RESEARCH ARTICLE

Association of food security and other socio-economic factors with dietary diversity and nutritional statuses of children aged 6-59 months in rural Bangladesh

Nazia Binte Ali[ID]‡*, **Tazeen Tahsina**‡, **Dewan Md. Emdadul Hoque, Mohammad Mehedi Hasan, Afrin Iqbal, Tanvir M. Huda, Shams El Arifeen**

Maternal and Child Health Division (MCHD), icddr,b, Dhaka, Bangladesh

‡ These authors are joint first authors on this work.
* nazia.ali@icddrb.org

Abstract

Introduction

Dietary diversity score (DDS) is a proxy indicator for measuring nutrient adequacy. In this study, we aimed to identify the nutritional statuses and current patterns of DDS among children between 6–59 months old and their associations with different individual and household level factors in rural Bangladesh.

Methods

The Nobokoli programme of World Vision Bangladesh was implemented in Mymensingh, Sherpur, Rangpur, Dinajpur, Thakurgaon, Panchagar, and Nilphamari districts of Bangladesh between 2014 and 2017. A cross-sectional community household survey was administered between July and October 2014 to collect baseline data to evaluate the Nobokoli programme. A total of 6,468 children between 6–59 months old were included in the final analysis. Anthropometric data was collected following WHO guidelines on using wooden height and digital weight scales. We collected food intake information for the past 24 hours of the survey. The WHO's child growth standard medians were used to identify the nutritional indices of stunting, wasting, and underweight. Food items consumed were categorized into nine food groups and the DDS was constructed by counting the consumption of food items across these groups during the preceding 24 hour period. The association of DDS and nutritional status (stunting, wasting and underweight) with sociodemographic factors and household food security status were examined using multivariable models; linear regression and logistics regression respectively.

Results

The prevalence of stunting, wasting and underweight among children aged 6-59months were 36.8%, 18.2% and 37.7% respectively. Our findings revealed that almost all children ate any form of starch followed by consumption of milk or milk products (76%) and fleshy

meat /fish (61%) respectively. The mean DDS among children was 3.93(sd 1.47). Forty percent of the children obtained a DDS score less than 4. Multivariable analysis suggested that children whose mothers had higher educational attainment and are skilled workers had higher DDS (15% and 48% respectively) compared to their counterparts. The DDS showed strong positive association with household wealth status. Children from food secure households had 26% higher DDS compared to children from food insecure households. Similarly, increasing maternal education and household wealth were found to be protective against childhood stunting and undernutrition.

Discussion

Our findings reiterate the need for improving household socioeconomic factors and household food security status for improving dietary diversity practices and nutritional status of children. Evidence-based solutions are needed to be implemented and expanded at scale to ensure appropriate dietary practices and improve nutritional status of the children in local context.

Introduction

Adequate nutrition is a prerequisite for optimal growth and cognitive development of children. Undernourished children have higher risks of mortality and morbidity [1]. Globally, undernutrition contributes to approximately 3.2 million children's deaths annually and leads to an 11% reduction in disability adjusted life year (DALY), with the majority of the burden coming from low and middle income countries (LMIC) [2]. Bangladesh is one of the LMICs with high prevalence of childhood undernutrition. In 2014, around 36% and 14% of under-five children in Bangladesh were stunted and wasted respectively [3].

The factors influencing childhood undernutrition are multifaceted [4]. The UNICEF conceptual framework of Malnutrition identified improper feeding practices as an immediate cause of childhood undernutrition [5]. Infant and young child feeding (IYCF) practices in Bangladesh is not satisfactory [6]. In 2014, only 23 percent of children between the ages 6 to 23 months were fed appropriately according to recommended IYCF practices [3]. Ensuring a minimum standard of food diversity, food quantity and food frequency still remains as an concern here[6–9]. At the household level, household food insecurity (HFI) status, socioeconomic conditions, and knowledge regarding nutritious foods are some of the key underlying factors influencing the nutritional status of children [9, 10]. Approximately 34% rural households in Bangladesh suffered from food insecurity in 2013 [3, 11, 12]. Ensuring household food security is thus among the most important long term factors that could prevent childhood under nutrition [13–15].

Dietary diversity is one way of conceptualising dietary adequacy and optimal nutrient intake. Several studies in both developed and developing countries have linked dietary diversity indicators with improved nutrient intake[16]. Evidence from 11 demographic surveys showed positive association of dietary diversity with sociodemographic factors when controlling for other individual, maternal, household, and community-level factors [17, 18]. Generally children from poor households had lower dietary diversity as their meals are based predominantly on starches with little fish, meat, egg, vegetables, and fruits[17]. Maternal education is another significant predictor of dietary practices of children who are between 6–23 months old[17]. While the association between sociodemographic factors and dietary practices has

been established in different settings, several studies have suggested that the association of dietary diversity with structural factors like food security in local context are needed[17, 19].

Although first 1000 days of life is considered as "Golden Period" for nutritional intervention, ensuring optimal nutrition in the first five-years is important for cognitive development. Children under five years are especially vulnerable to undernutrition and burden of undernutrition is higher in the rural areas compared to the burden in urban areas due to inequity in availability and accessibility of food items. Majority of the studies exploring the determinants of dietary diversity and nutritional status of children examined the association among children aged less than 2 years of age [7, 20–23] However, there is limited available evidence on the association between household food security status and dietary diversity among children under five of age in rural Bangladesh. In this study, we aimed to explore the nutritional statuses and current patterns of DDS among children aged 6–59 months and their associations with various immediate and underlying individual and household level factors including household food security status. Identifying this relationship will help policy makers identify vulnerable groups in a community and develop targeted intervention programmes.

Materials and methods

Study design and data

World Vision Bangladesh implemented "Nobokoli," an integrated nutrition programme, in 20 low performing sub-districts of Mymensingh, Sherpur, Rangpur, Dinajpur, Thakurgaon, Panchagar, and Nilphamari districts in Bangladesh from 2014 to 2017. Nobokoli interventions targeted nutrition, water, sanitation, hygiene, and livelihood to address the underlying causes of childhood undernutrition. A large community based household survey was conducted as part of baseline assessment of Nobokoli programme evaluation. The cross-sectional baseline data had utility beyond the purpose of program evaluation and was used to provide insight on the nutritional statuses of children for this study.

Mothers of under five children were interviewed during baseline assessment between July to October 2014. The interviews provided information on socio-demographic characteristics, household food security status, feeding practices of the children, childhood illnesses, care seeking practices etc. A separate team of data collectors conducted anthropometric measurements of the children whose mother's were interviewed.

Sampling and sample size

This study used a subset of data from a quasi-experimental study to evaluate the Nobokoli program. The sample size was calculated using the formula: $c = 1+ (z\alpha/2+z\beta) 2 [\pi0 (1-\pi0)/n+\pi1 (1-\pi1)/n + k 2(\pi02 +\pi12)]/ (\pi0 -\pi1)2$ (Hayes, 1999). Here, k is the coefficient of variation between the clusters within each arm. We calculated sample size for several indicators such as stunting, wasting, underweight among under-five children, exclusive breast feeding practices, IYCF practices etc. Using the coefficient of variation (k) between the range of 0.074 for anaemia among under-5 children to 0.423 for delivery-assisted by skilled personnel[24, 25], we estimated that highest 70 clusters were needed in each arm to detect 20% change in selected indicators with 80% power, 5% level of significance and 10% rate of refusal. The highest required sample per cluster was 52 which yield a total of 7280 under five children samples for the survey.

A multistage cluster sampling technique was used to select study participants. Sub-districts were defined as strata and villages with a population between 100–1800 were defined as clusters. Villages with smaller populations were combined to form clusters. In the first stage, Probability Proportional to Size (PPS) sampling was used to select 15 sub-districts of 20 Nobokoli
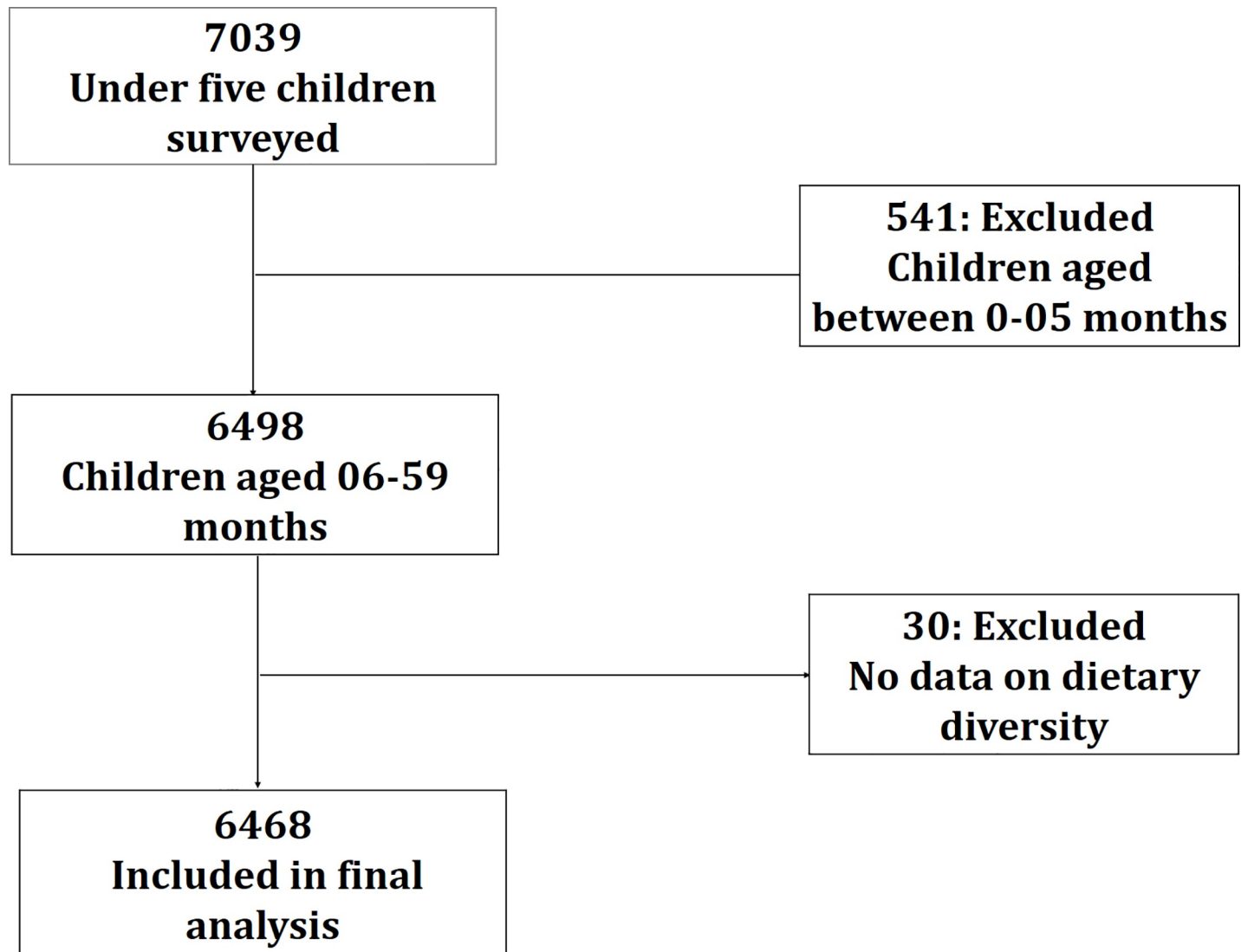
Fig 1. Participant flow diagram.

sub-districts. In the second stage, 140 clusters were selected from the 15 intervention and comparison sub-districts using PPS. In the final stage of sampling, 52 mothers of children under the age of 5 were selected from each cluster for interviews. Overall, 8,679 households were surveyed and the response rate was 99.9%. Details of the baseline survey has been published elsewhere [26, 27].

A total of 7039 mothers took part in the baseline survey. Children were omitted from the study population if complete information on feeding practices were not available. The final study population included 6468 children between 6 and 59 months old. Details of the participant flow in this analysis is shown in Fig 1.

Ethical consideration

The study was reviewed and approved by institutional review board of icddr,b. Approved protocol number was PR#14044. We followed the "Good Clinical Practices" guideline by

International Conference on Harmonisation (ICH) expert working group for data collection. Participation in the survey was voluntary. Informed written consents were taken from the study respondents before interview. In case of illiterate participant, thumb print was taken as part of informed consent.

Measurement process & quality assurance

A pre-validated structured questionnaire in Bangla was used for data collection. Mothers of the under-five children were interviewed after obtaining informed written consent. Experienced and trained data collectors conducted the household interviews. Anthropometric measurements were collected following WHO Anthro manual. Wooden height scales were used to measure height and TANITA digital weight scales were to measure weight. Anthropometric tools were calibrated before each day data collection. We collected three measurements of height and weight of each individual to ensure consistency. Data collection activities were monitored by two tiers of field supervisors who randomly selected interviews for direct observation. All completed questionnaires were double checked for completeness and consistency. Five percent of women were re-interviewed by a separate data quality assurance team to ensure data captured were accurate.

Variables

The primary outcomes of interest were the nutritional statuses and Dietary Diversity Score (DDS) of food intake in children aged 6–59 months. WHO Child Growth Standard Medians were used for identify whether a child was stunted, wasted, or underweight. Children with a height for age z score two standard deviations or below the standard median were identified as stunted[28]. Children with a weight for height z score two standard deviations or below standard median were considered wasted and those with weight for age z scores two standard deviations or below the standard median were considered underweight[28].

In low resource settings, DDS is a simple, valid, reliable, and commonly documented indicator to measure the nutrient adequacy of children [29–32]. There are different approaches to estimating DDS which include simple food counts, simple food group counts, or weight based food group counts [29, 33]. The study used a simple food count DDS score due as this was the most appropriate method given the limited resources for the study[30, 32–34]. Mothers were asked about the food intake of their children in the past 24 hours, using the standard coded WHO IYCF questionnaire. The food items reported were categorised into nine food groups: starchy staples, milk/milk product, egg, fleshy meat/fish, organ meat, legumes and nuts, vitamin A rich fruit and vegetables, dark green vegetables, and other fruits and vegetables[12, 35]. Individual DDS were calculated by adding the number of food groups consumed by the child in the past 24 hours [21, 32].

Explanatory variables for this study included household socioeconomic and food security statuses. Other characteristics examined in this study were mothers' ages, educational attainments, and employment statuses. Mother's age data was collected in years and two categorical age groups were created; 15–24 years and 25–49 years. Educational attainment only considered formal schooling and was divided into three categories; no education, primary incomplete (1–4 years of education) and primary and above (5 or more years of education). Employment status fell into one of three different categories: homemakers, unskilled workers, and skilled workers.

Information on the household's residence type, usual source of drinking water, access to sanitary latrines, ownership of homestead and other lands, ownership of household assets, possession of domestic animals, and transportation means were collected. Principal component

analysis (PCA) was used to construct an asset score. These scores were then divided into five wealth quintiles. Information on a household's food expenditure in the month preceding the survey was collected in taka. Monthly food expenditure data was not adjusted for household's consuming self-produced foods resulting in potential underestimation of the food expenditure by each household; one of the limitation of this variable.

The Food and Agriculture Organization (FAO) defined household food insecurity as a state or condition in which people experienced limited or uncertain physical and economic access to safe, sufficient, and nutritious food to meet their dietary needs or food preferences[36]. Food insecurity has four domains; availability, accessibility, utilization, and sustainability. In this study, we explored the accessibility domain of food insecurity. The standardized "Household Food Insecurity Access Scale" questionnaire developed by Food And Nutrition Technical Assistance (FANTA) initiative of USAID was used to measure household food security status [26]. For our analysis, we created a binary variable for household food security status: food secure and food insecure.

Data analysis

All statistical analysis were done using Stata 13. We examined the prevalence of stunted, wasted, and underweight children. The proportion of children consuming foods from different food groups and the distribution and variations in mean DDS across different socio-economic and household food security status were explored. Existing literature as well as bivariate analysis guided the selection explanatory variables. The Kruskal Wallis test was performed to test the association between DDS with categorical explanatory variables: sex of the children, mother's age, education, occupation, household's monthly expenditure on food, food security status and wealth quintiles. Variables found to produce significant differences in DDS then selected for multivariate linear regression in a stepwise fashion. Socio-economic determinants of childhood stunting, wasting and underweight were examined using three separate multivariable logistic regression models. The unit of analysis was the individual. We tested all underlying assumptions of multivariable regressions. We used the Variance Inflation Factor (VIF) to assess multi-collinearity. Mean VIF of the explanatory variables in the multivariable models were <4 which ensures absence of multi-collinearity. Association of the explanatory variables with DDS were reported using coefficients whereas odd ratios were reported for determinants of stunting, wasting and underweight. P-values <0.05 demonstrated statistically significant association.

Results

Table 1 summarises socioeconomic characteristics of the household with children aged 6–59 months. Fifty-two percent of the sampled children were boys. The majority of mothers (63%) were between the ages of 25–49. Nineteen percent of the mothers received no formal education and majority of the mothers were homemakers (90%). Sixty six percent of the households spend BDT 5000 / USD 60 or less on food per month. 43% of households experienced food insecurity. Households were equally distributed across wealth quintiles.

Fig 2 displays the prevalence of stunting, wasting, and underweight statuses among children in the study population with 36.8%, 18.2% and 37.7% of children belonging to each respective category.

Fig 3 represents the patterns of consuming foods from different groups. The data revealed that food groups with the highest levels of consumption in the 24 hours period preceding the survey were starchy staples, followed by milk/milk products (76%), and animal proteins (65%). Thirty-seven percent of the children ate dark green vegetables while 28% of consumed eggs in

Table 1. Socioeconomic characteristics of households having children aged 06–59 months in rural areas of Bangladesh, 2014.

Background characteristics		n = 6468	Percentage (%)
Characteristics of children			
Sex	Boy	3,367	52.1
	Girl	3,101	47.9
Characteristics of Mothers			
Mothers Age	15–24 years	2,380	36.8
	25–49 years	4,088	63.2
Mother's Education	No education (0 years)	1,247	19.3
	Primary incomplete (1–4 years)	1,172	18.1
	Primary to secondary (5+ years)	4,049	62.6
Mother's Employment Status	Homemaker	5,819	90.0
	Unskilled worker	300	4.6
	Skilled worker	349	5.4
Household Characteristics			
Household's monthly expenditure on food(in taka)	$\leq$ BDT 5,000 / USD 60	4,281	66.2
	> BDT 5,000 / USD 60	2,126	32.9
	Missing	61	0.9
Households food security status	Food secure	3,673	56.8
	Food insecure	2,795	43.2
	Mild Food Insecure	833	12.8
	Moderate Food Insecure	1,417	21.9
	Severe Food Insecure	545	8.4
Wealth Quintile	Lowest	1,327	20.5
	Second	1,302	20.1
	Middle	1,299	20.1
	Fourth	1,277	19.7
	Highest	1,263	19.5

https://doi.org/10.1371/journal.pone.0221929.t001

24 hour recall period. DDS scores greater than 4 indicate adequate nutrient intake, however 40% of children in this study had scores less than 4(Fig 4).

The mean DDS among sampled children was 3.93 (sd 1.47). DDS did not vary across the sex of the children or their mothers' ages (Table 2). Children whose mothers had higher educational attainment and were skilled workers, had a significantly higher mean DDS. The mean DDS increased as household wealth and monthly expenditure on food increased. Children whose households did not face food insecurity were found to have a higher mean DDS when compared to their counterparts (Table 2).

In the next stage, we looked at the determinants of DDS among children aged 6-59months. Table 3 presents the adjusted coefficients and p values of DDS from a multivariable regression analysis which used socioeconomic predictors. Children of mothers with primary or higher educations had a 15% higher DDS when compared to children of mothers with no education. Simlarly, on average children of mothers who were skilled workers had 47% higher DDS than children whose mothers were homemakers. Household's economic status showed strong positive association with DDS among the children. Children from households spending BDT 5000/ 60USD or more on food monthly, had 26% higher DDS when compared to their counterparts. DDS also showed a dose response relationship with household wealth. The children from the highest wealth quintile had 54% higher DDS than the children from the lowest wealth quintile. Children from the food secure households had 21% higher DDS when compared with children from food insecure households.
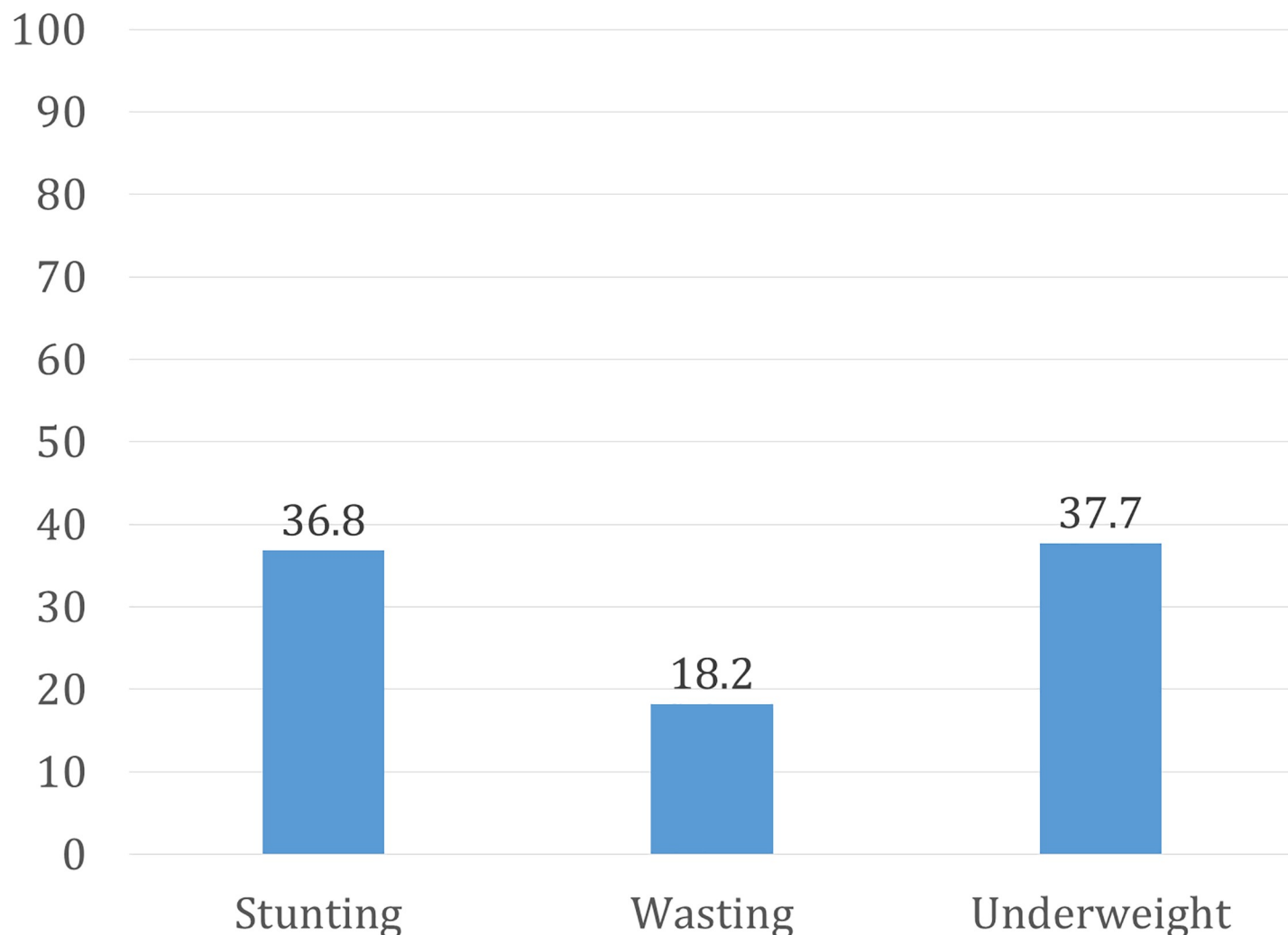
Fig 2. Prevalence of stunting, wasting and underweight among children aged 6-59months in rural areas of Bangladesh, 2014.

https://doi.org/10.1371/journal.pone.0221929.g002

In addition to DDS scores, the socio-economic determinants of nutritional statuses were examined. Results from the multivariable analysis showed that the adjusted odds of being stunted or underweight decreased as maternal education and household wealth increased (Table 4).

Discussion

In this study, we explored the nutritional statuses of children and the diversity of their food consumption. Bangladesh has burden of stunting, wasting and underweight among children 6–59 months in rural areas. Almost every child consumed a starchy staple in the 24 hours preceding the survey. A large majority of children consumed milk products (76%) and animal proteins (66%) during this period of time, while the consumptions of eggs, fruits, and vegetables were low. The mean DDS among the children sampled was 3.93 (sd 1.47) consistent with findings from other studies [37, 38]. Around 40% of the sampled children had a DDS less than 4 which indicates insufficient dietary diversity. Our findings also showed a strong positive association between DDS and maternal education, employment, and other socioeconomic

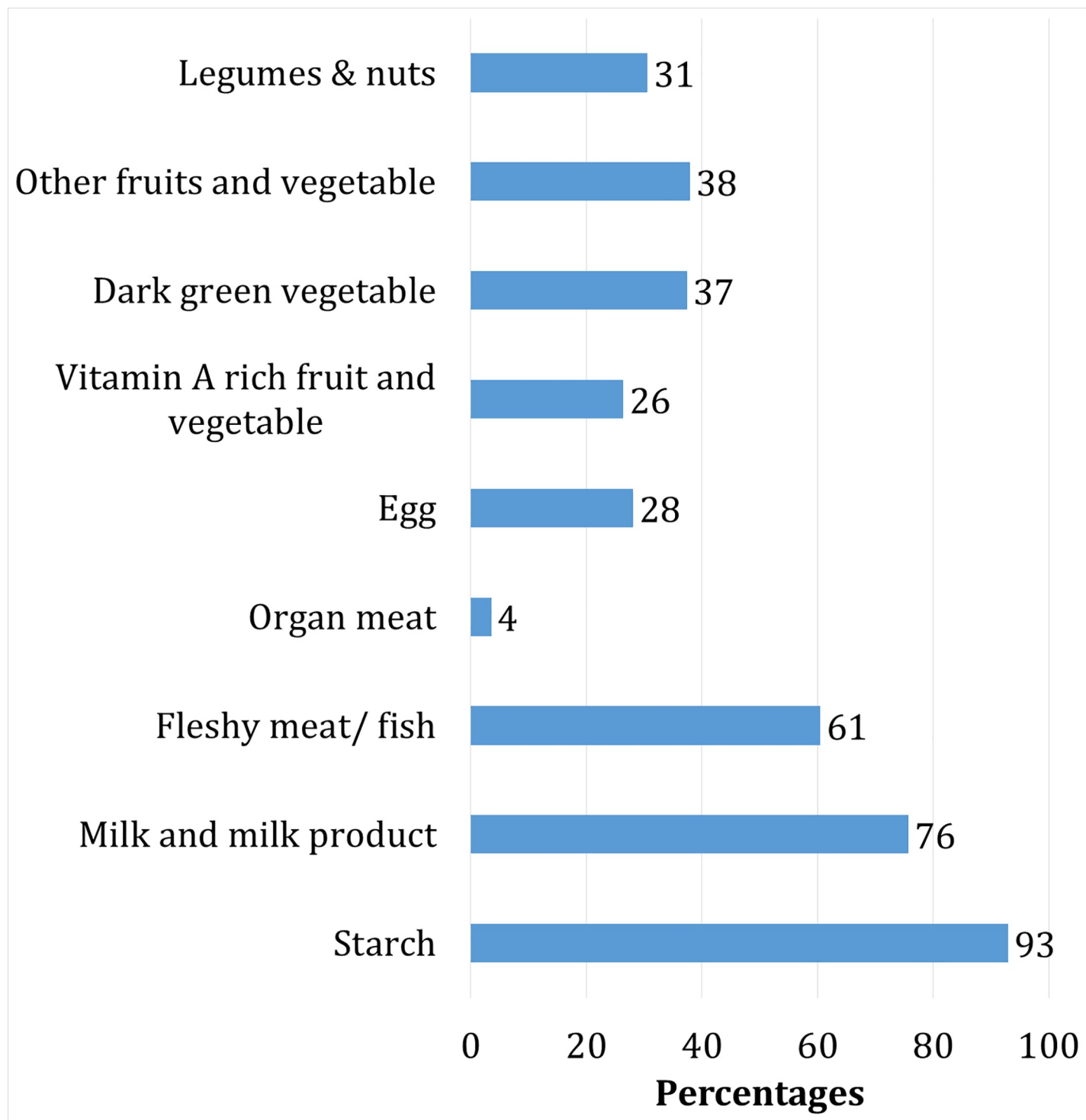**Fig 3. Proportion of children aged 6–59 months consumed foods from different food groups in the past 24 hours of survey in rural areas of Bangladesh, 2014.**

factors such as household monthly expenditure on food, household wealth status and household food security status. Finally, increasing maternal education and household wealth were found to be protective against childhood undernutrition.
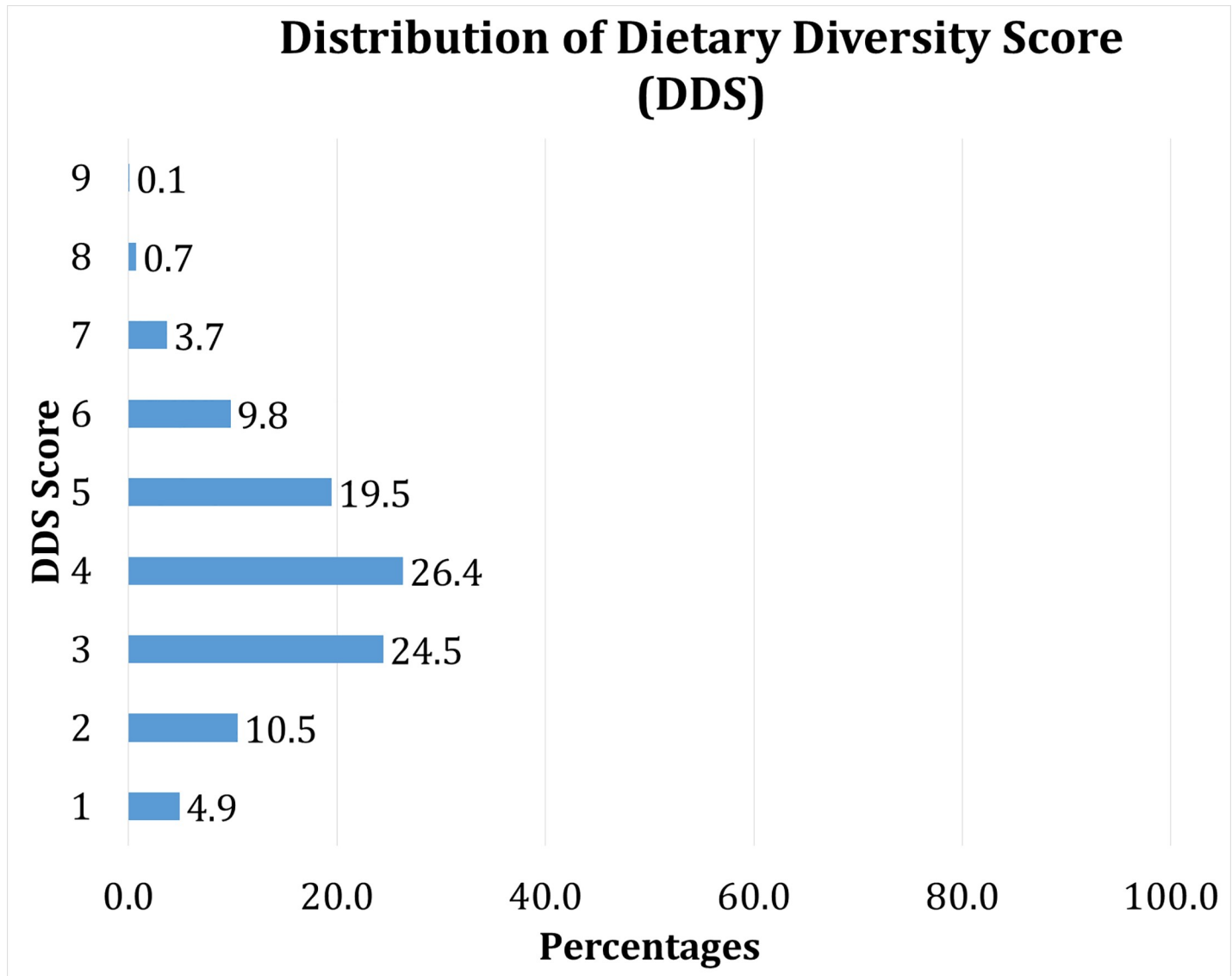
Distribution of Dietary Diversity Score (DDS)

Fig 4. Distribution of Dietary Diversity Score (DDS) among children aged 6-59months in rural areas of Bangladesh, 2014.

https://doi.org/10.1371/journal.pone.0221929.g004

The prevalence of stunting, wasting and underweight among children 6–59 months were 36.8%, 18.2% and 37.7% respectively in the study areas. The findings were consistent with the prevalence reported in Bangladesh demographic and Health survey 2014[3]. The WHO defines a 30% or greater prevalence of stunting, a 15% of greater prevalence of wasting, and a 30% of greater prevalence of underweight children as warranting public health concern[28]. Underlying factors of childhood undernutrition are multi-dimensional. Poor feeding practices, specifically a lack of dietary diversity, is one of the immediate cause leading to such high prevalence of childhood undernutrition among children in Bangladesh [5].

Our study revealed that children from the food secure households had higher dietary diversity compared to the children from the food insecure households during the monsoon season, consistent with other findings [39, 40]. Poverty, low agricultural production, high food price, natural calamity and seasonality are some of the reasons behind household food insecurity in the developing countries[41–43]. Studies looking at the impact of seasonality on household

Table 2. Mean Dietary Diversity Scores (DDS) among children aged 6–59 months across different socioeconomic characteristics in rural areas of Bangladesh, 2014.

Background characteristics		Number of children	Mean DDS (sd)	P values from (kwallis tests)
Mean DDS		**6,468**	**3.93 (sd 1.47)**	
Characteristics of children				
Sex	Boy	3,367	3.93 (sd 1.44)	0.709
	Girl	3,101	3.93 (sd 1.49)	
Characteristics of Mothers				
Mothers Age	15–24 years	2,380	3.93 (sd 1.46)	0.792
	25–49 years	4,088	3.93 (sd 1.47)	
Mother's Education	No education (0 years)	1,247	3.68 (sd 1.37)	<0.000
	Primary incomplete (1–4 years)	1,172	3.74 (sd 1.41)	
	Primary to secondary (5+ years)	4,049	4.06 (sd 1.49)	
Mother's Employment Status	Homemaker	5,819	3.90 (sd 1.46)	<0.000
	Unskilled worker	300	3.85 (sd 1.40)	
	Skilled worker	349	4.49 (sd 1.52)	
Household Characteristics				
Households monthly expenditure on food(in taka)	≤ BDT 5,000/ USD 60	4,281	3.79 (sd 1.40)	<0.000
	> BDT 5,000/ USD 60	2,126	4.20 (sd 1.54)	
Households food security status	Food Insecure	2,795	3.69 (sd 1.38)	<0.000
	Food secure	3,673	4.12 (sd 1.50)	
Wealth Quintile	Lowest	1,327	3.58 (sd 1.32)	<0.000
	Second	1,302	3.77 (sd 1.36)	
	Middle	1,299	3.88 (sd 1.43)	
	Fourth	1,277	3.99 (sd 1.52)	
	Highest	1,263	4.46 (sd 1.55)	

food insecurity and nutritional status of children in Bangladesh confirms that the prevalence of food insecurity and growth faltering among children is higher during monsoon season compared to dry season [38, 44]. Initiation and expansion of new social safety net programmes such as cash transfer, food transfer and other income generating programmes can improve the capacity of people to acquire foods and thereby maintain and ensure household food security status during low harvest seasons [45–49].

Household food security is also related with agricultural production [42, 50–53]. Agricultural interventions can improve household food security status by increasing the availability of and accessibility to various nutritious food items. A study from Nepal suggests that each additional food group produced by the household increases the log odds of meeting minimum dietary diversity of children aged 18–24 month by 0.25 (p value 0.01)[54]. Intake of dairy, poultry, vitamin A rich fruits & vegetables & other vegetables improve with diversification of household food production [54].

Children from wealthier households have improved dietary diversity and lower levels of undernutrition. Wealthier households often use additional income to purchase non-staple foods, thus increasing household dietary diversity. A recent analysis found income to be a significant determinant of household dietary diversity in Bangladesh [55, 56]. Evidence from different demographic studies also indicated that families with higher income and more resources tend to have more diverse diets and lower levels of childhood undernutrition [17, 45, 57].

Educated mothers are more likely to have better knowledge and practices of nutritious food habits. Our study also linked mothers' educational attainments with higher mean DDS and

Table 3. Association of food security and socioeconomic factors with Dietary Diversity Score (DDS) among children aged 6-59months in rural areas of Bangladesh, 2014.

Background characteristics		Unadjusted		Adjusted	
		Coefficients	P values	Coefficients	P values
Characteristics of children					
Sex	Boy	Ref		Ref	
	Girl	-0.00	0.942	-0.00	0.940
Characteristics of Mothers					
Mothers Age	15–24 years	Ref		Ref	
	25–49 years	0.00	0.956	0.00	0.903
Mother's Education	No education (0 years)	Ref		Ref	
	Primary incomplete (1–4 years)	0.06	0.279	0.02	0.718
	Primary to secondary (5+ years)	0.38	<0.000	0.15	<0.05
Mother's Employment Status	Homemaker	Ref		Ref	
	Unskilled worker	-0.05	0.531	0.03	0.736
	Skilled worker	0.59	<0.000	0.48	<0.000
Household Characteristics					
Households monthly expenditure on food(in taka)	≤ BDT 5,000/ USD 60	Ref		Ref	
	> BDT 5,000/ USD 60	0.41	<0.000	0.26	<0.000
Households food security status	Food insecure	Ref		Ref	
	Food secure	0.42	<0.000	0.21	<0.000
Wealth Quintile	Lowest	Ref		Ref	
	Second	0.19	<0.001	0.09	<0.113
	Middle	0.29	<0.000	0.18	<0.05
	Fourth	0.40	<0.000	0.23	<0.000
	Highest	0.87	<0.000	0.54	<0.000

https://doi.org/10.1371/journal.pone.0221929.t003

lower prevalence's of undernutrition in children. These results are supported by findings from other developing countries [22, 56, 58]. Nutritional education programmes can improve dietary diversity practices and nutritional status of children [59–61]. Home based nutrition counselling improved diet quality of children from both food secure and insecure population [60–64]. However, the translation of education to improved dietary practices and subsequent improvements in nutritional status, is a lengthy process. Improvements in IYCF practices took as long as 18 months of counselling sessions by health staffs including regular home visits and growth monitoring in Peru[65, 66].

Culturally shaped dietary habits can act as bottlenecks and prevent dietary diversity and improved nutritional statuses of children. In Bangladesh, the major portion of regular meals consists of starchy staples. Also, women and children receive small share of food due to inequity in intra-household food distribution [16]. However, the scenario can be different for mother's employed as skilled workers. The findings of this study confirmed those of others that children whose mothers are skilled workers are more likely to have higher DDS when compared to children with stay at home mothers [67, 68]. A working mother may have more control on food choices due to increased accessibility and affordability. They are also likely to have better knowledge about health and nutrition of their children, which may influence better feeding practices[49, 53, 68–72]. On a different note, given the nature of the work the women are involved in, further explorative study would be pertinent to identify the factors facilitating good feeding practices among working mothers in different areas.

Table 4. Association of food security and socioeconomic factors with nutritional status of the children aged 6-59months in rural areas of Bangladesh, 2014.

Background characteristics		Stunting		Wasting		Underweight	
		Adjusted		Adjusted		Adjusted	
		Odd ratios	P values	Odd ratios	P values	Odd ratios	P values
Characteristics of children							
Sex	Boy	Ref		Ref		Ref	
	Girl	0.98	0.814	0.96	0.511	1.06	0.240
Characteristics of Mothers							
Mothers Age	15–24 years	Ref		Ref		Ref	
	25–49 years	0.99	0.964	1.06	0.419	1.08	0.186
Mother's Education	No education (0 years)	Ref		Ref		Ref	
	Primary incomplete (1–4 years)	0.80	<0.05	1.03	0.754	0.86	0.089
	Primary to secondary (5+ years)	0.63	<0.000	0.95	0.585	0.74	<0.000
Mother's Employment Status	Homemaker	Ref		Ref		Ref	
	Unskilled worker	1.05	0.689	0.80	0.193	0.91	0.481
	Skilled worker	1.12	0.334	0.98	0.890	0.98	0.908
Household Characteristics							
Households monthly expenditure on food(in taka)	≤ BDT 5,000/ USD 60	Ref		Ref		Ref	
	> BDT 5,000/ USD 60	0.92	0.167	0.98	0.842	0.96	0.525
Households food security status	Food insecure	Ref		Ref		Ref	
	Food secure	0.94	0.314	0.95	0.462	0.95	0.414
Wealth Quintile	Lowest	Ref		Ref		Ref	
	Second	0.78	<0.05	0.92	0.446	0.75	<0.000
	Middle	0.87	0.105	0.96	0.659	0.87	0.098
	Fourth	0.83	<0.05	0.92	0.443	0.81	<0.05
	Highest	0.64	<0.000	0.76	<0.05	0.50	<0.000

https://doi.org/10.1371/journal.pone.0221929.t004

Strengths and limitations

The large geographically representative sample with a high response rate and the use of rigorous statistical analysis techniques have strengthened the findings of this study. Additionally, the usage of a well validated structured questionnaire may have controlled for instrumental and inter-rater biases. The use of a 24-hour food consumption recall period may have reduced the chance of recall bias when compared to longer recall periods. The minimized recall bias comes at the cost of providing no information on seasonal variations in food consumption and their usual food habits.

Some of the sampled children included in this study were breastfed at the time of this survey. Mothers' dietary practices might have influenced the nutritional statuses of breastfed children. Failure to explore the association of mothers' diets with their children's' nutritional statuses could have limited the findings of the study and requires further exploration in the subsequent studies. In addition, the cross-sectional design of the survey limits the use of study findings for causal inference. Further studies involving prospective monitoring of food security and dietary diversity determinants using 7 days or 3 month recall period questionnaires are required to establish epidemiological causality.

Conclusion and recommendation

Bangladesh has high burden of childhood undernutrition. Ensuring dietary diversity for under-five children is a challenge here due to presence of high level of food insecurity. The

2013 Lancet Maternal and Child Nutrition series proposed a framework for prioritizing evidence based interventions to improve the dietary practices and nutritional statuses of children. The Lancet series identified behaviour change communication to improve complementary feeding practices, as a nutrition specific intervention, and investments in rural infrastructure, measures to increase agricultural productivity, the usage of consumer food subsidies and women's education are some as nutrition sensitive interventions effective in addressing childhood nutrition. [2, 73, 74]. Our findings re-emphasized the need to combine knowledge with social transfers [75]. This study will build upon the available evidence on food security and other sociodemographic determinants of dietary diversity and childhood undernutrition. Findings from this study will also help policy makers identify high risk groups for childhood undernutrition and use context- specific solutions to ensure optimal dietary diversity in rural children between ages 6–59 months in Bangladesh.

Acknowledgments

Author Contributions

Conceptualization: Nazia Binte Ali, Tazeen Tahsina, Shams El Arifeen.

Data curation: Nazia Binte Ali, Tazeen Tahsina.

Formal analysis: Nazia Binte Ali, Tazeen Tahsina.

Funding acquisition: Tazeen Tahsina, Dewan Md. Emdadul Hoque, Shams El Arifeen.

Investigation: Nazia Binte Ali, Tazeen Tahsina, Dewan Md. Emdadul Hoque, Tanvir M. Huda, Shams El Arifeen.

Methodology: Nazia Binte Ali, Tazeen Tahsina, Shams El Arifeen.

Project administration: Nazia Binte Ali, Tazeen Tahsina, Mohammad Mehedi Hasan.

Resources: Nazia Binte Ali, Tazeen Tahsina.

Supervision: Nazia Binte Ali, Tazeen Tahsina, Mohammad Mehedi Hasan, Shams El Arifeen.

Validation: Nazia Binte Ali, Tazeen Tahsina, Shams El Arifeen.

Visualization: Nazia Binte Ali, Tazeen Tahsina, Shams El Arifeen.

Writing – original draft: Nazia Binte Ali, Tazeen Tahsina.

Writing – review & editing: Nazia Binte Ali, Tazeen Tahsina, Dewan Md. Emdadul Hoque, Mohammad Mehedi Hasan, Afrin Iqbal, Tanvir M. Huda, Shams El Arifeen.

References

1. Kirkpatrick SI, McIntyre L, Potestio ML. Child hunger and long-term adverse consequences for health. Archives of pediatrics & adolescent medicine. 2010; 164(8):754–62.

2. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013; 382(9890):427–51. https://doi.org/10.1016/S0140-6736(13)60937-X PMID: 23746772

3. National Institute of Population Research and Training (Bangladesh), Mitra and Associates (Firm), MEASURE DHS (Program). Bangladesh demographic and health survey, 2014: key indicators. Dhaka: National Institute of Population Research and Training, Ministry of Health and Family Welfare; 2015. vii, 56 pages p.

4. K M. Undernutrition. Malawi Med Journal. 2006; 18(4).

5. Gulati JK. Child Malnutrition: Trends and Issues. Anthropologist. 2010; 12(2):131–40.

6. Kimmons JE, Dewey KG, Haque E, Chakraborty J, Osendarp SJ, Brown KH. Low nutrient intakes among infants in rural Bangladesh are attributable to low intake and micronutrient density of complementary foods. The Journal of nutrition. 2005; 135(3):444–51. https://doi.org/10.1093/jn/135.3.444 PMID: 15735076

7. Saleh F, Ferdous Ara M, Hoque A, Alam MS. Complementary feeding practices among mothers in selected slums of Dhaka city: a descriptive study. Journal of health, population, and nutrition. 2014; 32 (1):89. PMID: 24847597

8. Hanif HM. Trends in infant and young child feeding practices in Bangladesh, 1993–2011. International breastfeeding journal. 2013; 8(1):10. https://doi.org/10.1186/1746-4358-8-10 PMID: 24073918

9. Rasheed S, Haider R, Hassan N, Pachón H, Islam S, Jalal CS, et al. Why does nutrition deteriorate rapidly among children under 2 years of age? Using qualitative methods to understand community perspectives on complementary feeding practices in Bangladesh. Food and nutrition bulletin. 2011; 32 (3):192–200. https://doi.org/10.1177/156482651103200302 PMID: 22073792

10. Ahmed AS, Ahmed T, Roy S, Alam N, Hossain MI. Determinants of undernutrition in children under 2 years of age from rural Bangladesh. Indian pediatrics. 2012; 49(10):821–4. PMID: 22728631

11. K. M. Human development report 2014. Sustaining human progress: Reducing vulnerabilities and building resilience. New York: United Nations Development Programme;. 2014.

12. (JPGSPH) HKIHaJPGSoPH. State of Food Insecurity and Nutrition in Bangladesh: 2013. Dhaka, Bangaldesh; 2014.

13. Na M, Mehra S, Christian P, Ali H, Shaikh S, Shamim AA, et al. Maternal Dietary Diversity Decreases with Household Food Insecurity in Rural Bangladesh: A Longitudinal Analysis. The Journal of nutrition. 2016; 146(10):2109–16. https://doi.org/10.3945/jn.116.234229 PMID: 27581578

14. Owais A, Kleinbaum DG, Suchdev PS, Faruque A, Das SK, Schwartz B, et al. Household food security and infant feeding practices in rural Bangladesh. Public health nutrition. 2016; 19(10):1875–81. https://doi.org/10.1017/S1368980015003195 PMID: 26563771

15. Hillbruner C ER. Seasonality, household food security, and nutritional status in Dinajpur, Bangladesh. Food Nutr Bull. 2008; 29(3):221–31. https://doi.org/10.1177/156482650802900308 PMID: 18947035

16. Arsenault JE, Yakes EA, Islam MM, Hossain MB, Ahmed T, Hotz C, et al. Very low adequacy of micronutrient intakes by young children and women in rural Bangladesh is primarily explained by low food intake and limited diversity. The Journal of nutrition. 2013; 143(2):197–203. https://doi.org/10.3945/jn.112.169524 PMID: 23256144

17. Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. The Journal of nutrition. 2004; 134(10):2579–85. https://doi.org/10.1093/jn/134.10.2579 PMID: 15465751

18. Iqbal S, Zakar R, Zakar MZ, Fischer F. Factors associated with infants' and young children's (6–23 months) dietary diversity in Pakistan: evidence from the demographic and health survey 2012–13. Nutr J. 2017; 16(1):78. https://doi.org/10.1186/s12937-017-0297-7 PMID: 29208001

19. Hoddinott J YY. Dietary diversity as a food security indicator. Food consumption and nutrition division discussion paper 136. Washington, DC. International Food Policy Research Institute; 2002.

20. Saha KK, Frongillo EA, Alam DS, Arifeen SE, Persson LA, Rasmussen KM. Household food security is associated with infant feeding practices in rural Bangladesh. The Journal of nutrition. 2008; 138 (7):1383–90. https://doi.org/10.1093/jn/138.7.1383 PMID: 18567765

21. Ochieng J, Afari-Sefa V, Lukumay PJ, Dubois T. Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. PloS one. 2017; 12(12):e0189022. https://doi.org/10.1371/journal.pone.0189022 PMID: 29232413

22. Patel A, Pusdekar Y, Badhoniya N, Borkar J, Agho KE, Dibley MJ. Determinants of inappropriate complementary feeding practices in young children in India: secondary analysis of National Family Health Survey 2005–2006. Maternal & child nutrition. 2012; 8 Suppl 1:28–44.

23. Prudhon C, Benelli P, Maclaine A, Harrigan P, Frize J. Informing infant and young child feeding programming in humanitarian emergencies: An evidence map of reviews including low and middle income countries. Maternal & child nutrition. 2018; 14(1).

24. National Institute of Population Research and Training (NIPORT,) Mitro and Assoicates, and ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2013.

25. National Institute of Population Research and Training (NIPORT) Mitro and Assoicates, and icddr,b. Bangladesh Maternal Mortality and Health Care Survey 2010. Dhaka, Bangladesh: NIPORT, MEASURE Evaluation, and icddr,b December 2012.

26. Tahsina T, Ali NB, Islam S, Hasan MM, Moinuddin M, Siddique AB, et al. Evaluation of Bangladesh Nutrition Initiative Project/Nobokoli: Findings from Baseline Survey, 2014. Dhaka, Bangladesh: icddr,b; 2015.

27. Tahsina T, Ali NB, Siddique MAB, Ahmed S, Rahman M, Islam S, et al. Determinants of hardship financing in coping with out of pocket payment for care seeking of under five children in selected rural areas of Bangladesh. PloS one. 2018; 13(5):e0196237. https://doi.org/10.1371/journal.pone.0196237 PMID: 29758022

28. Nutrition Landscape Information System (NLiS): WHO; [Available from: http://apps.who.int/nutrition/landscape/help.aspx?menu=0&helpid=391&lang=EN.

29. 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. https://doi.org/10.1177/156482650302400210 PMID: 12891828

30. Marriott BP, White A, Hadden L, Davies JC, Wallingford JC. World Health Organization (WHO) infant and young child feeding indicators: associations with growth measures in 14 low-income countries. Maternal & child nutrition. 2012; 8(3):354–70.

31. Onyango A, Koski KG, Tucker KL. Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers. International journal of epidemiology. 1998; 27(3):484–9. https://doi.org/10.1093/ije/27.3.484 PMID: 9698140

32. Steyn NP, Nel J, Labadarios D, Maunder EM, Kruger HS. Which dietary diversity indicator is best to assess micronutrient adequacy in children 1 to 9 y? Nutrition (Burbank, Los Angeles County, Calif). 2014; 30(1):55–60.

33. Reinbott A, Kuchenbecker J, Herrmann J, Jordan I, Muehlhoff E, Kevanna O, et al. A child feeding index is superior to WHO IYCF indicators in explaining length-for-age Z-scores of young children in rural Cambodia. Paediatrics and international child health. 2015; 35(2):124–34. https://doi.org/10.1179/2046905514Y.0000000155 PMID: 25226288

34. Ogle BM, Hung PH, Tuyet HT. Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety. Asia Pacific journal of clinical nutrition. 2001; 10(1):21–30. PMID: 11708605

35. Kennedy G BT, Dop MC. Guidelines for measuring household and individual dietary diversity: Food and Agriculture Organization of the United Nations. 2011.

36. Food and Agriculture Organization of the United Nations (FAO) IFfADI, and World Food Programme (WFP). The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. 2012.

37. Owais A, Kleinbaum DG, Suchdev PS, Faruque A, Das SK, Schwartz B, et al. Household food security and infant feeding practices in rural Bangladesh. Public health nutrition. 2016; 19(10):1875–81. https://doi.org/10.1017/S1368980015003195 PMID: 26563771

38. Stevens B, Watt K, Brimbecombe J, Clough A, Judd J, Lindsay D. The role of seasonality on the diet and household food security of pregnant women living in rural Bangladesh: a cross-sectional study. Public health nutrition. 2017; 20(1):121–9. https://doi.org/10.1017/S136898001600183X PMID: 27573667

39. Chandrasekhar S, Aguayo VM, Krishna V, Nair R. Household food insecurity and children's dietary diversity and nutrition in India. Evidence from the comprehensive nutrition survey in Maharashtra. Maternal & child nutrition. 2017; 13 Suppl 2.

40. Agbadi P, Urke HB, Mittelmark MB. Household food security and adequacy of child diet in the food insecure region north in Ghana. PloS one. 2017; 12(5):e0177377. https://doi.org/10.1371/journal.pone.0177377 PMID: 28494024

41. Bashir MK, Schilizzi S. Determinants of rural household food security: a comparative analysis of African and Asian studies. Journal of the science of food and agriculture. 2013; 93(6):1251–8. https://doi.org/10.1002/jsfa.6038 PMID: 23371798

42. Birhane T, Shiferaw S, Hagos S, Mohindra KS. Urban food insecurity in the context of high food prices: a community based cross sectional study in Addis Ababa, Ethiopia. BMC public health. 2014; 14:680. https://doi.org/10.1186/1471-2458-14-680 PMID: 24993286

43. Darmon N, Drewnowski A. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. Nutrition Reviews. 2015; 73(10):643–60. https://doi.org/10.1093/nutrit/nuv027 PMID: 26307238

44. Hillbruner C, Egan R. Seasonality, household food security, and nutritional status in Dinajpur, Bangladesh. Food and nutrition bulletin. 2008; 29(3):221–31. https://doi.org/10.1177/156482650802900308 PMID: 18947035

45. Torheim LE, Ouattara F, Diarra MM, Thiam FD, Barikmo I, Hatloy A, et al. Nutrient adequacy and dietary diversity in rural Mali: association and determinants. European journal of clinical nutrition. 2004; 58 (4):594–604. https://doi.org/10.1038/sj.ejcn.1601853 PMID: 15042127

46. Uraguchi ZB. Rural income transfer programs and rural household food security in Ethiopia. Journal of Asian and African studies. 2012; 47(1):33–51. PMID: 22451986

47. Alam A. Seasonal food security strategies of the 'extreme poor' of Haor in Bangladesh 2016.

48. Abstracts. Journal of the International AIDS Society. 2018; 21(Suppl Suppl 6):e25148.

49. Renzaho AMN, Chitekwe S, Chen W, Rijal S, Dhakal T, Dahal P. The Synergetic Effect of Cash Transfers for Families, Child Sensitive Social Protection Programs, and Capacity Building for Effective Social Protection on Children's Nutritional Status in Nepal. International Journal of Environmental Research and Public Health. 2017; 14(12):1502.

50. Motbainor A, Worku A, Kumie A. Level and determinants of food insecurity in East and West Gojjam zones of Amhara Region, Ethiopia: a community based comparative cross-sectional study. BMC public health. 2016; 16:503. https://doi.org/10.1186/s12889-016-3186-7 PMID: 27289456

51. Endale W, Mengesha ZB, Atinafu A, Adane AA. Food insecurity in Farta District, Northwest Ethiopia: a community based cross-sectional study. BMC research notes. 2014; 7:130. https://doi.org/10.1186/1756-0500-7-130 PMID: 24606757

52. Muehlhoff E, Wijesinha-Bettoni R, Westaway E, Jeremias T, Nordin S, Garz J. Linking agriculture and nutrition education to improve infant and young child feeding: Lessons for future programmes. Maternal & child nutrition. 2017; 13 Suppl 2.

53. Gelli A, Becquey E, Ganaba R, Headey D, Hidrobo M, Huybregts L, et al. Improving diets and nutrition through an integrated poultry value chain and nutrition intervention (SELEVER) in Burkina Faso: study protocol for a randomized trial. Trials. 2017; 18:412. https://doi.org/10.1186/s13063-017-2156-4 PMID: 28874177

54. Mulmi P, Masters WA, Ghosh S, Namirembe G, Rajbhandary R, Manohar S, et al. Household food production is positively associated with dietary diversity and intake of nutrient-dense foods for older preschool children in poorer families: Results from a nationally-representative survey in Nepal. PloS one. 2017; 12(11):e0186765. https://doi.org/10.1371/journal.pone.0186765 PMID: 29145391

55. Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, Kraemer K, et al. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. The Journal of nutrition. 2010; 140(1):182S–8S. https://doi.org/10.3945/jn.109.110809 PMID: 19923385

56. Tegegne M, Sileshi S, Benti T, Teshome M, Woldie H. Factors associated with minimal meal frequency and dietary diversity practices among infants and young children in the predominantly agrarian society of Bale zone, Southeast Ethiopia: a community based cross sectional study. Archives of Public Health. 2017; 75:53. https://doi.org/10.1186/s13690-017-0216-6 PMID: 29158896

57. Huda TM, Hayes A, El Arifeen S, Dibley MJ. Social determinants of inequalities in child undernutrition in Bangladesh: A decomposition analysis. Maternal & child nutrition. 2018; 14(1).

58. Kabir I, Khanam M, Agho KE, Mihrshahi S, Dibley MJ, Roy SK. Determinants of inappropriate complementary feeding practices in infant and young children in Bangladesh: secondary data analysis of Demographic Health Survey 2007. Maternal & child nutrition. 2012; 8 Suppl 1:11–27.

59. Kulwa KBM, Verstraeten R, Bouckaert KP, Mamiro PS, Kolsteren PW, Lachat C. Effectiveness of a nutrition education package in improving feeding practices, dietary adequacy and growth of infants and young children in rural Tanzania: rationale, design and methods of a cluster randomised trial. BMC public health. 2014; 14:1077. https://doi.org/10.1186/1471-2458-14-1077 PMID: 25318980

60. Nair N, Tripathy P, Sachdev HS, Bhattacharyya S, Gope R, Gagrai S, et al. Participatory women's groups and counselling through home visits to improve child growth in rural eastern India: protocol for a cluster randomised controlled trial. BMC public health. 2015; 15:384. https://doi.org/10.1186/s12889-015-1655-z PMID: 25886587

61. Nair N, Tripathy P, Sachdev HS, Pradhan H, Bhattacharyya S, Gope R, et al. Effect of participatory women's groups and counselling through home visits on children's linear growth in rural eastern India (CARING trial): a cluster-randomised controlled trial. The Lancet Global health. 2017; 5(10):e1004–e16. https://doi.org/10.1016/S2214-109X(17)30339-X PMID: 28911749

62. Vazir S, Engle P, Balakrishna N, Griffiths PL, Johnson SL, Creed-Kanashiro H, et al. Cluster-randomized trial on complementary and responsive feeding education to caregivers found improved dietary intake, growth, and development among rural Indian toddlers. Maternal & child nutrition. 2013; 9(1):99–117.

63. Osendarp SJ, Roche ML. Behavioral Change Strategies for Improving Complementary Feeding and Breastfeeding. World review of nutrition and dietetics. 2016; 115:184–92. https://doi.org/10.1159/000442104 PMID: 27197978

64. Sanghvi T, Haque R, Roy S, Afsana K, Seidel R, Islam S, et al. Achieving behaviour change at scale: Alive & Thrive's infant and young child feeding programme in Bangladesh. Maternal & child nutrition. 2016; 12 Suppl 1:141–54.

65. Sanghvi T, Seidel R, Baker J, Jimerson A. Using behavior change approaches to improve complementary feeding practices. Maternal & child nutrition. 2017; 13 Suppl 2.

66. Robert RC, Creed-Kanashiro HM, Villasante R, Narro MR, Penny ME. Strengthening health services to deliver nutrition education to promote complementary feeding and healthy growth of infants and young children: formative research for a successful intervention in peri-urban Trujillo, Peru. Maternal & child nutrition. 2017; 13(2).

67. Ahmadi D, Amarnani E, Sen A, Ebadi N, Cortbaoui P, Melgar-Quinonez H. Determinants of child anthropometric indicators in Ethiopia. BMC public health. 2018; 18(1):626. https://doi.org/10.1186/s12889-018-5541-3 PMID: 29764397

68. Alderman H, Headey DD. How Important is Parental Education for Child Nutrition? World Development. 2017; 94:448–64. https://doi.org/10.1016/j.worlddev.2017.02.007 PMID: 28579669

69. Kabir A, Maitrot MRL. Factors influencing feeding practices of extreme poor infants and young children in families of working mothers in Dhaka slums: A qualitative study. PloS one. 2017; 12(2):e0172119. https://doi.org/10.1371/journal.pone.0172119 PMID: 28207894

70. Muraya KW, Jones C, Berkley JA, Molyneux S. "If it's issues to do with nutrition. . .I can decide. . .": gendered decision-making in joining community-based child nutrition interventions within rural coastal Kenya. Health Policy and Planning. 2017; 32(Suppl 5):v31–v9. https://doi.org/10.1093/heapol/czx032 PMID: 29244104

71. Vir SC. Improving women's nutrition imperative for rapid reduction of childhood stunting in South Asia: coupling of nutrition specific interventions with nutrition sensitive measures essential. Maternal & child nutrition. 2016; 12(Suppl Suppl 1):72–90.

72. Miller LC, Joshi N, Lohani M, Rogers B, Mahato S, Ghosh S, et al. Women's education level amplifies the effects of a livelihoods-based intervention on household wealth, child diet, and child growth in rural Nepal. International Journal for Equity in Health. 2017; 16:183. https://doi.org/10.1186/s12939-017-0681-0 PMID: 29047376

73. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. Lancet. 2008; 371(9610):417–40. https://doi.org/10.1016/S0140-6736(07)61693-6 PMID: 18206226

74. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013; 382 (9890):452–77. https://doi.org/10.1016/S0140-6736(13)60996-4 PMID: 23746776

75. Huda TM, Alam A, Tahsina T, Hasan MM, Khan J, Rahman MM, et al. Mobile-Based Nutrition Counseling and Unconditional Cash Transfers for Improving Maternal and Child Nutrition in Bangladesh: Pilot Study. JMIR mHealth and uHealth. 2018; 6(7):e156. https://doi.org/10.2196/mhealth.8832 PMID: 30021707