through prior medical test reports, medical records, or discussions with family members. Participants' functional status was evaluated using the Katz Index of Independence in Activities of Daily Living (Katz ADL), which measures their capacity to perform essential daily activities independently. The Index assesses six specific functions: bathing, dressing, toileting, transferring, continence, and feeding. Scoring was based on respondents' yes/no responses regarding their independence in each of these functions. A score of 0-3 reflects severe impairment, 4-5 indicates moderate impairment, and a score of 6 represents full independence [29].

Data analysis

The collected data were carefully checked, edited, and coded prior to analysis. Data was entered into an Excel sheet, and the statistical analysis was conducted using R Studio, with descriptive statistics used to summarize the data. Categorical variables were reported as frequencies and percentages, and associations between them were tested using the Chi-square test. The adjusted multiple logistic regression model subsequently included only variables showing statistical significance in the Chi-square analysis. The strength of associations was assessed using adjusted odds ratios (AOR) with 95% confidence intervals (CI), and statistical significance was set at $P < 0.05$.

Ethical approval and consent to participants

The Institutional Ethical Approval Committee at Primeasia University (PAU/IEAC/23/118) granted ethical approval for the study. A written consent was obtained from each respondent before commencing data collection. Confidentiality and privacy of participants were strictly maintained.

RESULTS

Demographic characteristics of the study population

A total of 384 elderly individuals participated in the study, with a mean age of 67.9 (SD ±7.98) years. As shown in Table 1, the majority of participants were in the younger old age group (60-75 years) at 85.7%, followed by the old (76-85 years) at 11.2%, and the oldest old (over 85 years) at 3.1%. Among respondents, 58.3% were female, and 41.7% were male. The majority identified as Muslim (83.1%) in religion, with Hindu participants comprising 9.6% and others 7.3%. Regarding family structure, 41.1% were part of nuclear families, while 58.9% were in joint families. Education status shows 79.4% of respondents had no formal education, and in terms of employment, 64.3% were unemployed. Income levels were categorized, with 20.6% of respondents in the low-income group, 60.2% in the middle-income group, and 19.3% in the high-income group.

Table I: Correlation between demographic variables and nutritional status

Variables	Category	n=384	Malnourished	At risk of malnutrition	Well-nourished	P Value
Age Range	Young old 60-75	329(85.7%)	33(10.0%)	169(51.4%)	127(38.6%)	0.000
	Old 76-85	43(11.2%)	12(27.9%)	24(55.8%)	7(16.3%)	
	Oldest old >85	12(3.1%)	5(41.7%)	6(50.0%)	1(8.3%)	
Gender	Male	160(41.7%)	15(9.4%)	78(48.8%)	67(41.9%)	0.033
	Female	224(58.3%)	35(15.6%)	121(54.0%)	68(30.4%)	
Religion	Islam	319(83.1%)	27(8.5%)	171(53.6%)	121(37.9%)	0.000
	Hindu	37(9.6%)	15(40.5%)	17(45.9%)	5(13.5%)	
	Others	28(7.3%)	8(28.6%)	11(39.3%)	9(32.1%)	
Family Type	Nuclear	158(41.1%)	21(13.3%)	82(51.9%)	55(34.8%)	0.988
	Joint	226(58.9%)	29(12.8%)	117(51.8%)	80(35.4%)	
Education	No formal education	305(79.4%)	42(13.8%)	164(53.8%)	99(32.5%)	0.053
	Primary	57(14.8%)	6(10.5%)	29(50.9%)	22(38.6%)	
	Secondary & above	22(5.7%)	2(9.1%)	6(27.3%)	14(63.6%)	
Employment	Unemployed	247(64.3%)	39(15.8%)	128(51.8%)	80(32.4%)	0.061
	Employed	137(35.7%)	11(8.0%)	71(51.8%)	55(40.1%)	
Household monthly Income	Low income	79(20.6%)	19(24.1%)	42(53.2%)	18(22.8%)	0.000
	Middle income	231(60.2%)	28(12.1%)	124(53.7%)	79(34.2%)	
	Higher income	74(19.3%)	3(4.1%)	33(44.6%)	38(51.3%)	

Correlation between demographic variables and nutritional status

The nutritional status of the majority of older adults, as assessed by the Mini Nutritional Assessment, was significantly associated with various demographic factors (Table 1). Age demonstrated a strong influence on nutritional status (P = 0.000). Gender differences were observed, with malnutrition being more prevalent among females (P = 0.033). Religious affiliation was also a significant factor, showing higher malnutrition rates among Hindus and other groups compared to Muslims (P = 0.000). Additionally, household monthly income levels were significantly associated with nutritional status, as higher-income groups exhibited lower rates of malnutrition (P = 0.000).

Nutritional Status, IDDS, and food security of the study population

The Mini Nutritional Assessment indicated that 51.8% were at risk of malnutrition and 13.0% were malnourished. According to the Asian Body Mass Index (BMI) cut-off categories, 40.4% of respondents were healthy, with an equal prevalence of underweight and overweight at 18.0%, and obesity was 23.6% (pre-obese/obese). Mid-upper arm circumference (MUAC) revealed 22.1% undernourishment. Based on the Individual Dietary Diversity Score, 58.9% had high IDDS, with a higher score among males than females. Food security assessment indicated 72.7% were highly secure, with 17.4% low and 9.9% very low food security (Table 2).

Table II: Nutritional Status, IDDS, and food security of the study population (n=384)

Variables	Categories	Male (%)	Female (%)	Total (%)
BMI	Under Weight	29(18.1%)	40(17.9%)	69(18.0%)
	Normal	60(37.5%)	95(42.4%)	155(40.4%)
	Overweight	43(26.9%)	26(11.6%)	69(18.0%)
	Pre obese	24(15.0%)	50(22.3%)	74(19.3%)
	Obese	4(2.5%)	13(5.8%)	17(4.3%)
MNA	Malnourished	15(9.4%)	35(15.6%)	50(13.0%)
	At risk of malnutrition	78(48.8%)	121(54.0%)	199(51.8%)
	Well-nourished	67(41.9%)	68(30.4%)	135(35.2%)
MUAC	Under Nourished	28(17.5%)	57(25.4%)	85(22.1%)
	Normal	132(82.5%)	167(74.6%)	299(77.9%)
IDDS	High (7-9)	108(67.5%)	118(52.7%)	226(58.9%)
	Moderate (4-6)	43(26.9%)	87(38.8%)	130(33.9%)
	Low (0-3)	9(5.6%)	19(8.5%)	28(7.3%)
Food security	Highly secured	130(81.3%)	149(66.5%)	279(72.7%)
	Low food security	17(10.6%)	50(22.3%)	67(17.4%)
	Very low food security	13(8.1%)	25(11.2%)	38(9.9%)

The dietary habits of the respondents according to gender and age

Table 3 provides a summary of participants' weekly consumption (three or more times) of foods from each food group, analyzed by gender and age group. Starchy staples were consumed by 95.6% of males and 92.9% of females. Dark green leafy vegetables were consumed by 91.9% of males and 84.8% of females. Fish and meat intake was reported by 78.1% of males and 68.8% of females, while egg consumption was 96.3% for males and 80.4% for females. However, the consumption of milk and milk products, as well as legumes and nuts, was notably lower among both genders. Starchy staple intake was most frequent among individuals aged 76-85 years. Consumption of vegetables, fish, meat, and legumes declined with age, as did the intake of eggs and dairy products in the older age groups.

Table III: Dietary habits of the respondents according to gender and age

Food groups (consumed three times or more in a week)		Gender (N=384)		Age group (N=384)		
		Male (n=160)	Female (n=224)	60-75 (n=329)	76-85 (n=43)	>85 (n=12)
Starchy staples	Yes	153(95.6%)	208(92.9%)	309(93.9%)	41(95.3%)	11(91.7%)
	No	7(4.4%)	16(7.1%)	20(6.1%)	2(4.7%)	1(8.3%)
Vitamin A-rich fruits and vegetables	Yes	154(96.3%)	204(91.1%)	306(93.0%)	41(95.3%)	11(91.7%)
	No	6(3.8%)	20(8.9%)	23(7.0%)	2(4.7%)	1(8.3%)
Dark green leafy vegetables	Yes	147(91.9%)	190(84.8%)	292(88.8%)	36(83.7%)	9(75.0%)
	No	13(9.1%)	34(15.2%)	37(11.2%)	7(16.3%)	3(25.0%)
Fish and meat	Yes	125(78.1%)	154(68.8%)	243(73.9%)	30(69.8%)	6(50.0%)
	No	35(21.9%)	70(31.3%)	86(26.1%)	13(30.2%)	6(50.0%)
Egg	Yes	154(96.3%)	180(80.4%)	284(86.3%)	41(95.3%)	9(75.0%)
	No	6(3.8%)	44(19.6%)	45(13.7%)	2(4.7%)	3(25.0%)
Legumes & nuts	Yes	112(70.0%)	130(58.0%)	210(63.8%)	28(65.1%)	4(33.3%)
	No	48(30.0%)	94(42.0%)	119(36.2%)	15(34.9%)	8(66.7%)
Milk and Milk Products	Yes	102(63.8%)	114(50.9%)	191(58.1%)	23(53.5%)	2(16.7%)
	No	58(36.2%)	110(49.1%)	138(41.9%)	20(46.5%)	10(83.3%)

Association between health complications and geriatric nutritional status

The nutritional status of older adults, as classified by the MNA, showed significant associations with several health complications. Dementia was strongly associated with malnutrition, with 32.2% of participants with dementia categorized as malnourished (P = 0.000, χ2 = 49.365). Anorexia also displayed a significant association, with a malnutrition prevalence of 23.2% (P = 0.000, χ2 = 40.929). Visual impairment was another factor significantly correlated with malnutrition (P = 0.000, χ2 = 22.305), as were dental issues linked to increased malnutrition rates (P = 0.001, χ2 = 13.348). Additionally, limitations in activities of daily living were significantly associated with malnutrition (P = 0.000, χ2 = 34.550) (Table 4). However, diabetes mellitus and Cardiovascular Disease (CVD) did not exhibit significant associations with malnutrition.

Table IV: Association between health complications and geriatric nutritional status

Variables	Categories	Total N=384	Malnourished	At risk of malnutrition	Well-nourished	χ2	P Value
Dementia	Yes	90 (23.4%)	29 (32.2%)	49 (54.4%)	12 (13.3%)	49.36	0.000
	No	294 (76.6%)	21 (7.1%)	150 (51.0%)	123 (41.8%)		
Anorexia	Yes	138 (35.9%)	32 (23.2%)	83 (60.1%)	23 (16.7%)	40.92	0.000
	No	246 (64.1%)	18 (7.3%)	116 (47.2%)	112 (45.5%)		
Visual Impairment	Yes	177 (46.1%)	33 (18.6%)	102 (57.6%)	42 (23.7%)	22.30	0.000
	No	207 (53.9%)	17 (8.2%)	97 (46.9%)	93 (44.9%)		
Dental Problem	Yes	167 (43.5%)	27 (16.2%)	98 (58.7%)	42 (25.1%)	13.34	0.001
	No	217 (56.5%)	23 (10.6%)	101 (46.5%)	93 (42.9%)		
Diabetes Mellitus	Yes	85 (22.1%)	10 (11.8%)	39 (45.9%)	36 (42.4%)	2.48	0.289
	No	299 (77.9%)	40 (13.4%)	160 (53.5%)	99 (31.1%)		
CVD	Yes	58 (15.1%)	4 (6.9%)	34 (58.6%)	20 (34.5%)	2.58	0.274
	No	326 (84.9%)	46 (14.1%)	165 (50.6%)	115 (35.3%)		
Activities of Daily Living	Severe impairment	11 (2.9%)	6 (54.5%)	4 (36.4%)	1 (9.1%)	34.55	0.000
	Moderate impairment	67 (17.4%)	17 (25.4%)	36 (53.7%)	14 (20.9%)		
	Independent	306 (79.7%)	27 (8.8%)	159 (52.0%)	120 (39.2%)		

Factors associated with the nutritional status of geriatric people

Multinomial logistic regression analysis indicated that participants aged 60-75 years had a lower risk of malnutrition compared to those over 85 years old (AOR = 0.05, 95% CI: 0.00-0.66, p = 0.002). The odds of malnutrition were found to be eleven times higher (AOR = 11.27; 95% CI: 2.29-55.32, p=0.003) among elderly individuals with lower income levels. Older adults with dementia had a 6.33 times higher likelihood of being malnourished (AOR = 6.33; 95% CI: 2.47-16.20, p=0.000), while those with anorexia showed a 6.10 times increased risk of malnutrition (AOR = 6.10; 95% CI: 2.58-14.40, p=0.000). The analysis also revealed that participants with moderate impairment had three times the risk of malnutrition compared to independent participants (AOR = 3.01; 95% CI: 1.15-7.86, p=0.024) (Table 5).

Table V: Multinomial logistic regression model

Associated factors	Malnourished			Risk of Malnutrition		
	95% Confidence Interval			95% Confidence Interval		
	AOR	LCI – UCI	P Value	AOR	LCI–UCI	P Value
Gender (Male)	0.76	0.33-1.76	0.534	0.84	0.52-1.37	0.506
Age (Young old 60-75)	0.05	0.00-0.66	0.022	0.25	0.02-2.29	0.221
Age (Old 76-85)	0.24	0.01-3.56	0.303	0.56	0.05-6.06	0.640
Income (low Income)	11.27	2.29-55.32	0.003	2.33	1.06-5.10	0.034
Income (Middle income)	4.53	1.04-19.66	0.043	1.82	1.00-3.29	0.047
Dementia (Yes)	6.33	2.47-16.20	0.000	2.07	1.00-4.28	0.050
Anorexia (Yes)	6.10	2.58-14.40	0.000	2.86	1.62-5.05	0.000
Visual Problem (Yes)	1.62	0.69-3.79	0.267	1.51	0.90-2.53	0.111
Dental Problem (Yes)	0.74	0.32-1.73	0.502	1.32	0.78-2.21	0.290
ADL (Severe impairment)	8.58	0.63- 16.59	0.106	1.73	0.16-18.29	0.647
ADL (Moderate impairment)	3.01	1.15-7.86	0.024	1.36	0.66-2.80	0.392

AOR: Adjusted odd ratio, UCI: Upper Confidence Interval, LCI: Lower Confidence Interval, ref category: age (oldest old >85 years), income (higher income), ADL (independent), outcome variable (Healthy)

DISCUSSION

Malnutrition is a persistent health condition that is often difficult to identify, emphasizing the crucial necessity of early detection to minimize negative consequences such as increased dependence, reduced quality of life, higher healthcare costs, and elevated morbidity and mortality rates. This cross-sectional investigation underscores the continued prevalence of malnutrition and age-related health concerns among elderly populations residing in rural Bangladesh.

The study found that both overweight and underweight prevalence among geriatric's were 18%. However, another Bangladeshi study reported 31.9% of geriatric respondents as underweight, a higher rate than observed in our findings [24]. On the other hand, the national average of underweight among adults is about 20.9%, with the prevalence being higher among older individuals (Age≥60 years) [30]. Beyond BMI, we applied additional assessment tools, including MUAC, CC, and MNA, to evaluate nutritional status, as BMI may have limitations in the elderly due to factors like physical deformities or disabilities. The MNA tool offers a reliable method to screen for malnutrition in independently living elderly individuals without the need for biochemical tests [31]. Our findings showed that 51.8% of respondents were at risk of malnutrition, while 13.0% were malnourished according to MNA. Similarly, a previous study in Bangladesh found a similar pattern, where the risk of malnutrition was more prevalent than that of malnutrition [24]. In this study, females were more vulnerable to malnutrition. However, a previous study in the different regions of Bangladesh reported higher percentages of malnutrition among males [8]. This might be the reason for the place of residence, a study in Poland found a significant difference in food consumption and nutritional status of elders based on their place of living [32].

The study identified a significant association between malnutrition and older age, female gender, and financial dependence. Similar findings have been reported in studies from neighboring countries, including Nepal and India [33–35]. The analysis suggests that the risk of malnutrition rises with age, a trend also seen in an Ethiopian study [36]. Participants from low-income families were 11.27 times more likely to experience malnutrition compared to those with higher family incomes, aligning with prior research that associates low income or poor socioeconomic status with increased malnutrition risk [34,37]. Older adults with lower socioeconomic conditions often have limited access to food, which negatively impacts their food security and daily food intake, both in quantity and quality [36].
This study also demonstrated a significant relationship between Activities of Daily Living (ADL) limitations and malnutrition, supporting findings from an Iranian study [38]. This connection may stem from mobility and self-care restrictions that limit food access and meal preparation, leading to nutritional deficiencies. Health complications were found to be significantly linked to nutritional status, with results comparable to an Ethiopian study [39]. Dementia and anorexia were also key predictors of malnutrition in this study, likely due to cognitive issues affecting meal planning and the recognition of hunger signals, alongside anorexia-related food intake reductions. These factors, combined with physiological changes associated with aging and comorbid health conditions, heighten malnutrition risks among this population.

Based on the findings of this study, 58.9% of participants had a high Individual Dietary Diversity Score (IDDS), with males scoring higher than females. This aligns with a study from India, which reported that adult females tend to consume less diverse diets [40]. Similarly, another study found that women had the unhealthiest

food consumption patterns and the lowest dietary diversity compared to their counterparts [41]. These disparities may be attributed to socio-cultural practices and the traditional roles of women within households [42–44]. The limited availability of data in the literature constrains a comprehensive understanding of the reasons behind gender disparities in dietary diversity
Food insecurity is a complex, multi-dimensional issue influenced by various individual, household, social, political, economic, and environmental factors [45]. Regarding food security, 17.4% of participants experienced low food security, while 9.9% experienced very low food security. In comparison, nationally representative data from rural Bangladesh indicated that the overall prevalence of moderate or severe food insecurity was 18.92% [46]. Key determinants explaining variations in food insecurity include geographic location, access to electricity, household ownership, sanitation access, livestock ownership, family size, education level, and monthly per capita food expenditure [46]. Other studies have also identified factors such as monthly household income, age of the household head, land ownership, access to media, and wealth index as significantly associated with household food insecurity [47,48].

Our research revealed that participants primarily consumed starchy staples, fruits, vegetables, and eggs, likely influenced by their rural setting, where home gardening and agriculture are common practices. The high intake of starchy staples reflects both their availability and cultural preferences. Fruit and vegetable consumption varied with seasonal availability, while meat, fish, and dairy product intake remained moderate to low. Similarly, a study in Zambia found comparable patterns in starchy staple and vegetable consumption; however, a smaller proportion of respondents consumed milk and protein-rich foods compared to this study, potentially due to differences in the population's characteristics and profile [49].

Several limitations should be considered when interpreting these findings. First, the cross-sectional design of the study limits the ability to establish causal relationships between variables. Second, the relatively small sample size and the focus on specific rural areas may limit the generalizability of the results to the broader elderly population in Bangladesh. Third, the exclusion of elderly individuals residing in institutional settings, such as hospitals or elder care facilities, may have led to the underrepresentation of a potentially more vulnerable group. Lastly, the reliance on self-reported data for certain variables may have introduced recall bias, affecting the accuracy of the responses. Future longitudinal studies with larger, more diverse samples are warranted to confirm these associations and explore additional factors influencing malnutrition risk among older adults.

CONCLUSION

In conclusion, this study highlights the critical issues surrounding nutritional status and health complications among elderly individuals residing in rural areas of Bangladesh. The findings reveal a high prevalence of malnutrition and vulnerability within this population, largely influenced by socioeconomic constraints. Health conditions such as dementia and anorexia further compound the nutritional challenges faced by older adults. These results underscore the urgent need for targeted, evidence-based interventions to improve nutritional outcomes in this demographic. Policy efforts should focus on enhancing income stability, expanding access to healthcare services, and delivering tailored nutritional education programs. Additionally, improving access to diverse and nutritious foods, as well as providing targeted support for both older adults and their caregivers, is essential. A comprehensive, multisectoral approach is necessary to promote healthy aging and improve the overall quality of life for elderly populations in rural Bangladesh.

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