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Is the use of a questionnaire on non-cereal foods consumption is reliable and valid to measure households' food insecurity: experience and understanding from chronically poverty prone region in Bangladesh

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Abstract

The objective of this study is to assess the reproducibility and validity of Food Frequency Questionnaire (FFQ) from non cereal dietary diversity for the identification of rural households' food insecurity from an in-depth understanding at Tista and Jamuna basin poverty prone region in Bangladesh. Data in different season from the Bangladesh Nutritional Surveillance Project, 2005 of Helen Keller International was used in this study. Pearson co-relation, regression analysis and Kruskal-wallis test were carried to understand about the reproducibility of the FFQ. Sensitivity and specificity and chi-square test were performed for the validity study. The resulted Pearson correlation between total meal consumption in different seasons and total energy consumption were found 0.83 and 0.81 respectively. During monsoon rice harvesting period (December-January) the mean calorie consumption from non-cereal food were remarkably decreases compare to all other seasons but the energy consumption form meat other than chicken are significantly increased ($p < 0.05$). Sensitivity and specificity were found 97.70% and 12.50% respectively as well as the chi-square test resulted as 74.577 ($p < 0.001$). This FFQ measured can be best lead to suitable experience-based food insecurity measures.

Introduction

Household food security is an important measure of well-being. Although it may not encapsulate all dimensions of poverty, the inability of households to access enough food for an active, healthy life is surely an important component of their poverty. In a view of that, devising an appropriate measure of food security is useful in order to identify the food insecurity, assessing the severity of food shortfall, characterizing the nature of their insecurity (for example, seasonal versus chronic), predicting who is most at risk of future hunger, monitoring changes in circumstances, and assessing the impact of interventions.

Some tools like the food security survey are used to define household food insecurity (Wolfe and Frongillo, 2001; Hamelin *et al*., 2002) and the reliability and validity of them varies from country to country as well as region to region within a country. These approaches constructs a direct measure of food insecurity based on people's experience gained through in-depth, qualitative investigation in a locality in which the measure is to be used. However, obtaining detailed data on the food insecurity - such as recall data and estimation of caloric intakes is time consuming and expensive and require a high level of technical skill both in data collection and analysis as well as sometimes unreliable. The dietary diversity would appear to show promises as a means of measuring food insecurity and monitoring the changes and impact arises due to the intervention (Hoddinott and Yohannes, 2002). But in this system the information about seasonal food consumption variation is insufficient and the results are difficult to present and compare quantitatively. Hence, for evaluation, planning and targeting traditional food and nutrient assessment some of these methods are impractical for food and nutrition surveillance. Experience-based measures are intended to complement rather than replace commonly used indirect indicators of food insecurity because these often describe reasons for food insecurity and increase the use and value of regularly collected statistics (Frongillo *et al*., 2003). Lalatia *et al*. (2007) use the quantity of calories from

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non cereal food arguably as an indicator of dietary quality.

The Tista and Jamuna basin area of Rangpur district (locally known as Monga region) in Bangladesh malnutrition is desperately severe due to seasonal food insecurity (Hossain *et al*., 2005). Study shows that the poorest 14% of the rural population in this area consume fewer than 1600 calories per capita per day which is barely adequate for survival (Anonymous, 2005); 10% consume between 1600 and 1800 calories and roughly 23% consume more than 1800 calories (Anonymous, 2005) which is less than the minimum requirement (2122 calories/day) set for adult in Bangladesh (GB, 2005.) Cereals, largely rice, are the main food in Bangladesh. Nearly two-thirds of the daily diet of Bangladeshi people consists of rice, some vegetables, a little amount of pulses and small quantities of fish when available. Milk, dairy products and meat are consumed only occasionally and in a very small amount (Jahan and Hossain, 1998). More than four-fifths of the rural people's in Bangladesh comprises 62% cereal diet followed by non-leafy vegetables, roots and tubers (Frongillo, 2003). The consumption of protein and micronutrient-rich foods like fish, meat, eggs, milk, dairy products, fats and oil is often low at rural poor areas in Bangladesh (Lalita *et al*., 2007)

Hence, The purposes of this study are to (1) explore the experiences of an in-depth understanding of household seasonal food insecurity at Tista and Jamuna area in Bangladesh; (2) investigate an alternative indicator i.e., non cereal food dietary diversity whether provides information on household food security which is based on large, longitudinal, intervention study; (3) understand the seasonal variation of food consumption in Bangladesh using the data from Nutrition Surveillance Project (NSP) of Helen Keller International-2005.

Materials and Methods

Sample

This study was conducted with the data from Nutrition Surveillance Project (NSP), 2005 of Helen Keller International (HKI). HKI collected data from all over Bangladesh in different seasons 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 situated at Tista Jamuna Basin area of Bangladesh which experienced the Monga phenomenon. 25 households were selected with at least one child aged less than 5 years from each village. The data were collected at different rounds; the first round was from February to March defined as little hungry (or little Monga) which is before the winter rice (locally known as Boro) harvesting season. The second round was from April-to May during the winter rice (locally known as Amon) harvesting season. The third round was from June to September that is the post harvest session of winter rice. The fourth round was in October to November which is the lean season preceding the harvesting session of monsoon rice i.e., the season of hunger or locally known as Monga and the fifth round is December-January i.e., the harvesting session of monsoon rice. We don't consider the post harvest season of monsoon rice because of the production in this season is insufficient and extremely depends on the monsoon rain fall. Apart from that the production of monsoon rice is hampered almost every year with natural disasters like cyclone, flood and so on. As a consequence of low productivity of monsoon rice its effect on food security in post harvesting season is negligible (Zug, 2006). Thus in the first round the sample size comprised of 367. In second and third round the sample size were 371 and 375 respectively due to new born within the tagged households. In the fourth round the sample size was 372 due to migration of 3 mothers and in fifth round the sample size comprised 373 due to the same reason of new born in the selected household.

How dietary intake information was collected?

The data are based on seven days recall on dietary diversity from non-cereal foods. Trained research assistants of HKI visited every evening of a week to the respondents to record the data during the survey period. The mothers were asked to recall their consumption of five available common non-cereal foods, i.e., lentils, eggs, green leafy vegetables, yellow/orange fruit or vegetables and fish. The research assistants reported to the supervisor who was responsible for keeping the 7-days recall records. Dietary diversity is measured as the number of times that non-cereal food is eaten within one week. The amount of non cereal food consumed per meal was standardized in gram (Hossain *et al.*, 2005). To convert the energy and vitamin 'A' consumption from non-cereal food Ahmad and Malek analysis of Bangladeshi food stuff is used (Ahmad and Malek, 1996).

Access of food insecurity

Four grades of the severity of food insecurity were accounted among the households: (a) food secure, (b) occasionally food insecure (c) probability/moderately food insecure and (d) extremely/definitely food

insecure in this study according to Frongillo (1999), Food and Nutritional Technical Assistance Project - 2005 (FNTA) Saha *et al*., (2008). In this study we assigned scores to each category according to the Frongillo *et al.* (2003). Higher scores were assigned to those experiences that indicate better food security status. For example, for dietary diversity form non cereal food in last week 0-1, a score of 1 was assigned. To those households who consumed 2 non-cereal food in last week which indicate that the households had a little solvent and have probably / moderately food insecure a score 2 was assigned. A score 3 was assigned when a household consume 3 non-cereal food during last week that means the households' occasionally fall food insecure. A score of 4 was assigned to those households' who had 4 non cereal dietary diversities in last 7 days which indicated the households had adequate food security.

Statistical analysis

To understand the reproducibility of the questionnaire Pearson co-relation was calculated. Before calculating the Pearson co-relation coefficient the distribution of energy consumption was carefully checked and if it was not a normal distribution the energy values were log-transformed to improve the normality. The association between the seasonal differences of calorie consumption form non -cereal food and non-cereal dietary diversity were examined with the regression equation $Y_i = \alpha + \beta_i \text{Measure}_i + \grave{E}_i$; where Y_i is the vector of log of household per capita caloric available from non cereal food in different seasons, measure_i is a vector of log of dietary diversity in different seasons, the coefficient β_i measure vector of the differences of per-capita calorie consumption from non cereal food in different seasons. Kruskal-wallis ANOVA was used to test the differences in seasonal calorie and vitamin-A consumption variation while the Bonferroni method was applied for multiple comparisons.

Sensitivity and specificity by using a contingency table were assessed to validate household food insecurity form the FFQ of non cereal dietary diversity for the categories of the definite criterion of household with food insecurity (Swets, 1988). The sensitivity is defined as the percentage of the households definitely insecure or extremely insecure among the food insecure population and the specificity is the percentage of insecured households among secured population. Pre-harvest session of monsoon rice (October-November) was used for Sensitivity and specificity test (Table 2.) as this session was known as hunger period (Rahaman, 1995) For independence of FFQ and to capture all season's Pearson's chi-square test statistic was used. The analyses were performed using the SPSS package version 15.

Results

Characteristic of population

The participants were predominantly young; (mean age 23.64 ± SD5.31 years) 56. 44% mothers and 60.22% fathers were literate; 74.66% of the respondents had traditional home garden and amount of available land was 0.69 ± SE 0.02 hectors. Sex of household head was 99.7% male and 0.3% female respectively. Majority of main household earner engaged in farming (43.20%) (Table 1).

Table 1. Important characteristics of the population

Maternal education (%)	
No education	43.56
Completed 1-5 years schooling	32.70
Completed 6-10 years schooling	15
Completed 10-12 years schooling	5.2
Completed>10 schooling	3
Religious education	20.51
Parental education (%)	
No	39.78
Completed 1-5 years schooling	30.16
Completed 6-10 years schooling	7.10
Completed 10-12 years schooling	15.53
Religious education	0.51
Type of home gardening practice	
No	21.84
Traditional garden	74.66
Improved garden	0.50
Developed garden	11.17
Amount of cultivated land (decimals, mean)	0.69 ± SE 0.02
Sex of household head	
Male	99.70
Female	0.30
Occupation of main household earner	
Farmer	43.20
Share cropper	5.20
Agricultural day labour	25.20
Skilled labour	1.50
Unskilled labour	7.50
Rickshaw/cart/van puller/baby taxi driver/boatman	8.40
Fisherman	1
Businessman	8
Petty business man	6

Reliability of the Questionnaire

The Pearson correlation between total dietary diversity in different seasons and total energy consumption form non-cereal food are found 0.83 and 0.81 respectively. To capture over all season the result shows strong association between per capita calorie consumption and non-cereal dietary diversity (p-value < 0.05) (Table 3). Hunger period is used as reference category and the result evince that per capita calorie consumption from non-cereal foods is increases with the increase of number of dietary diversity except in the monsoon rice harvesting season (R^2 = 0.851) (Table 3). Though the mean calorie consumption from non-cereal food is low

Table 2. Themes for the experience of household food security in Bangladesh that emerged from the 7 days recall of dietary diversity from non cereal food stuff with graduation according to severity

Session	Extremely/Definitely insecure; (Dietary diversity: 0-1)		Probably insecure/Moderately food insecure; (Dietary diversity: 2)		Probably secure/ Occasionally food insecure (Dietary diversity: 3)		Defiantly secure (Dietary diversity:4 or more)		Total Number
	%	n	%	n	%	n	%	n	
pre-harvest session of winter rice; (February-March)	3	11	5.18	19	12.53	46	79.23	291	367
winter rice harvesting session(April –May)	2.4o	9	0.54	2	5.12	19	91.91	341	371
post harvesting session of winter rice (June-September)	2.67	10	1.33	5	0.8	3	95.52	357	375
*Pre-harvest session of monsoon rice (October-November)	0.81	3	2.15	8	5.65	21	91.30	340	372
monsoon rice harvesting period (December-January)	1.60	6	2.14	8	8.04	30	88.20	329	373

* Hunger period

Table 3. Parameter estimates for association between dietary diversity and per capita caloric availability from non-cereals food

Session	Co-efficient	95%Confidence Interval	Mean per capita calorie availability	Confidence Interval
Pre-harvest session of winter rice (little hunger) (Boro) (February -March)	0.039*	0.029,0.067	356.00[a]	334.72,375.27
Winter rice harvesting (April –May)	0.051*	0.039,0.073	389.98[b]	369.47,410.49
Post harvest session of winter rice (June-September)	0.036*	0.026, 0.066	535.75	510.62-560.89
**Pre-harvest session of monsoon rice (Hunger period) (Aman) (October-November)	-	-	433.73	415.29,452.18
Monsoon rice harvesting session (December- January)	-0.019*	-0.014,-0.024	391.57[ab]	372.44,410.70

*: significant ($p < 0.05$); [ab]: litter with same alphabet denotes the mean difference is not significant ($P \leq 0.05$); **reference category

(mean 356.00, with 95% confidence interval 334.72 to 375.27) in season of pre-harvest winter rice but dramatically the regression result shows that the frequency of dietary diversity from non-cereal food is low in monsoon rice harvesting session (co-efficient -0.019 with 95% confidence interval -0.014 to -0.024, p-value less than 0.05) (Table 3). To find out the explanation of the fact the mean calorie consumption in different season from different non-cereal foods are investigated (Figure 1) and the result evinces that during monsoon rice harvesting session (December-January) the mean calorie consumption from lentil, green vegetable, yellow vegetable and fruit, egg, fish, chicken declines compare to all other seasons but the calorie consumption form meat other than chicken significantly increases (p- value < 0.05).

Meanwhile, more remarkable calorie consumption decline are observed from yellow vegetable and fruits (mean 46.07 calorie/ 7 days, with 95 % confidence interval 42.3 to 49.83) (Figure 1). Yellow fruits and vegetables are a reach source of

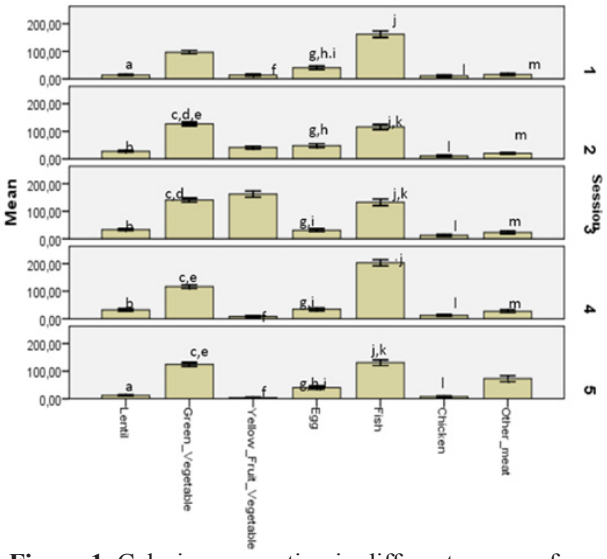

Figure 1. Calori consumption in different seasons from non staple food (7 days)

Error bars: 95 % CI; 1: Pre-harvest session of winter rice; 2: winter rice harvesting season; 3: post harvest session of winter rice; 4: Pre-harvest session of monsoon rice; %: Monsoon rice harvesting session; [a-m]; letter with the same alphabet denotes the mean difference is not significant ($p < 0.05$) for each dietary group

vitamin-A, hence we farther investigated the seasonal consumption of vitamin A. The result shows that the mean consumption of vitamin-A differ significantly with season (p-value 0.05, Figure 2). The result evidences that vitamin-A consumption (mean 16304 IU/ 7 days, with 95 % confidence interval 15322.67 to 17286.23) in post winter rice harvesting session is higher compression to all other session (Figure 2). However, more details about the possible cause of these incidences have been explained in discussion section.

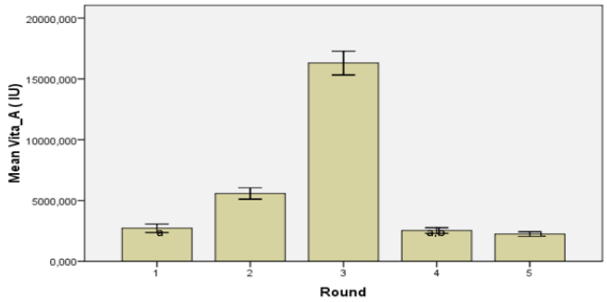

Figure 2. Vitamin A (IU) consumption in different Period (7 days) from nonstaple food

Error bars: 95 % CI; 1: Pre-harvest session of winter rice; 2: winter rice harvesting season; 3: post harvest session of winter rice; 4: Pre-harvest session of monsoon rice; %: Monsoon rice harvesting session; [a,b]: letter with the same alphabet denotes the mean difference is not significant ($p < 0.05$) for each dietary group

Validity of the questionnaire

Four type of severity of food insecurity among the households are used to understand the validity of the questionnaire: (a) food secure; (b) Occasionally food insecure; (c) Probability/Moderately food insecure and (d) Extremely/definitely food insecure. This classification is based on the theme of non-cereal dietary diversity in seven days recall system (Table 2). The resulted sensitivity i.e., the percentage of the households definitely insecure or extremely insecure among the food insecure population was found as 97.70% as well as specificity i.e., the percentage of those households insecure among secured population was found as 12.50% in hunger period i.e., pre-harvest monsoon rice harvesting season (Table 2). To capture over all seasons and for independences of the proposed four themes the resulted chi- square statistic is 74.57 ($p < 0.001$).

Discussion

Reproducibility

The Pearson correlation co-efficient which indicated the reliability of the questionnaire between total meal consumption in different seasons and total energy consumption are found 0.83 and 0.81 respectively. The reproducibility studies in Asian region the co-relation coefficient varied from 0.28 to 0.79 (Wakai *et al*., 1999; Kim, 2003; Shu *et al*., 2004). However, in this study it is expected that the household food insecurity would be lowest in hunger period i.e., pre-harvest session of monsoon rice (October-November). But dramatically the result indicated that the total calorie consumption from non-cereal food in hunger period is (mean 433.73/7 days with 95% confidence interval 415.29 to 452.18) much higher than other three seasons except post harvest session of winter rice (Table 2).

The possible explanation of this fact is the seasonal availability of fish in this season as this season belong to beginning of the dry season when all the lake, rivers started to dry and hunting of fish is increased that followed by more calorie consumption from fish. However, this study also illustrates that the state frequency of consuming non-cereal food is low in monsoon rice harvesting session (December-January) (Table 3). The plausible explanation is due to the seasonal scarcity and variation of non-cereal food production. Meanwhile, the mean calorie consumption form yellow vegetables and fruits (mean 3.74 kilocalories/7 days; with 95% confidence interval 1.86 to 5.61) is low in comparison to all other seasons (Figure 1) that suggest to consider the unavailability of seasonal fruits and vegetables during such kind of study. Extended researches have been carried out in the similar field and the results argue that the consumption of non-cereal food differ with season (Ferguson, 1993; Armando *et al*., 2006). The result shows that the mean calorie consumption form yellow vegetables and fruits in monsoon rice harvest season is highest throughout the year and the plausible explanation of the fact is huge production of ripe mango in the study area. It should indicated from the practical experience from the study area that greater Rajshahi division of Bangladesh is famous for the production of mango and June-September is the harvesting and post harvesting session of mango (Anonymous, 2005). Hence, the consumption of yellow fruits increases in post harvest session of winter rice (June-September) that followed by increasing Vitamin-A consumption (Figure 2) as ripe mango contain vitamin "A" 3834 IU per 100 gram (Yuyama, 1991). We finds that vitamin "A" consumption is highest (mean 16304 IU/ 7 days; with 95% confidence interval 15322.67 to 17286.23) in post harvesting session of winter rice. However, Vitamin-A is difficult to evaluate, and it requires several days (about 60) to have a precise estimate of intake. From this study it assume that the vitamin "A" intake much lower of the selected population because the result evinces that yellow vegetable and fruits consumption in June-September

is higher in compression to all other seasons. On the contradictory, another remarkable difference is found in meat consumption (except chicken meat) and the highest consumption (mean 72.92 calorie/7 days with 95% confidence interval 62.05 to 83.79) is observed in December-January i.e., monsoon rice harvesting season. The possible reason could be that this season belonging to the period of religious festival that consequently increases slaughtering animals and therefore poor households might has higher meat consumption. However, the newly developed FFQ is designed to assess dietary intake of major non-cereal food throughout the year. Our data collection is 7 days recall system for the development of the FFQ from non-cereal dietary diversity. It has been reported in other studies that major seasonal variation occurs in the intake of vegetables and fruit that followed by the intake of vitamin-A (Chen *et al.*, 2004; Fowke *et al*., 2004). Similar seasonal variation has been observed in vitamin-A consumption when the results of the present study were compared with those of the survey conducted in Bangladesh and other Asian countries (Hanh *et al*., 2001; Chen *et al*., 2004; Islam *et al.*, 2010).

Validity

For screening out to identify any household at risk of hunger and food insecurity, sensitivity is more important than specificity because specificity identify any false positive (i.e., those who appear to food secure but not) and again in general for targeting programs the goal is usually to identify those subgroups of the population most at risk. This study shows excellent sensitivity (97.70%) in pre-harvest session of monsoon rice which is almost identical with the study of Frongillo *et al*. (1997) who carried out the a study on validation of 24 hours recall FFQ based on the percentage of the sample responding. They use three sets of data in their study i.e., data from National Centre for Health Services (NCHS), Community Childhood Hunger Identification Program (CCHIP),and National Centre for Health Statistics (NHANES III-third national Health and nutritional Examination Survey) in a rural county of new work city of which (NCHS), and (CCHIP), questionnaire mainly based one household expenditure for food i.e, quantitative questionnaire and NHANES III-questionnaire is based on hunger score i.e, qualitative questionnaire (Frongillo *et al*., 1997). According to Frongillo *et al.* (1997) the sensitivities of the NCHS, CCHIP and NHANES-III measures were 89, 86 and 32% respectively. In conclusion in their study they agreed that for the assessment of household food insecurity only NCHS, CCHIP questionnaire was excellent in order to categorize as defiantly food insecure (Frongillo *et al.*, 1997). During checking the validity to capture overall season of the FFQ the resulted chi square is 74.577 (p-value < 0.001) which indicates strong association between non-cereal dietary diversity with farming seasons. It is indicated in technical prospective of validity study the least demanding use of the household food insecurity would be to capture overall differences in household food insecurity status across the season (Frongillo *et al.*, 1997).

Admittedly, there are some strong and weak points in this study. First, though recent study emphases the nutrition security during validity study (Wakai, 2009; Wiens *et al*., 2010) but using the rich set of information from the interviews, this study develop a criterion measure that approximated the most definitive measure of food insecurity from the dietary diversity of non-cereal foods consumption. Second, the accuracy of this definitive measure is limited somewhat by several factors like it is difficult to get access accurate information from the interviews because respondent may not answer truthfully on their food consumption if they do not anticipate gaining food or any assistance or due the shyness of saying hungry (Islam *et al.*, 2012). However, the potential bias can be avoid through close contact with the respondent and careful construction of the questionnaire (Frongillo *et al.*, 2003) that have been followed in this study. Third, although other kinds of qualitative and quantitative approaches are using to studying household food insecurity (Wolfe and Frongillo, 2001) the present study developed an in-depth understanding of the experience of household food insecurity in a chronically poverty prone county in Bangladesh. Forth, Frongillo and Nanama (2006) state that hunger and food insecurity should be carefully examined over the time period to capture the dynamics hence in this study we strongly emphasize to capture over all season to explain the seasonal consumption variation of non-cereal food through regression coefficient and chi-square test. Fifth, an important objective in developing this measure is to use it as an intervention study to understand the role of non-cereal dietary diversity on food insecurity during lactation and post lactation period in a poverty prone region of Bangladesh where rice is consider as staple food. So far, this is the first relativity and validity study of FFQ from non-cereal dietary diversity in chronically poverty prone region in Bangladesh considering the seasonal food consumption variation.

Conclusion

In conclusion it is recommended that though rice consider as a cash crop as its farming season affect on the seasonality of work which fluctuate the income for the poorest people that have ultimate effect on non-cereal food purchasing power i.e, accessibility of food but the seasonal availability of non-cereal food is also important factor for food accessibility. Dietary diversity from non-cereal food may use as a indicator of food insecurity but researcher should cautious about the availability and seasonal variation of non-cereal food-consumption during handling of the tools.

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