Chapter 1: Introduction

Good nutritional practice during childhood is essential for optimal growth, life and development of the child [1].The World Health Organization (WHO) recommends the introduction of complementary foods when a baby is 6 months old to meet the nutritional needs of children [2-7].

Sub-optimal nutritional practices in children contribute to poor physical growth, including irreversible consequences of the stunting, poor cognitive development, significantly increased risk of infectious diseases and mortality [8-16]. Worldwide, of the 10.9 million deaths under 5 years, malnutrition, are directly or indirectly responsible for 60.0% of deaths. More than two thirds of these deaths are associated with inappropriate dietary practices in the first 2 years of life [6, 9]. More than 3.4 million children under the age of 60 months die each year from inappropriate eating habits [17].

Dietary diversity refers to the increased consumption of a variety of foods in and within food groups that can ensure an adequate intake of essential nutrients that can promote health, physical and mental development [18]. Dietary diversity (DD) has been used as an indirect indicator of nutritional quality and nutrient sufficiency [19-22]. Minimum dietary diversity refers to the proportion of children aged 6 to 23 months who received at least 4 or more types of food from the seven standard food groups namely: grains; roots and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry and organ meats); eggs; fruits and vegetables rich in vitamin A; other fruits and vegetables, recommended by the WHO in the previous day without establishing a lower limit of intake [23].

Several studies have shown that nutritional diversity is positively associated with overall nutritional quality, micronutrient intake and better nutritional status of young children and food security of households [24-26]. In addition, the high socioeconomic status (SES), measured by the education and employment of mothers, can be associated with the health, their general eating patterns, the quality of nutrition and adequate nutritional diversity in low and middle-income countries [27-30]. In addition, culture, religion and traditional knowledge influence food and nutrition security by influencing the diet of communities, the distribution of food within the home and the feeding practices of children [31].

1.1 Objectives of the study

The goal of this study was to explore the prevalence of children nutritional status and DD score and associated factors of socio-demographic and other characteristics.

Chapter 2: Materials and Methods

2.1 Study design, area and period

A community based cross-sectional study was conducted from March to May, 2021. The study was conducted in Chakaria, Boalkhali and Raipura upazila which were under the district of Cox's Bazar, Chattogram and Narsingdi respectively. The lists of all households of the selected upazila were the sources of population.

2.2 Data collection

The data was collected from household mothers' face-to-face system using the structured questionnaire. The questionnaire mainly consists of three parts: 1) measurement tools of children dietary diversity (DD) and household food security (HFS), 2) socio-demographic factors consists of age of mother, education and profession of parents, family type and members, 3) anthropometric measurement consists of MUAC of the children, body mass index (BMI) of mother, 4) other parts consisting livestock rearing, microcredit loan taking, knowledge of nutrition. A 24-hour recall method was used to assess the dietary diversity. The structured questionnaire, mostly adopted from the WHO assessment tool for infant and young child feeding (IYCF) practices, was used and translated into Bengali. Then, before starting the actual data collection, we rechecked the accuracy and consistency of the questionnaire and whether the necessary changes were made in.

2.3 Sample size estimation and sampling procedure

A previous study [37] reported that the prevalence of inadequate children DD score (< 4 food groups) was 40%. With this prevalence, taking normal value of z = 1.96, $\propto$= 0.05, 5% margin of error, 80% power, the calculated sample size was 368 by using single population proportion test. A stratified random sampling procedure was applied to select the household from upazila.

2.4 Measures

2.4.1 Children dietary diversity (DD) score

Children DD score was created based on the mother's recall of the food that gave her child 24 hours before the date of the interview. According to WHO IYCF guidelines [35, 36] the foods were classified into seven food groups: (1) “grains, roots and tubers” (comprised of soup/clear broth OR bread, noodles, other grains OR fortified baby food OR potatoes, cassava, tubers); (2) “legumes and nuts” (comprised of beans, peas, or lentils); (3) “dairy products” (comprised of formula milk OR tinned powdered/fresh milk; OR cheese, yogurt, other milk products OR yogurt); (4) “flesh foods”(comprised of liver, heart, other organ meat OR fish, shellfish OR chicken, duck, or other birds); (5) “eggs” (com-prised of eggs); (6) “vitamin A rich fruits and vegetables”(comprised of pumpkin, carrots, squash OR dark green leafy vegetables OR mangoes, papayas, Vit A fruits); and (7) “other fruits and vegetables” (comprised of any other fruits). The possible answers were "yes, consumed" (score 1) and "no, not consumed" (score 0). These were summed to generate a child DD score in the range of 0-7. Children were considered to have adequately diversified dietary intake (ADDI) if they had food items from at least four of the seven food groups, while a score of 3 or less was considered to be inadequate [35, 36].

2.4.2 Household food security scale

Household Food Security (HFS) scale measures the household’s food security for the earlier month [38]. The HFS scale comprises 11 items that address subjects such as purchased rice and perishable food, cooking frequency, snack consumption, and management strategies, with a score assigned to each response [38]. Higher and lower scores were assigned for responses which indicated a higher (i.e. more favourable) v. lower (i.e. less favourable) food security status, respectively. For example, for the frequency of daily cooking, a score of 1 was assigned to those who responded they typically never cook on a daily basis, which indicated that the household had little-to-no store of food to cook with. For those respondents who reported cooking four or more times per day, a score of 5 was assigned, which indicated that the household had an adequate supply of food to use for cooking [38].

2.4.3 Mid-upper arm circumference (MUAC)

MUAC is the circumference of the left upper arm, measured at the mid-point between the tip of the shoulder and the tip of the elbow (olecranon process and the acromion). The left upper arm has come to be used for MUAC measurement, because triceps and biceps muscle development may be asymmetric, being greater in the dominant arm than in the non-dominant arm (assumed to be the left). MUAC is used for the assessment of nutritional status. Children were also classified into classes of wasting using the MUAC measurements according to WHO growth standards and guidelines [32, 33]. The four classes were severe wasting (MUAC < 115 mm), moderate malnutrition (MUAC 115–125 mm), possibly mildly malnourished (MUAC 125–135 mm), and nutritionally normal (MUAC > 135 mm) [34].

2.5 Data analysis

A descriptive analysis of frequency, percent, mean and standard deviation was computed for all variables. The children DD score was not normally distributed. We have applied Kruskal-Wallis test for more than two samples and Mann-Whitney test for two samples of nonparametric test to find out the association between children DD score across socio-demographic and other characteristics. A Spearmen rank correlation was applied to find out the relationship between children DD score and food security (FS) score. All analysis was done with IBM statistical software SPSS 23.0 and $P < 0.05$ level of significance was maintained during analysis.

2.6 Ethical considerations

This study was conducted accordance with ethical statement of Helsinki declaration 1964. Written informed consent was obtained from the household head after informing the purpose of the study and assuring the confidentiality of their information and not harmful of the study.

Chapter 3: Results

3.1 Socio-demographic and other characteristics

Table 1 summarises socio-demographic characteristics of the household with children aged 6–59 months. 51.38% of the sampled children were girls. The average age of mother was 35.04 years (SD 11.39 years). The majority of mothers (59.6%) were more than 30 years. Most of the fathers (46.3%) and mothers (59.9%) received secondary education and most of the family (82.1%) were nuclear type. Majority of the mothers (92.2%) were homemaker whereas most of the fathers were day labor (32.9%) followed by service holder (27.3%), businessman (24.2%) and foreigner (15.6%). The average family income was 27398 taka (SD 17192 taka). Forty six percent of the family income were 15001-30000 taka and majority of the family (55%) have more than four members. 61.2% family rear domestic animal whereas 26.8% have microcredit loan. 52.1% of the family have knowledge about eating egg. The average BMI of mother was 23.18 (SD 4.17). Majority of the mothers (64.6%) BMI were normal. MUAC of 84.2% baby was normal whereas 15.8% was under normal.

Table 1. Frequency and percentages of socio-demographic characteristics of households having children aged 06–59 months in rural areas of Bangladesh, 2021.

Determinants	n	Percentage (%)
Gender		
Boy	53	48.62
Girl	56	51.38
Age of mother		
≤ 30	124	40.4
> 30	183	59.6
Education of father		
Primary	58	19.6
Secondary	142	46.3
Higher secondary and above	96	31.3
Education of mother		
Primary	56	18.2
Secondary	184	59.9
Higher secondary and above	67	21.8
Profession of father		
Job	79	27.3
Business	70	24.2
Foreigner	45	15.6
Day labor	95	32.9

Determinants	n	Percentage (%)
Profession of mother		
Homemaker	283	92.2
Job	24	7.8
Family income		
≤15000	95	30.9
15001-30000	141	46
>30000	71	23.1
Family member		
≤ 4	138	45
> 4	169	55
Type of family		
Nuclear	252	82.1
Joint	55	17.9
Domestic animal rearing		
Yes	188	61.2
No	119	38.8
Microcredit loan taking		
Yes	51	26.8
No	139	73.2
Knowledge about energy by eating egg & drinking milk		
Yes	276	89.9
No	31	10.1
Knowledge about eating egg by adult people		
Yes	160	52.1
No	147	47.9
BMI of mother		
Underweight	22	7.2
Normal	197	64.6
Overweight	64	21
Obese	22	7.2
MUAC of baby		
Under normal (≤ 135 mm)	22	15.8
Normal (> 135 mm)	117	84.2

3.2 Different food consumption by children

Table 2 represents the frequency and percentages of different food groups by children. Data shows that the most consumed food group in the 24 hours prior to the survey was vitamin A rich fruits and vegetables (79.70%) followed by flesh foods (73.05%) and grains, roots and tubers (69.53). 68% of children ate eggs while 62.89% of children consumed other fruits and vegetables during a 24 hour reminder period. 46.90% children consumed dairy products while 40.20% consumed legumes and nuts. A graphical presentation of frequency of different food consumption was provided in Figure 1.

Table 2. Frequency and percentages of different food group consumption by children

Food groups	Consumed		Non-consumed	
	n	%	n	%
Grains, roots and tubers	178	69.53	78	30.47
Vitamin A rich fruits and vegetables	204	79.70	52	20.30
Other fruits and vegetables	161	62.89	95	37.12
Flesh foods	187	73.05	69	26.95
Eggs	174	68.00	82	32.00
Legumes and nuts	103	40.20	153	59.80
Dairy products	120	46.90	136	53.10

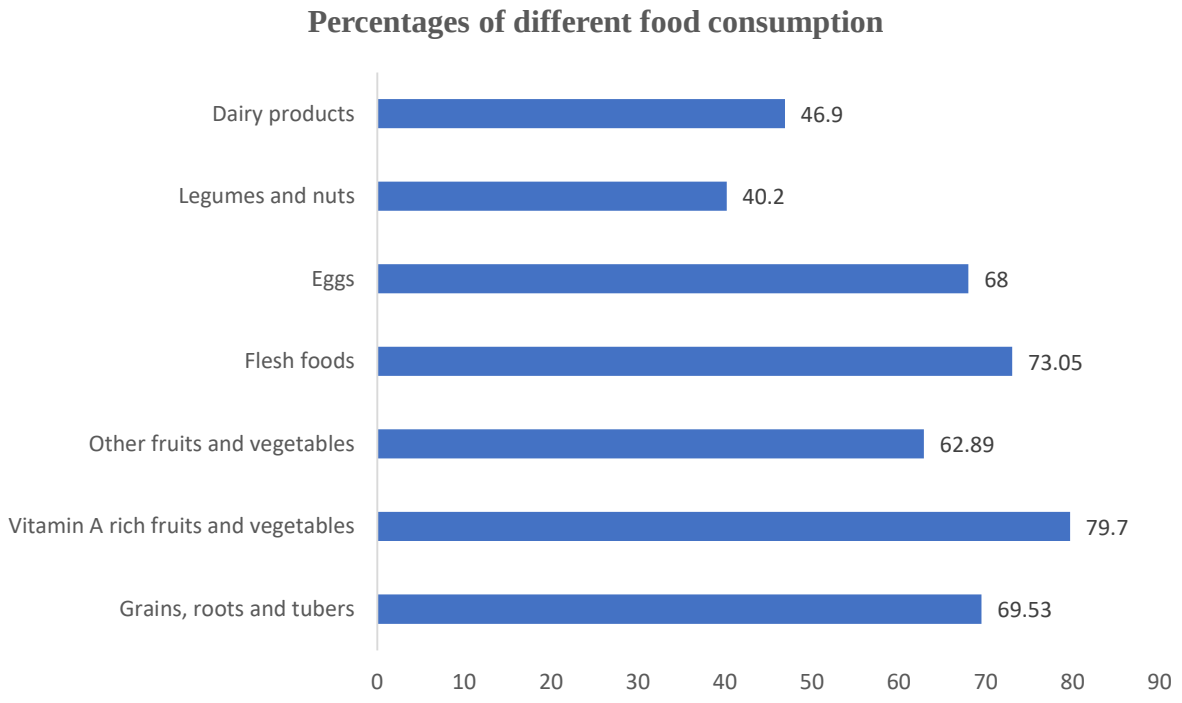

Fig 1. Proportion of children aged 6–59 months consumed foods from different food groups in the past 24 hours of survey in rural areas of Bangladesh, 2021.

3.3 Prevalence of children dietary diversity

The mean of children DD score was 4.49 (SD 1.47). It was observed that prevalence of inadequate children DD score (< 4 food groups) was 52 (20.3%) and adequate children DD score (≥ 4 food groups) was 204 (79.7%).

3.4 Children dietary diversity score across socio-demographic and other characteristics

Table 3 shows that children DD score has a significant relationship with family income while education of father shows marginal significance. The other variables didn't show any significance relationship with children DD score. The relationship between children dietary diversity and food security was significantly positively corelated (r_s =0.29, p-value < 0.01). We had 307 observations but children dietary diversity score was found for 256 and the remaining 51 children age were less than 6 months from the selected households.

Table 3. Mean DD score among children aged 6–59 months across different socio-demographic characteristics in rural areas of Bangladesh, 2021.

Determinants	Mean children DD score (SD)	P values from (Kruskal-Wallis tests)	P values from (Mann-Whitney test)
Gender			
Boy	4.63 (2.28)		0.468
Girl	4.49 (1.17)		
Age of mother			
≤ 30	4.60 (1.76)		0.917
> 30	4.42 (1.25)		
Education of father			
Primary	4.03 (1.10)	0.045[MS]	
Secondary	4.72 (1.69)		
Higher secondary and above	4.39 (1.12)		
Education of mother			
Primary	4.69 (1.79)	0.814	
Secondary	4.39 (1.20)		
Higher secondary and above	4.62 (1.86)		
Profession of father			
Job	4.50 (1.25)	0.468	
Business	4.85 (2.11)		
Foreigner	4.49 (1.20)		
Day labor	4.26 (1.08)		

Determinants	Mean children DD score (SD)	P values from (Kruskal-Wallis tests)	P values from (Mann-Whitney test)
Profession of mother			
Homemaker	4.51 (1.50)		0.300
Job	4.25 (1.15)		
Family income			
≤15000	4.05 (1.09)	0.000*****	
15001-30000	4.36 (1.21)		
>30000	5.30 (1.99)		
Family member			
≤ 4	4.57 (1.64)		0.662
> 4	4.42 (1.31)		
Type of family			
Nuclear	4.51 (1.53)		0.809
Joint	4.38 (1.22)		
Domestic animal rearing			
Yes	4.52 (1.65)		0.765
No	4.43 (1.03)		
Microcredit loan taking			
Yes	4.65 (1.34)		0.221
No	4.48 (1.77)		
Knowledge about energy by eating egg & drinking milk			
Yes	4.50 (1.49)		0.691
No	4.25 (0.46)		
Knowledge about eating egg by adult people			
Yes	4.45 (1.12)		0.577
No	4.54 (1.85)		
BMI of mother			
Underweight	4.84 (1.61)	0.429	
Normal	4.45 (1.62)		
Overweight	4.45 (1.08)		
Obese	4.58 (0.90)		

SD Standard deviation; MS marginally significant; * Significant at P < 0.001

3.5 Prevalence of nutritional status of children

We had available data for MUAC of children 139. The average MUAC of the children was 149.6 (SD 15.45). From the available data the MUAC categorical information portrays 2 (1.4%) were wasting, 1 (0.7%) were moderate malnutrition, 19 (13.7%) were possibly mildly malnourished and 117 (84.2%) were nutritionally normal.

Chapter 4: Discussion

The purpose of this study was to investigate the prevalence of nutritional status of children. Also, evaluate the prevalence and associated factors of children DD with respect to socio-demographic and other characteristics.

The results show that the mean of children DD score was 4.49 (SD 1.47). A mean DDS of 2.29 using 7-food groups has been reported among children in Ghana [39]. The mean DDS (4.39) reported at (Modjadji et al., 2020) [43] is almost similar to the means reported in other previous studies conducted among the under five children in other developing countries, such as Trinidad and Tobago (4.6) [40], Sri-Lanka (4.56) [41] and Filipino (4.91) [42]. However, these studies used either the 6-food groups or the 9-food groups systems [40–42]. Due to the type and number of foods used in DDS and the differences in the age rating system of the survey samples, it is difficult to compare Results between countries. Therefore, care must be taken when designing a DDS.

In our study it was observed that prevalence of inadequate children DD score (< 4 food groups) was 52 (20.3%) and adequate children DD score (≥ 4 food groups) was 204 (79.7%). In the study of (Temesgen et al. BMC Nutrition (2018) 4:5) [54] it was identified that only 12.8% of the children received four or more food groups with in the 24 h preceding the survey. Our result was also inverse with the findings from the studies done in Dangila 12.6% [48] and Tigiray 17.8% [50] districts of Ethiopia, India 13% [45] and Uganda 17.8% [51]. However, the finding is higher than the EDHS 2011 report [44] and lower than the studies done in India 27.4%, Tobago 48.23%, Cambodia 44%, Kenya 39.2%, 27.7%, Kamba district of Ethiopia 23.3% [46, 47, 49, 51–53]. Differences can be caused by study time, socio-economic differences, age difference and geographical differences. Possible explanations for low dietary diversity practices in the study area include a lack of practice giving complementary feeds after six months and family habits (e.g., preparing family food together, no food preparation for children alone.

In our study the average MUAC of the children was 149.6 (SD 15.45) and it shows 2 (1.4%) were wasting, 1 (0.7%) were moderate malnutrition, 19 (13.7%) were possibly mildly malnourished and 117 (84.2%) were nutritionally normal. In another study author have found the mean ± SD of MUAC was 129.7±11.3 mm an overall prevalence of wasting based on MUAC was 29%. [55]. Here data size can play an important role in result variation.

In our study the most consumed food group in the 24 hours prior to the survey was vitamin A rich fruits and vegetables (79.70%) followed by flesh foods (73.05%) and grains, roots and tubers (69.53). In the study of (Temesgen et al. BMC Nutrition (2018) 4:5) [54] the dominant food groups given to the children were grains, tubers and roots (98.8%) and legume (83.2%).This is comparable with the results from the studies done in Ethiopia [47, 48], and South Africa [56].

The average family income in our study was 27398 taka (SD 17192 taka) and the relationship between children dietary diversity and food security was significantly positively corelated (r_s =0.29, p-value < 0.01). In another study a positive relation between food security and individual dietary diversity was also found and they also found a positive relation between household income and food security [57].

Our study shows that children DD score has a significant relationship with family income while education of father shows marginal significance. Forty six percent of the family income were 15001-30000 taka while 30.9% of the family income were ≤ 15000 taka and 23.1% were more than 30000 taka. In another study it shows dietary diversity also tends to increase with income and wealth; thus, the association between dietary diversity and child nutrition may be confounded by socioeconomic factors [58].

Strengths and Limitations

A well-validated and structured questionnaire could have mitigated device and interracial bias. Using a 24-hour recall period for food consumption may have reduced the likelihood of recall bias compared to a longer recall period. Minimized recall bias comes at the cost of not providing information on food consumption and seasonal variations in its normal eating habits.

First, we had lower sample size than the estimated sample size. Finally, the children DD score was found for 256 which was very lower than estimated one so, the generalizability of the result was limited. Some of the sampled children included in this study were breastfed at the time of this survey. The mother's diet may have affected the nutritional status of breast-fed children. Failure to investigate the relationship between maternal nutrition and child nutrition may limit the results of the study. In addition, the cross-sectional design of the study limits the use of results from study for causal inference.

Conclusion and Recommendations

The findings show that child DD had a significant association with family income and fathers' education. A significant positive relation was found between HFS score and Children DD score. Improving socioeconomic conditions may encourage people to eat a wider variety of foods, which may help to alleviate malnutrition.

National-level strong study designs should be conducted. Dietary diversification strategies need to be promoted to improve children's food intake in the study area. Higher family income has positive association. We also suggests that programmers improve mass media coverage and accessibility. The results of this study will also help policy makers identify high risk groups for childhood under nutrition and use context- specific solutions to ensure optimal dietary diversity in rural children aged between 6–59 months in Bangladesh.

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Biography

I am Md. Ismail, son of Abu Nasar Md. Idris Kutubi and Zobaida Begum was born on 1st June, 1997. I have passed Secondary School Certificate examination from Chattogram Government Muslim High School, Chattogram in 2013 (GPA-5.00) followed by Higher Secondary Certificate examination from Hazera-Taju University College, Chattogram (GPA-5.00). I am now enrolled in year-long internship programme for completion of Doctor of Veterinary Medicine (DVM) degree in Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh.

Bangladesh is a developing country in South Asia where livestock plays a very important role in our economy as well as the food chain. I expect to be a future researcher of life science to address the present challenges we have in this field.