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Non-Cereal Food Consumption, Food Insecurity and Nutritional Status of Children and Mothers: A Case Study in Bangladesh

Rabiul Islam GM[*1], J**ahangir Alam M**[2,3] & **Buysse J**[2]

[1] *ICP Nutrition and Rural Development, Ghent University, Belgium and Department of Food Engineering and Tea Technology, Shahjalal University of Science and Technology, Bangladesh*

[2] *Department of Agricultural Economics, Ghent University, 653 Coupure Links, A-098, 9000 Ghent, Belgium*

[3] *Department of Agribusiness and Marketing, Bangladesh Agricultural University, Bangladesh*

ABSTRACT

Aim: The aim of this study is to investigate the effects of food insecurity derived from non-cereal food consumption on nutritional status of children and mothers in a poverty-prone region in Bangladesh. **Methods:** Data from the Bangladesh Nutritional Surveillance Project, 2005 of Helen Keller International were used to relate non-cereal food consumption and household food insecurity to nutritional status of children and their mothers. Multiple regressions were used to determine the association between the nutritional outcomes and the explanatory variables. In the case of binary and multi-level outcomes, logistic regressions were used as well. **Results:** Non-cereal dietary diversity was found to have little predictive power on BMI and MUAC of mothers and on the nutritional status of the children. Maternal education is strongly associated with mothers' and children's nutritional status. **Conclusion:** Dietary diversity based on non-cereal food consumption can be a useful tool to investigate the nutritional status of poor households, but more studies are needed to verify these findings.

Keywords: Bangladesh, children and mothers, food insecurity, non-cereal food consumption, nutritional status

INTRODUCTION

The prevalence of malnutrition due to food insecurity is well recognised in the ecologically vulnerable parts of Tista Jumana basin area (locally known as *Monga*[1] region) in Bangladesh (Hossain, Naher & Shahabuddin, 2005). The people of this region deserve special attention in relation to food insecurity and consequently their coping strategies not only due to the seasonality of labour demand but also its persistence over time. This situation appears to be the major cause of chronic malnutrition and/or inter-generational transmission of poverty in this region (Lee & Frongillo, 2001;

* Correspondence author: GM Rabiul Islam: Email: *rabi-ttc@sust.edu, rabiat14@yahoo.com*

[1] *Monga* is a Bangla term referring to the yearly cyclical phenomenon of poverty and hunger in Bangladesh leading to fewer available job opportunities for rural workers. Those who cannot migrate face malnutrition and starvation.

Shahabuddin & Ali 2006; Zug 2006). Hence, understanding the consequences of seasonal food insecurity on the nutritional outcomes is crucial to addressing the public health risk of food insecurity in children and mothers through more effective nutritional and health services by the service providers and policy makers.

In order to isolate the nutritional outcomes, that is, the consequences of food insecurity among children and adults, a careful examination of various determinants of nutritional and health status is required (Bhattacharya, Currie & Haider, 2004). In the case of children and mothers, a variety of factors like maternal age, education, child's sex and age group are closely associated with nutritional outcomes (Pryer & Rogers 2006); Idler & Benyamini. 1997; Lee & Frongillo, 2001; Bhattacharya *et al*., 2004).

However, most previous studies have investigated food insecurity based on a questionnaire measure of the household income, expenditure, hunger score, the availability of per capita energy etc. (Frongillo, 1999; Shaha *et al*., 2008; Hossain *et al.*, 2005). Of late, an indicator of dietary diversity derived from a recall of the number of foods or food groups consumed over a given time period has gained increasing attention among both nutrition and food security analysts (Thorne-Lyman *et al.*, 2010; Ruel, 2002). Dietary diversity indicators have become popular because data are fairly easy to collect, and associated with dietary quality, energy intake, and food security (Arimond & Ruel, 2004; Ruel, 2002). Thus, the use of dietary diversity indicators has great potential as a powerful tool for effective needs assessment and targeting, as well as effective program monitoring and evaluation. But only a few studies have been conducted on questionnaire-based measures of food insecurity from dietary diversity of non staple food consumption, especially in chronically poverty-prone regions and its consequences on the nutritional outcomes such as Body Mass Index (BMI), Mid-Upper Arms Circumference (MUAC), and children's Z-score of stunting, wasting and underweight.

Given the above backdrop, the objectives of this study are to (a) investigate the relationships between non-cereal food consumption and nutritional outcomes in children and mothers at Pirgon sub-district of Tista Jumana basin area in Bangladesh, and (b) analyse the determining factors of nutritional outcomes in children and mothers. To measure food insecurity, we used a questionnaire based measure of dietary diversity of non-staple food consumption.

METHODS

Sample

This study was conducted with data from the 2005 Nutrition Surveillance Project (NSP) of Helen Keller International (HKI, 2006). HKI collected data from throughout Bangladesh during the implementation of the Nutrition Surveillance Project. Based on this database, 15 villages were selected randomly from the administrative sub-units (*Mauza*) of Pirgong sub-division which experienced the *Monga* phenomenon. A total of 25 households with at least one child aged less than 5 years from each village was selected. In total, the sample size comprised 377 mothers and 447 children.

Statistical models

In order to estimate the differences of some important nutritional outcomes for mothers and children of food insufficient and food sufficient households and its association with important socio-demographic factors, the *first*- multiple regression model used is as as follows:

$$Y_i = \alpha + \beta X_i + \mu Z_i + e_i$$

where Y is nutritional outcome, X is a vector of food insecurity measure, and Z_i is the confounder. The coefficient β measures the differences in outcomes associated with food security / insecurity and μ is the coefficient measure of the confounding variables.

Second, a binary logistic mode was used to analyse binary outcomes with the multinomial logistic model to analyse multilevel outcomes. The models are as follows:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \alpha + \beta_i X_i \qquad (1)$$

$$L_i = \ln\left(\frac{P_{ij}}{1 - P_{ik}}\right) = \alpha + \beta_i X_i \qquad (2) \qquad [j \neq k]$$

where L is called 'the logit' and this is the log of the odds ratio linear in food security measure and also in the parameters. P_i is the probability of malnutrition (as one of nutritional outcomes), β_i is the coefficients, X_i is the explanatory variables and j is 1 ,2,—, (k-1)

In the case of multinomial logistic regression (Equation 2), the response variable has four categories such as normal, mild, moderate and severe malnourished. To construct the logit in multinomial, case one of the categories is considered as the base with all the categories constructed relative to the base. In our model 'normal' category is considered as the base. One way ANOVA and Kruskal–Wallis one-way ANOVA were used to analyse the association between children's Z-score (for wasting, stunting and underweight) with the age groups, while the Tukey and Bonferroni methods were applied for multiple comparisons. The analyses were performed using the SPSS package version 15.

Explanation on dependent variables

The nutritional outcomes of mother and children were investigated. Hence, in the case of the mothers, BMI (weight in kg / height in m^2) and MUAC (mm) were considered as screening tools of malnutrition. BMI is dichotomised as (i) less than 18.50 kg / m^2 as 'undernourished' and (ii) more than or equal 18.50 kg / m^2 as 'normal'. The MUAC is dichotomised as (i) less than 220 mm 'undernourished' and (ii) more than or equal 220 mm as 'normal'. These are widely used for screening malnutrition of Asian people (Ferro-Luzzi & James, 1996; WHO, 1995).

In the case of children, the Z-score values for weight-for-height (wasting), height-for-age (stunting) and weight-for-age (underweight) are commonly used as screening tools of malnutrition. Children were classified into four different groups of nutritional status based on their Z-score following the cut-off points recommended by WHO (1995). These are (i) Normal (Z-score $\geq$ -1); (ii) Mildly malnourished (Z-score < -1 to $\geq$ -2); (iii) Moderately malnourished (Z-score <- 2 to - $\geq$-3) and (iv) Severely malnourished (Z-score <-3). To determine the children's Z-score, the National Centre for Health Statistics (NCHS) reference population was used. This is because the WHO reference population only came into use after 2006, and therefore the HKI 2005 had applied the NCHS reference population to obtain children's Z -score.

Explanation on independent variables

Food sufficiency and food insufficiency are used as independent variables. Food sufficiency is measured by using recall data on non-staple food consumption. HKI (2002) had shown that dietary diversity could be used as a food security measure (HKI, 2006). The data are based on 7-day recall on dietary diversity from non-staple foods. In this case, trained research assistants of HKI visited the respondents every evening of a week to record the data during the survey period. The mothers were asked to recall their consumption of five common non-cereal foods, i.e., lentils, eggs, green leafy vegetables, yellow / orange fruits or vegetables and fish. The research assistants reported to the supervisor who was responsible for keeping the 7-day recall records. Dietary diversity was measured as the number of times that non-staple food was eaten within one week.

Households are considered as food sufficient using the definition of HKI (2002) when non-staple food was taken at least 4 times. On the contrary, households were considered as food insufficient if dietary diversity from non-staple food was less than 4 during past 7 days. Similar definitions of food sufficiency and food insufficiency have also been used by other researchers (Rose & Oliveira 1997; Vozoris, Valerie & Tarasuk, 2003).

Explanation of confounding variables

In order to estimate the relationship between food security status and nutritional outcomes, it is necessary to control the potential confounding variables. It has been known that socio-demographic, economic, physical functioning, health and behavioural conditions, adverse health conditions, psychological conditions, etc. influence nutritional intake, health status, nutritional risk as well as anthropometric measures (Rahman *et al.*, 2004; Lee & Frongillo, 2001). After reviewing all the potential confounding variables, we have chosen the confounders based on data availability and the real situation of the study area. In the case of the mothers, age and education level were included to control for potential confounding effects on observed association. In the case of children, age group, sex and maternal education level were included as potential confounding variables.

RESULTS

Mothers' nutritional outcome

The BMI and MUAC measurements of the mothers showed no significant differences between the food sufficient and food insufficient groups (Table 1). The plausible explanation is that the frequency method used may not reflect sufficiently the actual amounts of the non-staple food consumed. Moreover owing to poverty, the people tend to consume more staple food compared to non-staple food such as vegetables, fish, meat and milk.

Table 2 presents the estimated differences of confounders. Mothers with an education level of less than class eight were considered as non-educated and those who had completed class eight or more were considered as educated. The results showed a strong association between maternal age and MUAC (co-efficient 0.58 with *p*-value 0.003), as well as between maternal education and BMI (co-efficient -0.06 with *p*-value 0.08). This indicates that mothers with higher education tend to have higher BMI. This is due to the fact that a good level of education introduces higher income as well as adequate knowledge about the necessity of better food consumption which in turn contributes to an increase in the level of good food consumption. The relationship between MUAC and age indicates that the MUAC still increases during adult age.

Table 1. Average anthropometric measures of the mothers

Tools	*Mean*		*Mean difference estimate*
	Food insufficient (N= 31)	*Food sufficient (N= 336)*	
BMI (weight in kg/height in m^2)	19.57(18.90, 20.24)	19.79(19.55, 20.02)	-0.20(-1.01, 0.61)
MUAC (mm)	235.87(230.35, 241.39)	241.73(239.58, 243.87)	-5.10(-12.39,02.18)

Notes: Values in parentheses indicate the 95% confidence interval; multiple regression models are used

Table 2. Estimate of adjusted factor for mothers' anthropometric measures and odds ratios of mothers in food insufficient households

Confounders	*BMI*		*MUAC*	
	Coefficients	*P Value*	*Coefficients*	*P Value*
Maternal age	0.03 (-0.01,-0.07)	0.16	0.58** (0.20, 0.96)	0.003 (-0.01,-0.07)
Maternal level of education	-0.06* (-0.12, 0.01)	0.08	-0.25 (0.83, 0.37)	0.42
Odds ratios of mother in food insufficient households				
Groups and odds ratio	*BMI*		*MUAC*	
	Under weight BMI<18.50	Normal weight [a]BMI $\geq$18.50	Normal weight [a]BMI $\geq$18.50	Normal weight [a]BMI $\geq$18.50
Food insufficient N=31	n=11, 35%	n= 20, 65%	n=4,12.9%	n=27, 87.1%
Food sufficient N=346	n=101, 29%	n=245, 71%	n=245, 71%	n=306, 88.4%
Adjusted odds ratio	1.30 (0.6, 2.84)	-	1.12 (3.7, 3.40)	-
p-value	0.51	-	0.84	-

Notes: [a] reference category is normal weight / nourished; CI: confidence interval; values in parentheses indicate the 95% confidence interval, ** and * indicate the probability at 1% and 10% levels

Table 3. Average anthropometric measures of the children

Z-scores	*Mean*		*Mean difference estimate*
	Food insufficient (N= 37)	*Food sufficient (N= 410)*	
Child weight for height Z-score	-0.63(-0.99, -0.28)	-0.81(-0.90, -0.72)	0.09(-0.28, 0.40)
Child height for age Z-score	-1.85(-2.21, -1.51)	-1.72(-1.82, -1.62)	0.11(-0.47, 0.24)
Child weight for age Z-score	-1.63(-1.99, -1.27)	-1.75(-1.84,-1.66)	0.06(-2.56,0.72)

Notes: Values in parentheses indicate the 95% confidence interval; multiple regression models are used

Table 2 also presents data on the odds ratio of BMI and MUAC of the mothers in food insufficient households. Mothers from food insufficient households have higher odds ratios in both BMI and MUAC. These indicate that mothers in the food insufficient group have a greater chance of being underweight and undernourished.

Children's nutritional outcome

Table 3 presents the estimates of children's Z-scores with the different indicators of nutritional outcomes. The results show that the mean differences do not significantly differ. This may be due to the fact that food insufficiency measured as dietary diversity of adults does not directly link with child nutritional outcomes. In general, child nutritional outcomes are closely related to complementary feeding patterns in addition to socio-demographic factors like poverty, education, physical exercises.

The estimates of the adjusted confounders are presented in Table 4. Strong associations are found in the case of the age group with children Z-score of weight for height (coefficient -0.19 with *p*-value 0.00), weight for age (coefficient –0.06 with *p*-value 0.04), and height for age (coefficient -0.15 with *p*-value 0.000) as well as maternal education level with height for age (coefficient 0.31 with *p*-value 0.01).

Table 5 presents the odds ratios of nutritional outcomes in children in the food insufficient household group. The results show that children in the food insufficient households have higher odds of being mildly malnourished in the case of the child's height for age. The Z-scores of children's height for age in food insufficient households have higher odds of being moderate and severely malnourished. This may be because of existing chronic malnutrition in the study region.

Strong associations between the children's Z-score of different indicators of nutritional outcomes with food insecurity are observed (see Table 3). Figure 1 shows mean children's Z-score differences of weight for height in different age groups. Significant differences were found in both cases, that is, children from food insufficient (*p*-value 0.000) and children from sufficient (*p*-value 0.002) households. These results indicate that children from the food insufficient group and in the age group of 6-11 months suffer from mild malnourishment (mean Z-score: 1.09). The results confirm that children from the food sufficiency group and in the age group of 24-36 months also suffer from mild malnutrition (mean Z-score: -1.21). This could be due to the nutritional requirement of the children in the age group of 0-5 months being met by breast feeding but subsequently, complementary or supplement food in addition to the feeding practices being insufficient to meet the requirements for standard physical growth and development.

The mean children's Z-score is different in different age groups of height for age and is shown in Figure 2. There are no significant differences in both cases - children in the food insufficient and the food sufficient households. However, children from food insufficient households and in the age groups of 6-11 months and 24-35 months suffer from moderate malnutrition (Figure 2). Again, most of the age groups in both cases suffer from mild malnutrition except

Table 4. Estimate of confounding variables for child's anthropometric measures

Confounding variables	*Child weight for height Z score*		*Child height for age Z score*		*Child weight for age Z score*	
	Coefficients	*p-value*	*Coefficients*	*p-value*	*Coefficients*	*p-value*
Child age group [a]	-0.19*** (-0.24, -0.14)	<0.01	-0.06** (-0.13, -00)	0.04	-0.15*** (- 0.21, 0.10)	0.01
Child sex	0.08 (-0.09, 0.24)	0.36	-0.14 (-0.34, 0.05)	0.15	-0.10 (0.28, 0.07)	0.12
Maternal education	0.02 (-0.16, 0.21)	0.82	0.31*** (0.09, 0.53)	0.01	0.15 (-0.04, 0.35)	0.24

Notes: Values in parentheses indicate the 95% confidence interval; *** and ** indicates the probability at 1% and 5% levels; [a] indicates six different age groups such as 0-5, 6-11, 12-23, 24-47, 36-47 and 48-59 months.

Table 5. Odds ratio of children in food insufficient households

	Normal [a] *(Z-score ≥ -1)*	*Mildly malnourished (Z-score < -1 to ≥ -2)*	*Moderately malnourished (Z-score <- 2 to - ≥-3)*	*Severely malnourished (Z-score <-3)*
Child weight-for-height				
Food insufficient group N= 37	n= 19 (54.3%)	n=18 (45.7%)	n=0	n=0
Food sufficient group N= 410	n=227 (55.5%	n=152 (37.1%)	n=30 (7.1%)	n=1 (0.2%)
Odds ratio (95% CI)		1.46 (0.62, 3.16)	1	-
p-value		0.34	0.99	
Child height-for-age				
Food insufficient group N= 37	n= 9 (24.3%)	n= 10 (27%)	n= 12 (32.4%)	n= 6 (16.2%)
Food sufficient group N= 410	n=90 (22.2%)	n=155 (38%)	n= 120 (29.4%)	n= 45 (10.4%)
Odds ratio (95% CI)		0.70 (0.26, 1.85)	1.03 (0.40, 2.64)	1.38 (0.44, 4.29)
p-value		0.44	0.69	0.57
Child weight-for-age				
Food insufficient group N= 37	n=9 (24.3%)	n=13 (35.10%)	n=13 (35.1%)	n=3 (5.4%)
Food sufficient group N= 410	n=73 (17.8%)	n=175 (42.5%)	n=132 (32.3%)	n=30 (7.3%)
Odds ratio (95% CI)		0.70 (0.27, 1.86)	0.92 (0.34, 2.50)	0.57 (0.10, 3.15)
p-value		0.48	0.86	0.52

Notes: [a] base category is normal; CI means confidence interval. The significant association between maternal education levels with height for age is due to the fact that maternal education has an effect on income regeneration and children's feeding practices. Further, the significant relationship among the child age groups with child weight-for-height, weight-for-age and height-for-age may be because of the prevalence of acute and chronic malnutrition in the study region that was exposed to the phenotype as well as poverty which is closely related with complementary feeding practices of the children.

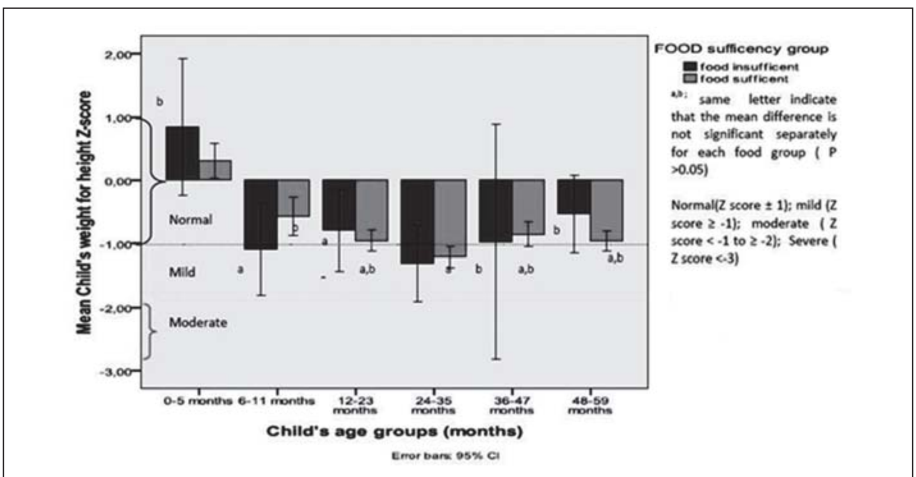

Figure 1. Z-score, child's weight-for-height

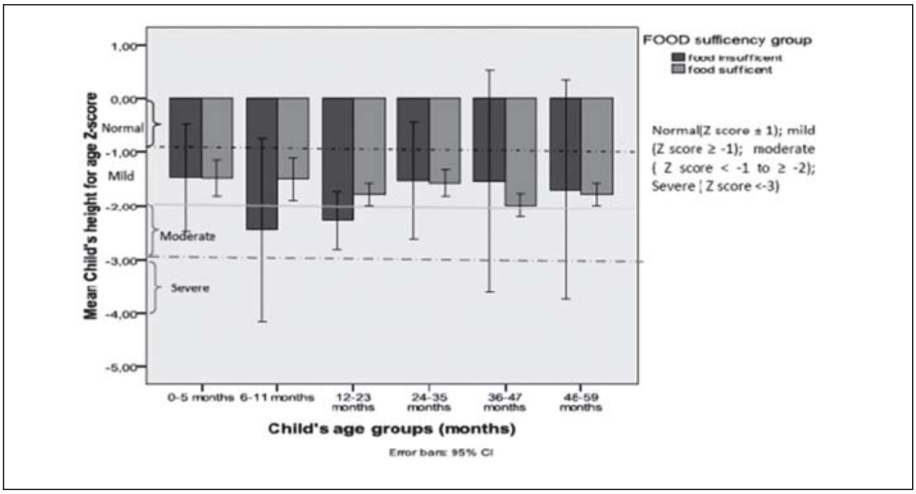

Figure 2. Z-score of children's height-for-age

for the age groups of 6-11 and 12-23 months from food insufficient households (Figure 2). The most striking point is that the children in these age groups suffer moderate malnutrition or moderate stunting which is evidence of the prevalence of chronic malnutrition in the region. In the case of weight-for-age (Figure 3), the mean differences in children's Z-scores in different age groups are significantly different for both food insufficient (*p*-value 0.002) and food sufficient households (*p*-value 0.000).

Children within the age group of 0-5 months are in the normal-nourished group in both food insufficient (mean Z-scores: -0.41) and food sufficient households (mean Z-scores: -0.84). The Z-score of weight for age indicates that children in the 6-11 months age group from food insufficient households suffer from moderate malnutrition (mean Z-score: -2.69) (see Figure 3). Meanwhile children in the age group of 24 -35 months for both food sufficient and the food insufficient

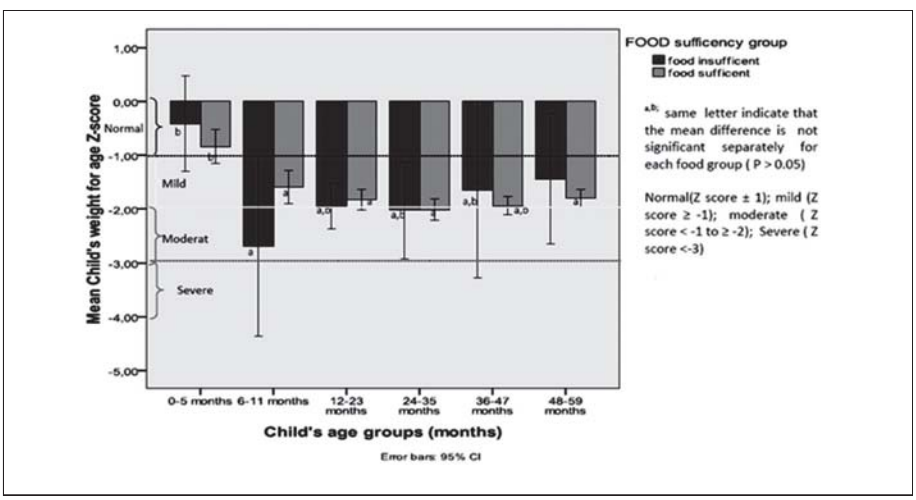

Figure 3. Z score of child's weight-for-age

households suffer from moderate malnutrition (Figure 3). All other age groups in both cases are on average affected by mild malnourishment. The plausible explanation is that breast milk fulfils the requirements for children up to the age of 5 months but subsequently the feeding practices in both food sufficient and insufficient households are not sufficient to meet the standard requirements for physical growth. Besides, the existence of chronic malnutrition could be responsible for this occurrence.

DISCUSSION

As indicated earlier, significant time and resources have been devoted to developing measures of food insufficiency and nutritional outcomes. We acknowledge that the development of methods for measuring food insufficiency and nutritional outcome is a continuous process. Researchers have therefore been working to progress the 'state of art knowledge' by critically evaluating the strong points and avoiding the limitations of previous methods (Savy *et al*., 2005). Many nutrition researchers (i. e., Campbell *et al.*, 2010; Ruel 2002; Savy *et al.*, 2005; Thorne-Lyman *et al*., 2010) advocate that dietary diversity could be a good indicator of nutrient adequacy because data are fairly easy to collect, and associated with dietary quality, energy intake, and food security. Hence, this study is an attempt to contribute to the growing literature on food insecurity measures based on non-staple dietary diversity to the nutritional outcome in children and mothers. However, this study highlights several underlying issues of interest, which are discussed below:

First, the study shows that dietary diversity from non-staple food has little predictive power on the nutritional outcome in mothers. Again, the findings indicate that odds of undernutrition in mothers in food insufficient households are higher. This effect has been studied widely (Weinreb *et al.*, 2002; Vozoris *et al.*, 2003). However, the absence of significant positive associations between food insufficiency and measures of underweight or undernutrition after adjusting for potentially confounding variables may be due to the methodological differences, for example, the sample size differences, deviation of food insecurity measurement, disparity in the definition of BMI and MUAC cut-off points that denote underweight and malnutrition, as well as the problem of controlling other potential confounding variables. However, our results agree with the findings of Bhattacharya *et al.* (2004); and Vozoris *et al.* (2003). These studies explicitly concluded that researchers should be conscious of the quantity of non-staple food consumption. Bloem *et al.* (2010) had mentioned that Bangladeshi people get higher calories from consumption of rice, rather than from a diversity of food items, and this increases the risk of malnutrition. According to Lalita, Sanjib & Biplab (2007), the consumption of protein and micronutrient-rich foods such as fish, meat, eggs, milk, dairy products, fats and oil is low in rural poverty-prone regions in Bangladesh. In Bangladesh, cereals make up the staple food (62 %) of the diet, followed by non-leafy vegetables, roots and tubers, which together comprise more than four-fifths of the rural people's diet (FAO, 2003).

Second, the study shows that the stated frequency of non-staple dietary food intake has a very little predictive power in children's nutritional outcomes. There are several possible explanations for this. First, it is possible that the nutritional outcomes of the children (0-59 months) are not as closely associated with dietary diversity of adults. Similar conclusions have been drawn by other studies (Shaha *et al.* 2008; Islam, Rahman & Mahalanabis, 1994) Shaha *et al.* (2008) reveal that child feeding patterns are not closely linked with adult feeding as it is closely tied with traditional culture. A similar notion has also been expressed by Islam *et al.* (1994).

Third, other studies (Leary *et al.*, 2006; Black *et al.*, 2008) have illustrated that children's physiological processes and genetic origin translating into nutritional outcomes are complex, rendering detection difficult. Geographical variation is also a determining factor of body size (Leary *et al.*, 2006; Black *et al.*, 2008). The children in this study area have been suffering from chronic severe malnutrition, as reflected by the high prevalence of stunting. This precarious nutritional status of the children may be manifested throughout life and also could be transmitted to the next generation (Victoria et al., 2008, Weinreb *et al.* (2002). These studies have widely illustrated that children with nutritional deficiencies show poor physical capabilities in adulthood due to their smaller body mass, which in turn has repercussions on productivity.

Fourth, this study showed that maternal education level has good predictive power both on the children and mother's nutritional outcomes. Similar results were found by Bloem *et al.* (2004) and Islam *et al.* (1994). The former reported a significant positive effect of maternal education on child Z-scores of height-for-age in the urban slums in Bangladesh. Smith and Haddad (2000) argued that improvements in women's education have contributed by far the most, accounting for 43% of the reduction in child malnutrition while improvements in per capita food availability contributed about 26%. Hence, in the future, policy makers and researchers should pay special attention to mother's basic nutritional education in any sustainable intervention programme against malnutrition,

Admittedly, there are some limitations in this study. It is very difficult to measure household food insecurity precisely. The accuracy of this definitive measure of food insecurity is limited by difficulties to access accurate information from the respondents. It is also noted that respondents may not answer truthfully due to various non-controllable reasons such as (i) the shyness to say they are hungry, (ii) the anticipation that they might get assistance if they say they are hungry, and (iii) the lack of interest of the poor people to participate in an interview. However, the potential bias can be minimised through close contact with the respondents and careful construction of the questionnaire (Frongillo *et al.*, 2003).

CONCLUSION

While qualitative and quantitative approaches have reported on household food insecurity and its association with nutritional outcomes in Bangladesh (Shaha *et al.*, 2008; Thorne-Lyman *et al.*, 2010), the present study has attempted to contribute to an understanding of the role of non-cereal food consumption in relation to food insecurity and nutritional outcomes in mothers and children. Non-cereal dietary diversity was found to have little predicative power on BMI and MUAC of mothers and on the nutritional outcomes of children. Maternal education is strongly associated with mothers' and children's nutritional outcomes. Therefore, long-term sustainable intervention efforts should focus on maternal education. More studies are necessary to capture a wider spectrum of socio-demographic factors that may impinge on household food insecurity.

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REFERENCES

Arimond M & Ruel M (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr* 134: 2579–85

Bhattacharya J, Currie J & Haider S (2004). Poverty, food insecurity, and nutritional outcomes in children and adults. *J Health Econ* 23(4): 839-862

Black RE, Allen LH, Bhutta ZA, Laura E, Caulfield LE, de Onis M, Ezzati M, Mathers C & Rivera (2008). Maternal and child under nutrition: global and regional exposures and health consequences. *Lancet* 07: 61692-4

Bloem MW, Moench-Pfanner R, Graciano F, Stalkamp G & de Pee S (2004). Trends in Health and Nutrition Indicators in the Urban Slums of Three Cities in Bangaldesh, Compared to its Rural Areas. Paper No. 83, Globalization of Food Systems in Developing Countries: Impact on Food Security and Nutrition FAO, Rome: FAO Food and Nutrition Division. *ftp://ftp.fao.org/docrep/fao/007/y5736e/y5736e00.pdf* [accessed 16 August 2010].

Campbell AA, de-Pee S, Sun K, Kraemer K, Thorne-Lyman A, Moench-Pfanner R, Sari M, Akhter N, Bloem MW & Semba RD (2010). Household rice expenditure and maternal and child nutritional status in Bangladesh. *J Nutr* 140(1): 189S-94S

Food and Agriculture Organization(FAO) (2003). Launch of Expert Report on Diet, Nutrition and Prevention of Chronic Diseases. Nutrition Planning, Rome: Assessment and Evaluation Service, Food and Nutrition Division

Ferro-Luzzi A & James, WPT (1996). Adult malnutrition: simple assessment technique for use in emergencies. *Br J Nutr* 75: 3-10

Frongillo EA (1999). Validation of measures of food insecurity and hunger. Symposium: Advances in Measuring Food Insecurity and Hunger in the US. *J Nutr* 129: 506S-509S

Frongillo, EA, Chowdhury N, Ekstrom EC & Naved RT (2003). Understanding the experience of household food insecurity in rural Bangladesh leads to a measure different from that in other countries. *J Nutr* 133: 4158-4162.

HKI (2002). Halen Keller International. Nutrition and Health Surveillance in Rajshahi Division. Nutritional Surveillance Project Bulletin No. 3 HKI, Dhaka, Bangladesh.

HKI (2006). Halen Keller International. Household and Community Level Determinants of Malnutrition in Bangladesh, Nutritional Surveillance Project Bulletin No. 15 HKI, Dhaka, Bangladesh.

Hossain M, Naher F & Shahabuddin Q (2005). Food security and nutrition in Bangladesh: progress and determinants. *J Agr Dev Econ* 2: 103–32

Idler EL, & Benyamini Y (1997). Self-reported health and mortality: a review of twenty seven community studies. *J Health Soc Behav* 38: 21-37.

Islam MA, Rahman MM & Mahalanabis D (1994). Maternal and socio-economic factors and the risk of severe malnutrition in a child: a case-control study. *Eur J Clin Nutr* 48 (6): 416-24.

Lalita B, Sanjib KS & Biplab KN (2007). Food-Based Nutrition Strategies in Bangladesh. Experience of Integrated Horticulture and Nutrition Deve-lopment. Thailand: *FAO. www.fao.org/docrep/010/ag126e/AG126E00.HTM*

Leary S, Fall C, Osmond C, Lovel H, Campbell D, Eriksson J, Forrester T, Godfrey K, Hill J, Jie M, Law C, Newby R, Robinson S & Yajnik C (2006). Geographical variation in relationships between parental body size and off spring phenotype at birth. *Acta Obstet Gynecol Scand* 85: 1066–79

Lee JS & Frongillo EA (2001). Nutritional and health consequences are associated with food insecurity among US elderly persons. *J Nutr* 131: 1503-1509

Pryer JA & Rogers S (2006). Epidemiology of under nutrition in adults in Dhaka slum households, Bangladesh. *Eur J Clin Nutr* 60 (7): 815-22.

Rahman A, Iqbal Z, Bunn J, Lovel H & Harrington R (2004). Impact of maternal depression on infant nutritional status and illness: a cohort study. *Arch Gen Psychiatry* 61(9): 946-52

Rose D and Oliveira V (1997). Nutrient intakes of individuals from food-insufficient households in the United States. *Am J Public Health* 87: 1956–1961

Ruel M (2002). Is Dietary Diversity an Indicator of Food Security or Dietary Quality? A Review of Measurement Issues and Research Needs. FCND Discussion Paper No. 140. Washington, DC: International Food Policy Research Institute

Shaha KK, Frongillo EA, Alam DS, Arifeen SE, Persson LA & Rasmussen KM (2008). Household food security is associated with infant feeding practices in rural Bangladesh. *J Nur* 138:1383-139

Savy Y, Martin-Prével M, P Sawadogo P, Y Kameli Y & Delpeuch F (2005). Use of variety / diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *Eur J Clin Nutr* 59: 703–716

Shahabuddin Q & Ali Z (2006). Natural Disasters, Risks, Vulnerability and Persistence of Poverty: An Analysis of Household Level Data. PRCPB Working Paper No. 15. Bangladesh Institute of Development Studies, Dhaka, Bangladesh.

Smith LC & Haddad LJ (2000). Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis. Research Reports 111, International Food Policy Research Institute: Washington D.C.

Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, Kraemer K, Akhter N, de-Pee S, Moench-Pfanner R, Sari M & Bloem MW (2010). Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. *J Nutr* 140: 182S-8S

Victoria GC, Adair L, Fall C, Hallal PC, Martorell R, Richter L & Sachdev, HS (2008). Maternal and child undernutrition: consequences for adult health and human capital, maternal and child undernutrition. *Lancet* 2371: 340–57.

Vozoris NT, Valerie S & Tarasuk VS (2003) Household food insufficiency is associated with poorer health. *J Nutr* 133: 120-126

Weinreb L, Cheryl W, Jennifer P, Scott R, Hosmer D, Sagor L & Gundersen C (2002). Hunger: its impact on children's health and mental health. *Pediatrics* 110 (4): 41

WHO (World Health Organization) (1995). World Health Organization. Physical Status: The Use and Interpretation of Anthropometry: WHO Technical Report Series 854, Geneva: World Health Organization

Zug S (2006). Monga seasonal food insecurity in Bangladesh - bringing the information together. *J Social Studies* 111: 791-796.