

Assessment of Micro Nutritional Malnutrition in an Urban Area of Bangladesh among the Adult Population on the Basis of Individual Dietary Diversity Score (IDDS)

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Abstract

Background/objectives: Micro nutritional malnutrition is a global public health problem contributing directly and indirectly to morbidity and mortality of billions of peoples worldwide. Vitamin and mineral deficiencies are widespread, affecting one third of the global population. The general objective of the study was assessment of average Individual Dietary Diversity Score (IDDS) in selected adult urban population.

Subjects and methods: In this study 300 subjects of which 150 male and 150 female were studied. Among 300 subjects 100 were hostel student, 100 were non hostel student and 100 were slum people with ranges were 18-30 years of age. The Study was conducted in an urban area of Dhaka. Pre-structured questionnaire was developed with relevant information's. The food intake patterns of the subjects were recorded by 24 hours recall method and used nine food groups for IDDS information. IDDS was calculated according to Low IDDS (<3 Food groups), Moderate IDDS (4-5 Food groups) and High IDDS (>6 Food groups).

Results: Our Results showed that 150 male out of 300 participants IDDS and FCS were 4.15 ± 0.88 , 6-2, 9.88 ± 1.88 , 15-5. On the other hand, among 150 female their IDDS and FCS were 4.28 ± 1.2 , 7-2, 9.43 ± 2.38 , 15-4. P value of IDDS and FCS were 0.064 and 0.069. Education was the highly significant ($p < 0.001$) associated with Food Consumption Score (FCS) and sex was significant ($p < 0.03$) with Food Consumption Score (FCS).

Conclusion: Academic qualification of the family is associated with Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS).

Keywords: Micronutrients; Dietary diversities; Malnutrition; IDDS and FCS

Introduction

Dietary diversity has long been recognized as a key element of high quality diets because all people need a variety of foods to meet requirements for essential nutrients. Lack of dietary diversity is a particularly severe problem in developing countries where diets are predominantly based on starchy staples and little or no animal products. These plant-based diets tend to be low in a number of micronutrients including zinc, and those micronutrients often exist in the forms with low bioavailability [1]. It reflects household access to a wide variety of foods, and is used as a proxy of the nutrient adequacy for individuals [2,3]. The two dietary diversity scores recommended by FAO are the Household Dietary Diversity Score (HDDS) based on twelve food groups and the Women's Dietary Diversity Score (WDDS) as IDDS based on nine food groups (FAO, 2011). Twelve food groups were included in the HDDS (Household Dietary Diversity Score). These twelve food groups are Cereals, White tubers and roots, Vegetables, Fruits, Meat, Eggs, Fish and other seafood, Legumes, nuts and seeds, Milk and milk products, Oils and fats, Sweets, Spices, condiments and beverages. The last two groups (sweets; spices, condiments and beverages) are indicators of economic access to food, but do not contribute substantially to micronutrient intake. According to FAO, European Union, 2011 [4] they included that nine food groups in IDDS (Individual Dietary Diversity Score) as WDDS. These nine food groups are starchy staples, dark green leafy vegetables, other vitamin A rich fruits and vegetables, other fruits and vegetables, Organ meat, meat and fish, eggs, legumes, nuts and seeds and milk and milk

products. According to FANTA, 2006 said eight food groups included in Children Dietary Diversity Score such as Grains, Roots and tubers, Vitamin A-rich plant food, Other fruits or vegetables, Meat, Poultry, Fish, Seafood, Eggs, Pulses/legumes/nuts, Milk and milk products and Foods cooked in oil/fat [5]. Lack of dietary diversity is a particularly severe problem among poor populations in the developing world, because their diets are predominantly based on starchy staples and often include little or no animal products and few fresh fruits and vegetables. These plant-based diets tend to be low in a number of micronutrients, and the micronutrients contain are often in a form that is not easily absorbed. Although other aspects of dietary quality, such as high intakes of fat, salt, and refined sugar, have not typically been a concern in developing countries, recent shifts in global dietary and activity patterns resulting from increases in income and urbanization are making these problems increasingly relevant for countries in

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Received November 21, 2014; **Accepted** March 24, 2015; **Published** March 31, 2015

Citation: Islam NM, Akther F, Saliheen Sultana SS, Nahar Q (2015) Assessment of Micro Nutritional Malnutrition in an Urban Area of Bangladesh among the Adult Population on the Basis of Individual Dietary Diversity Score (IDDS). J Nutr Food Sci 5: 362. doi:10.4172/2155-9600.1000362

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transition as well [6,7]. Dhaka is the national capital and the largest city of Bangladesh. 30 million people, over 20% of the total population of Bangladesh, live in urban areas; By the year 2005 this figure will have raised to 46 million and by 2015 projections indicate that 68 million (more than a third of the total population of Bangladesh) will live in urban areas. In the absence of commensurate industrialization and on the account of little planned urban or spatial development, this rapid expansion of the urban population has serious implication for physical and socio-economic conditions for the country's cities [8].

Over the last decades, Bangladesh has made considerable progress in increasing national level food availability and individual level energy intake. Nevertheless, the intake of energy and other essential nutrients is still far below the nutrient requirements and recommended dietary allowances. Diets are largely imbalanced with the staple food cereals contributing around 73% [9] of total energy intake and a substantial proportion of dietary protein. In addition to imbalances in macronutrient intakes, diets are largely deficient in micronutrients, essential fatty acids and individual amino acids. Partly as a consequence of the paucity of diets, there is a high prevalence of malnutrition notably among young children and mothers along with emerging problems of diet related chronic diseases in the population. Diet plans that identify the quantities of different foods to be consumed to provide the human body with the required energy and nutrients play an important role in supporting long-term planning for balanced food intake but are not yet available for Bangladesh. Policy makers thus lack an important instrument with which to assess the adequacy of food intake and undertake diet planning [10].

Materials and Methods

The most commonly used method to measure dietary diversity is count one score for consumption, one food group out of 10 food groups, known as dietary diversity score (DDS) [11,12] consumed over a reference period, usually ranging from 1 to 3 days, sometimes 7 days [13]. The calculation of score is different if used at household or individual level. The household dietary diversity score (HDDS) reflects the economic ability of a household to consume a variety of foods, whereas individual dietary diversity score (IDDS) aims to capture nutrient adequacy. Andrew, et al., [14] expressed that in Bangladesh there is associations between a simple dietary diversity score and commonly used indicators of socioeconomic status.

Name of the study: Cross-sectional study.

Sample size calculation: Samples were estimated by using the following formula.

$$\text{Formula, } n = \frac{z^2 pq}{d^2}$$

Where, P is the current prevalence of low IDDS which is about 0.5(50%) and q is the proportion of attendants which is (1-0.5) and z value is 1.96 at 95% confidence interval and d is the difference of interest will be kept at 5% level.

$$\begin{aligned} n &= \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} \\ &= \frac{3.8416 \times 0.5 \times 0.5}{0.0025} \\ &= 384.16 \end{aligned}$$

Study population

In this study 300 subjects of which 150 male and 150 female were studied. Among 300 subjects 100 were hostel student, 100 were non-hostel student and 100 were slum people with ranges were 18-30 years of age.

Area of subject collection

- Tejgaon slum, Tejgaon, Dhaka-1215
- Home Economics College Hostel, Azimpur, Dhaka
- Dhaka University Hall
- Azimpur area, Dhaka
- Shabag area, Dhaka

Study period: May, 2012 to April, 2013.

Development of questionnaire

A standard questionnaire was developed in accordance with the study objectives to obtain relevant information regarding dietary intake, socio-economic status, self-occupation, family size and number of family member etc. Anthropometric indices such as height and weight were included in the questionnaire to obtain data from the individual who were 18-30 years of age.

Questionnaire design and final trial

Before starting the final survey, the initial questionnaire was pre-tested among the respondent in another area of different economic status who were unaware about the study. Then it was modified as required and finalized for collection of data from the selected study population.

Collection of socio-economic information

The socio-economic status such as age, educational qualification, and family size, number of family member, monthly income and occupation pattern were obtained mainly from the respondent. Information's were recorded in the respective places of the questionnaire. The purpose of the study was explained to each respondent. After having permission from them, the data were collected.

Collection of anthropometric data

To assess the nutritional status the anthropometric measures such as height, weight and BMI were taken.

Height: Standing height was measured using appropriate scales (Detect-Medic, Detect scales INC, USA) without shoes. The patient was positioned fully erect, with the head in the Frankfurt plane (with the line connecting the outer canthus of the eyes and the external auditory meatus perpendicular to the long axis of the trunk); the back of the head, thoracic spine, buttocks, and heels touched the vertical axis of the anthrop meter, and the heels were together. Height was recorded to the nearest 5 millimeter. If the reading fell between two values, the lower reading was recorded.

Weight: The balance was placed on a hard flat surface and checked for zero balance before measurement. The subjects were in the center of the platform wearing light cloths without shoes. Weight was recorded to the nearest 0.5 kg.

BMI: BMI of the subjects were calculated as the weight in kg divided by the square of height in meters. The widely used BMI classification was followed in the study.

Collection of dietary information

The food intake patterns of the subjects were recorded by 24 hrs recall method and used nine food groups for IDDS information. The 18-30 years of age male and female were the respondents. The interviews included a detailed description of the foods eaten, the cooking method, and brand names (e.g. for milk consumed or other processed snack foods). The amount consumed by the respondent was estimated, expressed in terms of cups, spoons, matchbox pieces, and other common household utensils. The respondents were shown visual aids to assist them in accurately reporting food intake. For mixed recipes, the respondent was asked how the food was prepared and how much of the visible components (e.g. pieces of meat, vegetables etc.) were eaten by them.

Calculation of IDDS and FCS

For calculation of IDDS nine food groups were included in the questionnaire. IDDS was calculated according to,

- Low IDDS <3 Food groups
- Moderate IDDS 4-5 Food groups
- High IDDS >6 Food groups

The frequency weighted diet diversity score or Food consumption score (FCS) was calculated using the frequency of consumption of different food groups consumed by a Household / individual during the 7 days before the survey. In this study FCS was calculated consumption of different food groups consumed by an individual during the 1 day before the survey. In this study definitive Food groups were also calculated by addition of definitive Weight e.g. Main staples by 2, pulses by 3, Vegetables by 1, Fruit by 1, Meat and fish by 4, and Milk by 4 by following standard FCS profile.

Consumption of fortified foods

Fortified foods are not taken into consideration in the questionnaire. However, it can be useful to obtain information on the local availability and use of fortified foods, particularly those fortified with iron or vitamin A.

Nutrition and food biodiversity

Food biodiversity is defined as the diversity of plants, animals and other organisms used as food, covering the genetic resources within species, between species and provided by ecosystems [15] (FAO, 2011). Information on food biodiversity can be collected by expanding one or more of the dietary diversity food groups of the questionnaire.

Data coding, editing and entry

After collection of raw data through interview and observation it was cleaned and checked for analysis. Data entering into the computer was preceded. To enter and analysis of data software used in computer were SPSS (Version 11.5).

Data analysis

All variables were checked for distribution. Appropriate statistical test were performed to look for the differences.

Results

According to our result, we were found that respondent's regarding age, height, weight, BMI, IDDS, total FCS were 22.6 ± 3 , 30-18, 160 ± 9 , 183-136, 53 ± 10 , 82-31, 21 ± 3 , 29-14, 4.4 ± 1 , 7-2, 9.7 ± 2 , 15-7 (Table 1).

We found that all participants consumed Starchy staples, 27.7% consumed dark green leafy vegetables and 38.7% consumed other Vitamin A rich fruits and vegetables (Table 2). We found that among 150 male their IDDS and FCS were 4.15 ± 0.88 , 6-2, 9.88 ± 1.88 , 15-5. On the other hand, among 150 female their IDDS and FCS were 4.28 ± 1.2 , 7-2, 9.43 ± 2.38 , 15-4. p value of IDDS and FCS were 0.064 and 0.069 (Table 3). Age, BMI, IDDS and FCS of the Hostel Student Non Hostel Student Slum People were 21 ± 1.84 , 21 ± 2.4 , 4.41 ± 0.9 , 9.7 ± 22 (Mean \pm SD) 23 ± 3 , 22 ± 3 , 5 ± 0.92 , 11 ± 2 (Mean \pm SD), $23 \pm 419 \pm 2.75$, 3.7 ± 0.95 , 8.41 ± 1.7 (Mean \pm SD) respectively. IDDS and FCS were highly Significant in Non Hostel Student vs. Slum People, Slum People vs. Non Hostel Student and Non Hostel Student vs. Hostel Student ($p < 0.001$). On the hand, only BMI was highly Significant in Slum People vs. Non Hostel Student ($p < 0.001$) (Tables 4 and 5).

Discussion

In this study, 300 subjects of whom 100 were hostel student, 100 were non hostel student and 100 were slum people with ranges 18-30 years of age. The specific objectives if this study were to assess the gender, religion, educational qualification, family status, family member and monthly income among the study participants. To assess the age, nutritional status (BMI), Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS) of the participants and to

Variables	Mean \pm SD	Range	
		Maximum	Minimum
Age (yrs)	22.6 ± 3	30	18
Height (cm)	160 ± 9	183	136
Weight (kg)	53 ± 10	82	31
BMI	21 ± 3	29	14
IDDS	4.4 ± 1	7	2
FCS	9.7 ± 2	15	7

Table 1: Distribution of respondents according to average age, height, weight, total IDDS and FCS.

Variables		No	Percent
Starchy staples	Yes	300	100
	No		
Dark green leafy vegetables	Yes	83	27.7
	No	217	72.3
Other vitamin A rich fruits and vegetables	Yes	116	38.7
	No	184	61.3

Results were expressed number and percent.

Table 2: Distribution of respondents (300) according to Starchy staples, Dark green leafy vegetables and other vitamin A rich Fruits and vegetables consumption.

Gender		IDDS	FCS
Male	Mean	4.51	9.88
	N	150	150
	SD	0.88	1.88
	Maximum	6	15
	Minimum	2	5
Female	Mean	4.28	9.43
	N	150	150
	SD	1.2	2.38
	Maximum	7	15
	Minimum	2	4
p value			
Male vs. Female		0.064	0.069

Results were expressed range and Mean \pm SD

Table 3: Distribution of respondents (300) according to IDDS and FCS in relation to gender.

Variables	B	T	p value
Age	0.04	1.17	0.24
Gender	-0.51	-2.09	0.03
Education	0.76	5	0.001
Religion	0.17	0.3	0.76
BMI	-0.05	-1.19	0.23
Family status	0.39	0.6	0.5
Family member	-0.04	-0.52	0.6
Occupation	0.01	0.2	0.83
Monthly income	4.29E-06	0.99	0.31

Dependent variable: FCS

Table 4: Distribution of respondents (300) according to the factors associated with food consumption Score (FCS).

Variables	Mean ± SD			
	Age	BMI	IDDS	FCS
Hostel Student	21 ± 1.84	21 ± 2.4	4.41 ± 0.9	9.7 ± 22
Non Hostel Student	23 ± 3	22 ± 3	5 ± 0.92	11 ± 2
Slum People	23 ± 4	19 ± 2.75	3.7 ± 0.95	8.41 ± 1.7
P value				
Non Hostel Student vs. Slum People	0.05	0.003	0.001	0.001
Slum People vs. Non Hostel Student	1	0.001	0.001	0.001
Non Hostel Student vs. Hostel Student	0.3	0.15	0.001	0.001

Results were expressed Mean ± SD p<0.05 was considered as a test of significant.

Table 5: Distribution of respondents according to Age, BMI, IDDS and FCS among hostel student, non-hostel and slum people.

assess the risk factor associated with Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS).

The main finding of this study was the risk factor associated with Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS). Education was highly significant both Individual Dietary Diversity Score (IDDS) and Food Consumption Score (FCS) (p<0.001). On the other hand occupation was only significant for IDDS (p<0.05). IDDS and FCS were highly Significant in Non Hostel Student vs. Slum People, Slum People vs. Non Hostel Student and Non Hostel Student vs. Hostel Student (p<0.001).

In 285 Malaysian households they showed Food variety scores (FVS) and dietary diversity scores (DDS) based on foods consumed weekly using a food frequency questionnaire. The scoring system of FVS and DDS was based on a scale of 0-7 and 0-6 respectively. The mean household FVS and DDS was 164.1 Å ± 93 and 6 Å ± 0.4. The age of respondents (husbands or wives; p<.01), sex (p<0.05), and household food expenditure (p<0.01) had a significant influence on both FVS and DDS. The food-intake pattern of Malaysian households showed that their typical diets had high protein and energy-based foods Households [15]. Another study showed in Australia on adolescent aged 12-18 yrs who completed a 108-item FFQ (n=764). Dietary patterns were identified using factor analysis and associations with socio demographic factors and behavioral and health outcomes investigated. The high fat and sugar pattern was positively associated with being male (P<0.001), the vegetables pattern was positively associated with rural region of residence (P<0.004), and the fruit, salad, cereals, and fish pattern was inversely associated with age (P<0.03). Dietary patterns were not associated with socioeconomic indicators. The fruit, salad, cereals, and fish pattern was inversely associated with diastolic blood pressure (P<0.0025) after adjustment for age, sex, and

physical activity in adolescents >16 yrs [16]. Another objective of this study was the assessment of nutritional status of the participants. Result showed that BMI of non-hostel students were 22 ± 3 (Mean ± SD) ,hostel students were 21 ± 2.4 (Mean ± SD) and slum people were 19 ± 2.75 (Mean ± SD). Only BMI was highly Significant in Slum People vs. Non Hostel Student (p<0.001). Parvin Mirmiran et al. 17 showed that adolescent BMI was higher (19.81 ± 4.08 vs. 18.95 ± 3.30 Kg/m², P <0.01) than others. In a rural area in Burkina Faso observed that a clear relationship was shown between both FVS and DDS (in terciles) and most nutritional indices. Women with a FVS in the lowest tercile had a mean BMI of 20.1, while those in the highest tercile had a BMI of 20.9 (P<0.009). Those in the lowest tercile of DDS had a 22.8% prevalence of underweight vs. 9.8% in the highest tercile (P<0.0001). The latter relationship remained significant even when the subjects' socio-demographic and economic characteristics were accounted for 18. In Burkina Faso a study was done on 557 urban women and found that Mean BMI of the women was 24.264.9 kgm⁻² and 37% of them were overweight or obese (BMI=25 kgm⁻²) 19. A study on 286 females aged 18-80 years in 13 District of Tehran, Iran showed that energy intake was a strong predictor of the mean probability of adequacy in models controlled for age, BMI, education level and job status (model R²=0.53). Adding the number of servings from each of the food group to the models significantly improved the model fit (model R²=0.59) [17-19]. Adding the dietary diversity score improved the model fit significantly (model R²=0.64). Dairy diversity score had the strongest association with improved nutrient adequacy [20]. Among children 12-36 months of age in rural Western Kenya, dietary diversity based on a count of individual foods consumed, was significantly associated with weight-for-age, height-for-age, and weight for- height Z scores as well as triceps skin fold and mid-upper-arm circumference [21]. Another study was done by Rah et al. [22] in Bangladesh and they observed total 165111 under-fives who participated in the National Surveillance Project in 2003-2005. The association between stunting and DDS was determined adjusting for confounders using logistic regression models. One-half of the children were stunted. Those having diarrhea in the past week and coming from families with low socioeconomic status were more likely to have decreased diversity (P<0.05). Reduced dietary diversity is a strong predictor of stunting in rural Bangladesh.

This study showed that in hostel students their IDDS were 4.41 ± 0.9, range 2-7 and FCS were 9.7 ± 22, range 4-15. IDDS were 5 ± 0.92; range 3-7 and FCS were 11 ± 2, range 6-15 for non-hostel participants. Interviewer of slum peoples showed that IDDS were 3.7 ± 0.95; range 2-6 and FCS were 8.41 ± 1.7, range 5-15. on the other hand, average male (N=150) IDDS was 4.41 ± 0.88, range 6-2 and FCS was 9.88 ± 1.88, range was 5-15. Similarly, average female IDDS was 4.28 ± 1.2, range 2-7 and FCS was 9.43 ± 2.38, range 4-15. So it can be said that slum peoples had lower IDDS and FCS than other two groups. On average female respondents had lower IDDS and FCS than male respondents, p value of IDDS and FCS of male and female were 0.064 and 0.069 respectively. Food variety scores (FVS) and dietary diversity scores (DDS) were estimated based on foods consumed weekly by 285 Malaysian households using a food frequency questionnaire. The scoring system of FVS and DDS was based on a scale of 0-7 and 0-6 respectively. The mean household FVS and DDS was 164.1 Å ± 93 and 6 Å ± 0.4. The age of respondents (husbands or wives; p<.01), sex (p<0.05), and household food expenditure (p<0.01) had a significant influence on both FVS and DDS. The food-intake pattern of Malaysian households showed that their typical diets had high protein and energy-based foods Households [15]. Food Consumption Score (FCS) in Bangladesh Context, 2009 created four food consumption group based on 7 days household survey such as Poor consumption (≤28),

Borderline Consumption (>28 and ≤42), Acceptable Consumption (>42), an additional threshold was introduced to distinguish the acceptable households between acceptable low (43-52) and acceptable high (>52). But no study was found on individual level FCS IN Bangladesh [15-18].

Among 300 respondents all consumed starchy staples. 27.7% consumed dark green leafy vegetable, 38.7% consumed other Vitamin A rich fruits and vegetables, 50.7% consumed other fruits and vegetable, 49.3% consumed organ meat, 90.3% consumed meat and fish, 42.7% consumed eggs, 70.3% consumed Legumes, nuts and seeds, and 15.7% consumed Milk and milk product. Parvin Mirmiran, et al. [19] demonstrated that mean ± SD of dietary diversity score (DDS) was 6.25 ± 1.08 (range 0-10). The maximum and minimum scores of dietary diversity were related to the fruit (1.46 ± 0.61) and bread-grain (0.95 ± 0.27) groups, respectively. A study on 286 females aged 18-80 years in 13 District of Tehran, Iran showed that whole grain diversity score mostly correlated with protein and vitamin B2 ($r=0.35$, $p<0.05$). Fruit diversity score was correlated with vitamin C ($r=0.44$, $p<0.05$). Dairy diversity score was correlated with calcium intake ($r=0.54$, $p<0.05$). Meat diversity score was correlated with protein intake ($r=0.34$, $p<0.05$). Most subjects failed to meet vitamin B6, zinc, magnesium, calcium, copper, and vitamin B12 adequacy. Parvin Mirmiran et al., [17] in Burkina Faso a study was done on 557 urban women and found that the mean DDS-9 and DDS-22 were 4.961.0 and 6.561.8 food groups, respectively. In the high tertile of DDS-22, more women consumed fatty and sweetened foods, fresh fish, non-fatty meat and vitamin-A-rich fruits and vegetables. The DDS-9 was not associated with the women's socio-economic characteristics whereas the DDS-22 was higher when the women were younger, richer and had received at least a minimum education [20-22].

Limitation of the Study

- Sufficient sample sizes were not included in this study.
- Further a large study is needed in all age group in different society to make a more conducive conclusion and recommendation.
- The interviewee can over or under report intakes of certain food groups or provide a poor memory record of variety and quantities of food consumed.
- Some of the respondent refused to participate in anthropometric measurement. In that case, it was needed to convince them and make favorable response, in order to obtain data and perform interview ultimately.
- It was observed that some of the respondents did not feel comfortable during the time of data collection.
- Survey period was too short and single survey limits to comment on the real socio-economic condition of the studied.

References

1. Ruel MT (2003) Operationalizing dietary diversity: a review of measurement issues and research priorities. *J Nutr* 133: 3911S-3926S.
2. Swindale A, Bilinsky P (2006) Household dietary diversity score (HDDS) for measurement of household food access: indicator guide, Version 2. Food and Nutrition Technical Assistance Project, (FANTA), Academy for Educational Development (AED), Washington, DC.
3. Mirmiran P, Azadbakht L, Azizi F (2006) Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women. *J Am Coll Nutr* 25: 354-361.
4. European Union (2011) Guideline for measuring household and individual dietary diversity FAO.
5. FANTA (2006) Developing and validating simple indicators of dietary quality and energy intake of infants and young children in developing countries: Summary of findings from analysis of 10 data sets. working group on infant and young child feeding indicators. Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED), Washington, DC.
6. Popkin BM (1994) The nutrition transition in low-income countries: an emerging crisis. *Nutr Rev* 52: 285-298.
7. WHO/FAO (1996) Preparation and use of food-based dietary guidelines. Geneva: Nutrition Programme, World Health Organization.
8. Government of Bangladesh (1992) Report of the task forces on Bangladesh development strategies for the 1990 S.
9. BBS (2007) Report of the HIES 2005; HIES 2010 (upcoming).
10. Ruel MT (2003) Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. *Food Nutr Bull* 24: 231-232.
11. Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J (1987) The effects of variety in food choices on dietary quality. *J Am Diet Assoc* 87: 897-903.
12. Lowik MR, Hulshof KF, Brussaard JH (1999) Food-based dietary guidelines: some assumptions tested for The Netherlands. *Br J Nutr* 81 Suppl 2: S143-149.
13. Drewnowski A, Henderson SA, Driscoll A, Rolls BJ (1997) The Dietary Variety Score: assessing diet quality in healthy young and older adults. *J Am Diet Assoc* 97: 266-271.
14. Andrew L, Lyman T, Valpiani N, Sun K (2006) Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis 1-3. *J Nutr* 182-188.
15. Zainal Badari SA, Arcot J, Haron SA, Paim L, Sulaiman N, et al. (2012) Food variety and dietary diversity scores to understand the food-intake pattern among selected Malaysian households. *Ecol Food Nutr* 51: 265-299.
16. McNaughton SA, Ball K, Mishra GD, Crawford DA (2008) Dietary patterns of adolescents and risk of obesity and hypertension. *J Nutr* 138: 364-370.
17. Mirmiran P, Azadbakht L, Esmailzadeh A, Azizi F (2004) Dietary diversity score in adolescents - a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study. *Asia Pacific J Clin Nutr* 56-60.
18. Savy M, Martin-Prévès Y, Sawadogo P, 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. *European Journal of Clinical Nutrition* 703-716
19. Savy M, Martin-Prével Y, Danel P, Traissac P, Dabiré H, et al. (2008) Are dietary diversity scores related to the socio-economic and anthropometric status of women living in an urban area in Burkina Faso? *Public Health Nutr* 11: 132-141.
20. Mirmiran P, Azadbakht L, Azizi F (2006) MD. Dietary diversity within food groups: An indicator of specific nutrient adequacy in tehranian women. *Journal of the American College of Nutrition*, 25: 354-361.
21. Onyango A, Koski KG, Tucker KL (1998) Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers. *Int J Epidemiol* 27: 484-489.
22. Rah JH, Akhter N, Semba RD, de Pee S, Bloem MW, et al. (2010) Low dietary diversity is a predictor of child stunting in rural Bangladesh. *Eur J Clin Nutr* 64: 1393-1398.