Original Research Article

Prevalence and Socio-economic Determinants of Low and Medium Individual Dietary Diversity and Nutritional Status among Young Adults in Noakhali, Bangladesh

Abstract

Background: Dietary diversity (DD) is an increase in the variety of foods within and between food categories over a certain period of time. This study investigates the relationship between the Individual Dietary Diversity Score (IDDS) and its many socioeconomic variables among young individuals, aiming to discover prospective strategies and interventions for improving dietary diversity and general health status.

Method: A cross-sectional survey using convenience sampling method was carried out from January to February, 2023 at Noakhali, Bangladesh. A pretested, standard and structured questionnaire was used for sociodemographic characteristics, nutritional status, Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS). Multivariate logistic regression and correlation analyses were carried out using IBM SPSS version 26.0.

Result: Most of the participants were observed to have either medium (46.1%) or high (44.1%) IDDS. Participants with higher income and higher BMI scores had more diverse diets, as we found a strong and significant positive relationship between IDDS and income level (R = 0.662); and IDDS and BMI category (R = 0.290), where both have significant effects on each other (*P*=.000). Borderline FCS relative to high FCS was more significantly and independently associated with low dietary diversity relative to high dietary diversity considering other factors when adjusted (adjusted RRR (aRRR) 0.64 (95% CI 0.012 to 0.335), *P*=.001). Males were found to be significantly at higher risk of being overweight compared to female counterparts (aRRR 2.422, *P*=0.03). On the other hand, individuals with no formal education have a lower risk of being overweight (aRRR 0.241, *P*=0.01) compared to those who completed secondary level or above.

Conclusion: Dietary diversity score reveals the nutritional intake and potential nutrient deficiencies of an individual. Since income and education are not the sole determinants of nutritional status, other determinants like hygiene, healthcare facilities, physical activity level and employment opportunities should also be considered to improve IDDS.

Keywords: Dietary Diversity; Nutritional status; Food Consumption Score (FCS); Individual Dietary Diversity Score (IDDS); Nutrition; Noakhali

1. Introduction:

It was demonstrated that dietary risk accounted for over one-third of deaths globally in 2013 (1). The World Health Organization has thus focused on nutritional habits in an effort to slow the current rise of non-communicable diseases (2). A diverse, ranging well-balanced diet is essential at every stage of life. One of the most important life periods is adolescence, which calls for a certain nutrition (3, 4). The transition from childhood to adulthood occurs during the second ten years of life, known as young adulthood. It is thought to be a crucial period to lay the groundwork for a healthy and successful adult life and also for the wellbeing of generations to come (4). Early adulthood and young adulthood are critical transitional times for acquiring health-related behaviors (such as food, exercise, sleep patterns, and alcohol and tobacco use) that could otherwise lead to the development of non-communicable diseases (5, 6).

Worldwide young adults are bearing a complicated burden of malnutrition in this era of rapid changes in the population, epidemiology, and nutrition (7). Malnutrition is described as an insufficient or excessive amount of nutritional intake which causes imbalance between nutrient intake and energy expenditure, and a body that cannot utilize the nutrients effectively (8). When someone is undernourished, their ability to sustain bodily processes is compromised, they are more likely to end up in the hospital, and their immune system suffers from a lack of vitamins and minerals, which serve as enzymes and coenzymes.

In Bangladesh and other developing nations, teenage undernourishment, deficiency of micronutrients, overweight and obesity are common problems (9, 10). An insufficient diet, in the sense of amount and diversity, is a major contributor to all sorts of malnutrition at all stages in life. Dietary diversity (DD) can be described as "an increase in the diversity of foods between and among food groups over an indicative period," according to research (11), is a good indicator of how well a person's diet meets their nutritional needs on an individual basis (12-14).

A person might become malnourished for a variety of reasons, including insufficient nutritional intake, poor income, poverty, poor sanitation, natural catastrophes, gender discrimination, a lactating mother who is undernourished, and malabsorption of food that they fail to utilize (15). Additionally, comprehensive reviews show that the variety of foods and micronutrient supplies of young adult diets in nations with low or middle incomes are influenced by a range of demographic and socioeconomic variables at the person, parent, family members, the natural environment, and microsystem levels in different situations. (16).

Natural catastrophes and climate change are familiar concepts in Bangladesh, both recently and historically. Environmental change and natural disasters influence lives and livelihoods. Both the supply and the distribution of food are under threat, which has an impact on all individuals but is particularly detrimental to growing children (0–5 years) (8), adolescent females, pregnant

women, and breastfeeding mothers. In order to combat malnutrition and prevent chronic diseases linked to diet, dietary recommendations based on food recommend consuming a greater range of foods (17, 18). Young adult diets around the world are typified by a lack of variety in the food, a decrease in nutrient-dense food, and an increase in processed foods and drinks (19, 20). Due to the widespread consumption of a high percentage of starchy staples in entire meals, inadequate dietary diversity is more common in countries with low and moderate incomes across all age groups (21). Similarly, young adult's diets in Bangladesh are deficient in micronutrient content and diversity (22).

To know a nutritious diet or measure a healthy diet, three major indicators are used, 1) Food or food group-based indicators; 2) Nutrient-based indicators; and 3) combination indexes. Individual dietary varieties are employed worldwide based on food groups (23).

A person's food intake is attributed using the Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS) tools, which provide detailed information about how many macronutrients and micronutrients they consume. The variety of food a person consumes can be influenced by seasonal foods, age, gender, family members, religion, ethics, and cultural behavior (24). However, gender discrimination, education, and dietary awareness can all have an impact. In that case, Unicef reports that about 6,04,000 underweight infants are born in Bangladesh each year, and 28% of them are trapped in a poverty and hunger cycle that extends through their entire family (25). In the Noakhali district, both of these are common, and natural disasters also exist. The most vulnerable region is the Chattogram Division. Natural catastrophes negatively affect people in Noakhali and the food management system as a result. These places also show signs of malnutrition and double-burden malnutrition. When it comes to severe malnutrition and micronutrient disorders such anemia, low birth weight, poor growth, underweight, stunting and wasting; women, girls, and children are the most susceptible groups.
Few studies have been conducted to this point that examine the major outcome of IDDS in teenagers in Bangladesh and look into the factors that may be related to it. Furthermore, all of the subjects of this research were young adults in the Noakhali District. These studies are limited to a certain region. The Noakhali region was not included in any of the previous studies as a study area. For this reason, there are little regionally representative statistics on the prevalence of IDDS and FCS and their causes in young adults. In light of this fact, our aim was to investigate the prevalence of inadequate IDDS in Noakhali district among young adults by area as well as the factors that are linked to inadequate IDDS.

2. Materials and Methods:

Study Location: Noakhali district of Bangladesh served as the study location. The investigation was cross-sectional. The study's duration was set for January through March of 2023. 406 young adults participated in the study.

Sampling technique and data collection:Participant eligibility for the study was determined by four criteria: (a) age range of 18 to 25 years; (b) mental capacity and verbal communication skills; (c) ability to give informed consent; and (d) willingness to engage in the study on a voluntary basis. Non-respondents and participants with any kind of acute or chronic disease were not allowed.

Sample size was calculated according to the Cochran equation.

Sample size, $n= Z^2pq/e^2$

Where, Z: standard normal variate (1.96 at 5% type I error), p: the estimated proportion of the population, q: 1-p, e: the desired level of precision (5%)

Since the prevalence of IDDS in the Noakhali region of Bangladesh is unknown, p=0.5 will be used to calculate the required sample size (n). Hence, the required sample size is 384. However, 406 participants were recruited for the current study using a convenience sampling technique.

We assessed IDDS using the 9 food groups, all of which are included in the Women Dietary Diversity Score (WDDS). IDDS and FCS were assessed using a validated and field-tested questionnaire. In this study, a locally tailored and translated version of the questionnaire was used in Bengali. Both closed-ended and open-ended questions were included in the questionnaire. The questionnaire was used for data collection after being pre-tested by 40 participants to ensure comprehension, readability, and ease of administration. The reliability of each required section of the questionnaire was verified using Cronbach's coefficient alpha (α> 0.700).

Weight and height of the respondents were measured using a standard stadiometer and weighing scale respectively.The body mass index (BMI) of the participants was calculated as weight (kg)/height^2 (m^2). They were also questioned on the nine food types they had consumed over the previous seven days, as well as the socio demographic characteristics of themselves.

Food consumption score (FCS): Data on the variety and frequency of food groups ingested over the course of the preceding seven days is weighed based on the relative nutritional value of the food groups consumed. Foods were divided into nine food categories and the weight allocated to each food category multiplied by its frequency of intake in the past seven days. The following requirements are deemed acceptable by WFP in a broad range of situations.

1.Poor food consumption: 0 to 21

2.Borderline food consumption: 21.5 to 35

3.Acceptable food consumption: > 35

The formula for calculating FCS is given below:

$$FCS=a_{Staple} \times X_{Staple} + a_{pulse} \times X_{pulse} + a_{vegetable} \times X_{vegetable} + a_{fruit} \times X_{fruit} + a_{Meat\& fish} \times X_{Meat\& fish} + a_{Dairy} \times X_{dairy} + a_{Sugar} \times X_{Sugar} + a_{oil} \times X_{oil} + a_{condiments} \times X_{condiments}$$

Here,

FCS = Food consumption score

a_1 = weight of each food group

$X_{1 =}$ food consumption frequency (number of days for which each group was consumed during the past seven days) (1).

3. Result:

Table 1: Sociodemographic characteristics of participants (n=406)

Characteristics	**Frequency (N)**	**Percent (%)**
Sex		
Male	230	56.7
Female	176	43.3
Religion		
Islam	371	91.4
Other than Islam	35	8.6
Marital status		
Unmarried	173	42.6

Married	233	57.4
Educational qualification		
No schooling	80	19.7
Primary incomplete	49	12.1
Secondary incomplete	33	8.1
Secondary complete and above	244	60.1
Income category		
Poorest	30	7.4
Poorer	174	42.9
Middle	108	26.6
Higher	86	21.2
Highest	8	2
BMI		
Underweight	67	16.5
Normal	193	47.5
Overweight	80	19.7
Obese	66	16.3
FCS		
Low	0	0

Borderline	39	9.6
High	367	90.4
IDDS		
low	40	9.9
medium	187	46.1
high	179	44.1

Based on the frequency of the participants' sociodemographic variables, data from 406 replies were evaluated. Of them, every nine out of ten belonged to the Islamic religion, with more than half being men and the remaining women. More than a fifth of the respondents (61.1%) have never attended any formal schooling, while more than half of them have completed at least their secondary education. Approximately 57% of participants are married, and two out of five (42.9%) fall into the lower income bracket, with the other one-quarter falling into the middle and higher income categories. Underweight and obese respondents were nearly equal, overweight respondents were greater than obese respondents and about half of the respondents had normal BMI. Over 90% of respondents had high food consumption scores, and none of them had low FCS. The percentage of respondents who reported having a diverse diet is nearly identical, at 46.1% and 44.1%, respectively.

Table 2: Spearman correlations between individual dietary diversity score and selected indicators

Characteristic	R	P-value
Sex	.026	.605
Religion	-.002	.963
Marital status	.039	.438
Education level	.165**	.001
Income level	.662**	.000
FCS category	.129**	.009

BMI category	.290**	.000

In order to show the strength and direction, we have examined the Spearman correlation between IDDS and the aforementioned sociodemographic characteristics. This correlation was measured using correlation coefficients R and matching P-values. It appears that people with higher incomes and higher BMI scores tend to have more diverse diets, as we found a strong and significant positive relationship between IDDS and income level (R = 0.662) and IDDS and BMI category (R = 0.290), where both have significant effects on each other (*P*=.000). Furthermore, a statistically significant (*P*=.001) relationship was observed between the respondents' education level (from no schooling to secondary complete or above) and IDDS (R = 0.165), as well as a moderately positive relationship between the FCS category (R = 0.129) and IDDS. These findings suggest that people with higher food consumption scores and higher education levels also tend to have better dietary diversity. The data are presented in Table 2.

Table 3: Factors associated with low individual dietary diversity (reference: high dietary diversity) in the regression model

Indicators		Unadjusted RRR (95% CI) for low dietary diversity	P value	Adjusted RRR (95% CI) for low dietary diversity	P value
Sex	male	1.010 (.507-2.012)	.977	1.686 (.600-4.739)	.322
	female	Reference		Reference	
Religion	Islam	1.128 (.311-4.098)	.855	.458 (.092-2.282)	.341
	Other than Islam	Reference		Reference	
Marital status	unmarried	1.314 (.660-2.615)	.437	1.093 (.333-3.583)	.884
	married	Reference		Reference	
Educational qualification	No schooling	2.563 (1.067-6.154)	.035	1.982 (.471-8.347)	.351
	Primary incomplete	2.050 (.726-5.787)	.175	2.449 (.450-13.316)	.300
	Secondary incomplete	1.757 (.525-5.878)	.360	.639 (.115-3.549)	.608

	Secondary complete and above	Reference		Reference	
Income level	Poorest	1.457 (0.382- 5.536)	.565	1.478 (0.573- 3.887)	.427
	Poorer	1.175 (0.537- 2.563)	.662	2.474 (0.528- 11.591)	.237
	Middle	0.887 (0.563- 1.446)	.673	0.568 (0.274- 1.205)	.157
	Higher	1.028 (0.368- 2.784)	.949	0.979 (0.718- 1.374)	.885
	Highest	Reference		Reference	
FCS category	Borderline	2.698 (.853-8.541)	.091	.064 (.012-.335)	.001
	High	Reference		Reference	

Compared to secondary completed or higher education, the regression model shows that having no schooling was significantly related with a low degree of dietary diversity (Unadjusted RRR (uRRR) 2.563 (95% CI 1.067 to 6.154), *P*=.035), suggesting that people without formal education are more likely to have low dietary diversity in the unadjusted model than high dietary diversity. However, an adjusted model (adjusted RRR (aRRR) 1.982 (0.471 to 8.347)), suggests that there is no meaningful association. In the FCS category, borderline FCS score relative to high FCS score was more independently and significantly associated with low dietary diversity relative to high dietary diversity considering other factors when adjusted (adjusted RRR (aRRR) 0.64 (95% CI 0.012 to 0.335), *P*=.001), implying individuals with borderline FCS are at a higher risk of low dietary diversity in the adjusted model. No significant association was found relative to the reference with low dietary diversity relative to high dietary diversity in sex, religion, and marital status categories.

Table 4: Factors associated with medium individual dietary diversity (reference: high dietary diversity) in the regression model

Indicators		Unadjusted RRR (95% CI) for medium dietary diversity	P value	Adjusted RRR (95% CI) for medium dietary diversity	P value
Sex	male	1.181 (.780-1.786)	.432	1.809 (1.003-3.264)	.049
	female	Reference		Reference	
Religion	Islam	.915 (.442-1.892)	.810	1.351 (.585-3.118)	.481

	Other than Islam	Reference		Reference	
Marital status	unmarried	1.110 (.732-1.681)	.624	1.034 (.528-2.025)	.922
	married	Reference		Reference	
Educational qualification	No schooling	2.334 (1.334-4.084)	.003	1.380 (.598-3.182)	.451
	Primary incomplete	1.691 (.874-3.274)	.119	1.969 (.753-5.148)	.167
	Secondary incomplete	1.305 (.601-2.831)	.501	.948 (.347-2.586)	.917
	Secondary complete and above	Reference		Reference	
Income category	Poorest	1.437 (.362- 3.546)	.365	0.468 (.563- 3.827)	.527
	Poorer	1.125 (.567- 2.583)	.462	1.474 (.598- 5.571)	.198
	Middle	0.787 (.593- 1.476)	.773	0.538 (.294- 1.245)	.377
	Higher	1.028 (0.328- 2.754)	.649	0.967 (.748- 1.314)	.615
	Highest	Reference		Reference	
FCS category	Borderline	2.915 (1.321-6.434)	.008	.255 (.082-.793)	.018 .
	High	Reference		Reference	

We have established another logistic regression model to examine the factors associated with medium individual dietary diversity using high dietary diversity as the reference category. The analysis shows, relative to female counterparts, male respondents are independently and significantly associated with medium dietary diversity relative to high dietary diversity in adjusting other factors. That means males are 1.809 times more likely to have medium dietary diversity compared to females which is statistically significant (aRRR 1.809 (1.003 to 3.264), *P*=0.049). Similarly, relative to secondary education or above, no education has positive and

significant impact on medium dietary diversity than high dietary diversity which implies respondents with no formal education are 2.334 times more likely to have medium dietary diversity than those who completed at least secondary education in unadjusted model (uRRR 2.334 (1.334 to 4.084), *P*=.003). For FCS category, compared to high FCS, Borderline FCS is found more positively associated with medium dietary diversity relative to high dietary diversity in both unadjusted models (uRRR 2.915 (1.321 to 6.434), P=.008) and adjusted model (aRRR 0.255 (0.082 to 0.793), P=.018) which implied that in both models borderline FCS are significantly more likely to have medium dietary diversity relative to high dietary diversity. These results are shown in table 4.

Table 5: Factors associated with nutritional status (reference: obese) in the unadjusted model

BMI category		P value	Unadjusted RRR (95% CI) for nutritional status	95% Confidence Interval	
				Lower Bound	Upper Bound
Underweight	**Sex**				
	Male	.258	1.484	.749	2.942
	Female	Reference			
	Religion				
	Islam	.397	1.605	.537	4.795
	Other than Islam	Reference			
	Marital status				
	Unmarried	.000	12.632	5.467	29.184
	Married	Reference			
	Education level				
	No schooling	.000	8.941	3.536	22.609
	Primary incomplete	.001	6.222	2.048	18.903
	Secondary incomplete	.016	6.000	1.392	25.858

	Secondary complete and above	Reference			
	Income level				
	Poorest	.624	.476	.000	1.261
	Poorer	.551	.549	.164	2.816
	Middle	.343	.273	.121	1.576
	Higher	.587	.381	.092	2.137
	Highest	Reference			
	FCS				
	Borderline	.243	.323	.135	1.536
	High	Reference			
	IDDS				
	low	.000	63.429	7.069	72.090
	medium	.000	9.061	3.566	23.027
	high	Reference			
Normal	**Sex**				
	male	.042	1.799	1.022	3.165
	female	Reference			
	Religion				
	Islam	.161	1.874	.778	4.511
	Other than Islam	Reference			
	Marital status				
	unmarried	.000	4.461	2.201	9.040
	married	Reference			
	Education level				
	No schooling	.001	.278	.130	.594

	Primary incomplete	.186	.555	.231	1.329
	Secondary incomplete	.703	1.248	.400	3.899
	Secondary complete and above	Reference			
	Income level				
	Poorest	.784	.534	.014	1.361
	Poorer	.351	.616	.064	2.756
	Middle	.183	.279	.091	1.496
	Higher	.251	.311	.082	2.267
	Highest	Reference			
	FCS				
	Borderline	.133	.253	.037	1.758
	High	Reference			
	IDDS				
	low	.028	9.867	1.287	75.628
	medium	.614	1.160	.652	2.064
	high	Reference			
Overweight	**Sex**				
	male	.001	3.363	1.691	6.689
	female	Reference			
	Religion				
	Islam	.140	2.368	.753	7.451
	Other than Islam	Reference			
	Marital status				
	unmarried	.089	2.018	.899	4.528

	married	Reference			
	Education level				
	No schooling	.004	.239	.091	.632
	Primary incomplete	.145	.452	.155	1.316
	Secondary incomplete	.461	.581	.137	2.464
	Secondary complete and above	Reference			
	Income level				
	Poorest	.892	.404	.000	1.988
	Poorer	.451	.519	.094	2.856
	Middle	.143	.280	.051	1.536
	Higher	.287	.397	.072	2.177
	Highest	Reference			
	FCS				
	Borderline	.214	.487	.083	2.496
	High	Reference			
	IDDS				
	low	.443	2.467	.246	24.716
	medium	.855	.940	.482	1.833
	high	Reference			

In another regression model it was found what factors were associated with nutritional status, using obese as the reference category. In the underweight category, we found unmarried individuals are at a significantly higher risk of being underweight compared to married individuals (uRRR 12.632, *P*=.000). Similarly, respondents with no formal education, primary

incomplete or secondary incomplete have a significantly higher risk of being underweight as well (No schooling= uRRR 8.941, *P*=.000, Primary Incomplete= uRRR 6.222, *P*=.001 and Secondary Incomplete=uRRR 6.00, *P*=.016).

For the Normal category, males (uRRR 1.799, *P*=.042), unmarried individuals (uRRR 4.461, *P*=.000) are likely to be at significantly higher risk of having normal weight compared to female, married individuals respectively. On the other hand, individuals with no formal education have a significantly lower risk of having normal weight (uRRR 0.278, *P*=.001).

In the overweight category, we found males are at significantly higher risk of being overweight compared with females (uRRR 3.363, *P*=.01). Contrary to that, those who have no schooling found a significantly low risk of being overweight (uRRR 0.239, *P*=0.04). These results are presented in Table 5.

Table 6: Factors associated with nutritional status (reference: obese) in the adjusted model

BMI category		P- value	Adjusted RRR (95% CI) for nutritional status	95% Confidence Interval	
				Lower Bound	Upper Bound
Underweight	**Sex**				
	Male	.140	.389	.111	1.365
	Female	Reference			
	Religion				
	Islam	.723	1.752	.079	8.755
	Other than Islam	.	. Reference	.	.
	Marital status				
	Unmarried	.000	465.792	444.047	584.796
	Married	Reference			
	Education level				
	No schooling	.000	49.767	37.490	65.499
	Primary incomplete	.000	88.335	48.340	92.527
	Secondary incomplete	.095	5.312	.749	7.674
	Secondary complete and above	Reference			
	Income level				
	Poorest	.639	.167	.018	1.985

	Poorer	.524	.657	.089	4.317
	Middle	.356	.483	.060	2.317
	Higher	.342	.682	.076	3.032
	Highest	Reference			
	FCS				
	Borderline	.089	2.312	.783	5.635
	High	Reference			
	IDDS				
	Low	.057	32.627	.907	54.058
	Medium	.019	11.657	1.508	20.123
	High	Reference			
Normal	**Sex**				
	Male	.896	1.046	.533	2.054
	Female	Reference			
	Religion				
	Islam	.263	1.766	.652	4.784
	Other than Islam	Reference			
	Marital status				
	Unmarried	.000	5.288	2.325	12.024
	Married	Reference			
	Education level				
	No schooling	.075	.449	.186	1.083
	Primary incomplete	.899	1.067	.392	2.908
	Secondary incomplete	.979	.983	.278	3.477
	Secondary complete and above	Reference			
	Income level				
	Poorest	.635	.135	.026	2.473
	Poorer	.591	.681	.029	4.333
	Middle	.113	.231	.036	2.617
	Higher	.374	.419	.079	3.922
	Highest	Reference			
	FCS				
	Borderline	.079	.428	.146	1.013
	High	Reference			
	IDDS				
	low	.556	1.981	.203	9.324

	medium	.266	.642	.294	1.402
	High	Reference			
Overweight	**Sex**				
	male	.023	2.422	1.128	5.202
	Female	Reference			
	Religion				
	Islam	.112	2.754	.789	9.617
	Other than Islam	Reference			
	Marital status				
	unmarried	.954	1.027	.413	2.556
	Married	Reference			
	Education level				
	No schooling	.011	.241	.081	.722
	Primary incomplete	.189	.455	.140	1.475
	Secondary incomplete	.334	.478	.107	2.135
	Secondary complete and above	Reference			
	Income level				
	Poorest	.999	.137	.000	1.109
	Poorer	.723	.690	.089	5.370
	Middle	.386	.423	.060	2.957
	Higher	.440	.482	.076	3.072
	Highest	Reference			
	FCS				
	Borderline	.071	2.169	1.172	5.298
	High	Reference			
	IDDS				
	low	.521	2.283	.184	8.362
	medium	.824	.904	.372	2.197
	high	Reference			

The result of the adjusted regression model examines factors associated with nutritional status, using obese as the reference category. Considering several factors, males are found to be 2.4 times higher risk of being overweight compared to female counterparts which is significant (aRRR 2.422, *P*=0.03). On the other hand, individuals with no formal education have a lower risk of being overweight (aRRR 0.241, *P*=0.01) compared to those who completed secondary level or above. We found no significant relationship for nutritional status with religion, marital status, income level, FCS, and IDDS compared to their reference in the adjusted model.

4. Discussion:

The findings of the current study reveal some important insights into the dietary habits and nutritional status of the respondents. A significant proportion of young adults had low individual dietary diversity, with 9.9% falling into this category. Previous studies also found similar types of results (26). Additionally, 46.1% of the participants had medium dietary diversity. These findings highlight the existence of dietary challenges in the study population, with a considerable portion having limited food diversity in their diets. Dietary diversity is a crucial indicator of nutritional adequacy and is associated with better health outcomes. Food variety and nutritional diversity scores are favorably correlated with socioeconomic characteristics, according to a recent study on the topic. Consequently, assessing dietary diversity may be a simpler process than assessing household-level food security (27).The prevalence of low dietary diversity emphasizes the need for targeted interventions to improve food choices and promote a more balanced diet among young adults in Noakhali.

Our analysis identified several factors associated with low and medium dietary diversity. Notably, individuals with no schooling and those with primary incomplete education were at a higher risk of having low dietary diversity. Education plays a pivotal role in raising awareness about nutrition and making informed dietary choices.A few studies conducted in Bangladesh with adolescent girls who were pregnant (28) and women who were in reproductive age (29) also discovered a strong correlation between education and DD. A study conducted in 2023 focusing on women also emphasized the importance of education over dietary diversity. Higher education promotes nutritional diversity among young women, as they gain better health and literacy skills, leading to better understanding of the benefits of a balanced diet (30). Therefore, efforts to improve dietary diversity should include educational interventions targeting individuals with limited schooling.

Income level was also associated with dietary diversity, with the poorest individuals facing a higher risk of low dietary diversity. Economic constraints can limit access to a variety of foods, making it challenging to achieve a diverse diet. Addressing income disparities and promoting economic opportunities for young adults can contribute to improving dietary diversity. The findings are consistent with a study carried out in Nigeria which found that all low-income urban

homes had food diversity that was below average, and that the high dependency ratio was a major factor in the extremely low dietary diversity of these households (31).The similar conclusion was also reached from a study conducted in the south-western Bangladesh (32).

Food Consumption Score (FCS) emerged as a significant predictor of dietary diversity. Individuals with a borderline FCS were more likely to have low dietary diversity. A study reveals that individuals with food insecurity, including pregnant women, often resort to coping mechanisms that compromise their diet, reducing fruits, vegetables, and macronutrients (33).FCS reflects food access and affordability, suggesting that economic factors play a vital role in shaping dietary patterns. Policies to reduce food insecurity and improve access to a wider range of nutritious foods may positively impact dietary diversity.

Our study also assessed the nutritional status of young adults, categorized as underweight, normal weight, overweight, or obese. The prevalence of underweight individuals was noteworthy, with several factors contributing to this condition. Unmarried individuals faced a significantly higher risk of being underweight. This finding may reflect social and economic factors influencing unmarried individual's dietary choices and food access. The educational level also played a role, with those having no schooling or primary incomplete education being at a higher risk of being underweight. According to a study, the incidence of underweight was higher in men in most categories, while the prevalence of overweight/obesity was higher in women. Participants who had completed primary and secondary education, lived in a household that was in the middle, richer, or richest wealth quintiles, and were married at the time of the study were more likely to be overweight or obese than other participants in the same age group. Conversely, higher wealth index and educational achievement were negatively correlated with underweight in both genders.(34).

In contrast, males were more likely to be overweight, which aligns with global trends. The association between overweight status and educational level was mixed, suggesting that other factors, such as dietary habits and physical activity, may contribute to weight status.

5. Strengths and Limitations

The study has several strengths. A field-tested, validated questionnaire was used which helped to improve the credibility of the findings of the study. The questionnaire included both open and closed ended items which enabled the researchers to overcome the drawbacks of following only quantitative and qualitative approaches. It has a relatively large sample size and appropriate statistical analyses were used.

The study also has some unavoidable limitations. A possibility of a recall bias could exist while the participants answered questions regarding dietary diversity, seven days food frequency questionnaire and 24-hour recall method. The cross-sectional nature of the study itself is a limitation. Moreover, the findings are not nationally representative as they focused only on a particular age group and a specific region of Bangladesh.

6. Conclusion:

Dietary diversity is a qualitative indicator of food intake that represents access to a range of foods and serves as a standard for a diet's sufficiency of an individual in terms of nutrients. Higher income and education may lead to better nutritional status, but genetics, lifestyle, hygiene, healthcare facilities, physical activity level and employment opportunities also influence this relationship. In summary, while income and education can be factors influencing nutritional status and individual dietary diversity score, it is important to consider other factors and the complex interplay of various determinants in order to improve the nutritional status of individuals.

Consent and Ethical Approval

In accordance with the code of conduct, ethical permission was received from the ethical committee of Noakhali Science & Technology University. The local authority also granted approval, and the participants gave their informed written consent after being informed of the benefits and drawbacks of the study.

References:

1. Collaborators GRF. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England). 2015;386(10010):2287.

2. Kashyap VH, Shivaswamy M. Assessment of implementation of the national programme for the prevention and control of cancer, diabetes, cardiovascular diseases, and stroke at subcenters of Belagavi taluka: A cross-sectional study. Indian Journal of Health Sciences and Biomedical Research kleu. 2019;12(1):21-7.
3. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, et al. Our future: a Lancet commission on adolescent health and wellbeing. The Lancet. 2016;387(10036):2423-78.
4. Azzopardi PS, Hearps SJ, Francis KL, Kennedy EC, Mokdad AH, Kassebaum NJ, et al. Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990–2016. The Lancet. 2019;393(10176):1101-18.
5. Sawyer SM, Afifi RA, Bearinger LH, Blakemore S-J, Dick B, Ezeh AC, et al. Adolescence: a foundation for future health. The lancet. 2012;379(9826):1630-40.
6. Winpenny EM, Penney TL, Corder K, White M, van Sluijs EM. Changes in consumption of added sugars from age 13 to 30 years: a systematic review and meta-analysis of longitudinal studies. Obesity reviews. 2017;18(11):1336-49.
7. Weiss HA, Ferrand RA. Improving adolescent health: an evidence-based call to action. The Lancet. 2019;393(10176):1073-5.
8. Rahman MN, Alam SS, Mohsin FM, Hasan MM, Islam K. Dietary habits, food consumption, energy and nutrients intake of adults of selected areas of Bangladesh. Indian Journal of Public Health Research & Development. 2022;13(1):188-97.
9. Capacci S, Mazzocchi M, Shankar B, Traill B. The triple burden of malnutrition in Europe and Central Asia: a multivariate analysis. FAO Regional Office for Europe and Central Asia Policy Studies on Rural Transition. 2013;7:7-8.
10. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The lancet. 2014;384(9945):766-81.
11. Ruel MT. Operationalizing dietary diversity: a review of measurement issues and research priorities. The Journal of nutrition. 2003;133(11):3911S-26S.
12. Ruel MT. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. Food and nutrition bulletin. 2003;24(2):231-2.
13. Labadarios D, Steyn NP, Nel J. How diverse is the diet of adult South Africans? Nutrition journal. 2011;10(1):1-11.
14. Mirmiran P, Azadbakht L, Esmaillzadeh A, Azizi F. Dietary diversity score in adolescents-a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study. Asia Pacific journal of clinical nutrition. 2004;13(1):56-60.
15. Buttriss JL. Food and nutrition: attitudes, beliefs, and knowledge in the United Kingdom. The American journal of clinical nutrition. 1997;65(6):1985-95.
16. Madjdian DS, Azupogo F, Osendarp SJ, Bras H, Brouwer ID. Socio-cultural and economic determinants and consequences of adolescent undernutrition and micronutrient deficiencies in LLMICs: a systematic narrative review. Annals of the New York Academy of Sciences. 2018;1416(1):117-39.
17. Preparation JFWCot, Guideline UoF-BD, Organization WH. Preparation and Use of Food-based Dietary Guidelines: Report of a Joint FAO/WHO Consultation: World Health Organization; 1998.
18. Nahar Q, Choudhury S, Faruque M, Sultana S, Siddiquee M. Desirable dietary pattern for Bangladesh. Final Res Results. 2013;15:226-44.
19. Akseer N, Al-Gashm S, Mehta S, Mokdad A, Bhutta ZA. Global and regional trends in the nutritional status of young people: a critical and neglected age group. Annals of the New York Academy of Sciences. 2017;1393(1):3-20.
20. Keats EC, Rappaport AI, Shah S, Oh C, Jain R, Bhutta ZA. The dietary intake and practices of adolescent girls in low-and middle-income countries: a systematic review. Nutrients. 2018;10(12):1978.

21. Arimond M, Wiesmann D, Becquey E, Carriquiry A, Daniels MC, Deitchler M, et al. Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. The Journal of nutrition. 2010;140(11):2059S-69S.
22. Leroy JL, Ruel M, Sununtnasuk C, Ahmed A. Understanding the determinants of adolescent nutrition in Bangladesh. Annals of the new York Academy of Sciences. 2018;1416(1):18-30.
23. Mirmiran P, Azadbakht L, Azizi F. Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women. Journal of the American college of nutrition. 2006;25(4):354-61.
24. Hatløy A, Torheim LE, Oshaug A. Food variety—a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. European journal of clinical nutrition. 1998;52(12):891-8.
25. Ross AC. Nature and Extent of Malnutrition in Bangladesh: Bangladesh National Nutrition Survey, 1995-96, Volumes 1 & 2. JSTOR; 2001.
26. Zhou Y, Wang J, Duan Y, Luo X, Wan Z, Luo Y, et al. Dietary diversity and determinants of young adults in central China: A cross-sectional study from 2015 to 2020. Frontiers in Nutrition. 2022;9:931107.
27. Weerasekara PC, Withanachchi CR, Ginigaddara G, Ploeger A. Understanding dietary diversity, dietary practices and changes in food patterns in marginalised societies in Sri Lanka. Foods. 2020;9(11):1659.
28. Mridha MK, Matias SL, Arnold CD, Dewey KG. Factors associated with nutritional status and dietary practices of Bangladeshi adolescents in early pregnancy. Annals of the new York Academy of Sciences. 2018;1416(1):66-76.
29. Harris-Fry H, Azad K, Kuddus A, Shaha S, Nahar B, Hossen M, et al. Socio-economic determinants of household food security and women's dietary diversity in rural Bangladesh: a cross-sectional study. Journal of Health, Population and Nutrition. 2015;33(1):1-12.
30. Makate M, Nyamuranga C. The long-term impact of education on dietary diversity among women in Zimbabwe. Review of Development Economics. 2023;27(2):897-923.
31. Obayelu OA, Osho FR. How diverse are the diets of low-income urban households in Nigeria? Journal of Agriculture and Food Research. 2020;2:100018.
32. Shamim AA, Mashreky SR, Ferdous T, Tegenfeldt K, Roy S, Rahman AF, et al. Pregnant women diet quality and its sociodemographic determinants in southwestern Bangladesh. Food and nutrition bulletin. 2016;37(1):14-26.
33. Saaka M, Mutaru S, Osman SM. Determinants of dietary diversity and its relationship with the nutritional status of pregnant women. Journal of Nutritional Science. 2021;10:e14.
34. Gupta RD, Haider SS, Eusufzai SZ, Hoque Apu E, Siddika N. Differences in prevalence and associated factors of underweight and overweight/obesity among Bangladeshi adults by gender: Analysis of a nationally representative survey. International journal of environmental research and public health. 2022;19(17):10698.