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Household Food Security in Bangladesh: Going beyond Poverty Measures

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In this paper, we analyze changes in the dietary diversity scores of the Bangladeshi population over time. Our results show that although there was a clear increase in real per capital consumption expenditure in Bangladesh between 2005 and 2010, the dietary diversity of Bangladeshis showed no sign of improvement over the same period. Moreover, while poor families typically report a lower dietary diversity than non-poor households, irrespectively of their poverty status, households in Bangladesh limit their food consumption to an inadequate number of food items. Unlike dietary diversity, dietary vulnerability is significantly more prevalent among poor households, suggesting that point-in-time measures of consumption are likely to underestimate chronic deprivation in dietary quality. Given the importance of dietary adequacy and vulnerability, particularly among women and children, we conclude that the policy dialogue should pay special attention to the dietary patterns of the Bangladeshi population, going beyond the focus on short-term expenditure-based measures of nutritional status.

Keywords: Poverty, Food Security, Dietary Diversity Score, Bangladesh

JEL Codes: I3, I15, Q18

I. INTRODUCTION

Bangladesh has recorded impressive poverty reduction over the last two decades. Over the most recent decade (2000-2010), the head count poverty rates have declined by almost 18 percentage points (Bangladesh Bureau of Statistics 2011, 2005). According to the Planning Commission (2011), Bangladesh is on track for reaching both the poverty *Millennium Development Goals* (MDGs).

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Giménez *et al.* (2013) and World Bank (2012) report that increases in real income, private sector development, external migration and remittances, growth in social safety nets coverage along with development efforts of non-governmental agencies (through microfinance or otherwise), and declining dependency ratios have each contributed to the significant increase in the real consumption expenditures of the households, allowing a large number of them to graduate out of poverty.

However, unlike poverty, improvements in the nutritional status of Bangladeshi households have been lackluster. According to the latest *Bangladesh Demographic and Health Survey*, stunting among children declined modestly, going from 43 percent in 2007 to 41 percent in 2011 (NIPORT *et al.* 2012). A nationally representative survey (State of Food Security and Nutrition in Bangladesh, 2011) estimates that nearly 45 percent of households in Bangladesh suffer from some form of food insecurity. This survey also highlights that the prevalence of inadequate maternal dietary diversity is nearly 62 percent whereas that of chronic malnutrition among children is 45 percent. In other words, the higher levels of household consumption observed in Bangladesh have not been paralleled by similar nutritional improvements, suggesting that higher purchasing power does not necessarily translate into practices leading to long-term improvements in households' welfare (e.g. better nutrition and dietary practices leading to healthier and more capable citizens).

The official poverty estimates for Bangladesh are derived using the cost of basic needs method.[2] Under this method, a household is considered poor when its consumption level falls short of the cost of basic needs, or poverty line. In this study, we go beyond the traditional poverty measures by taking a closer look at the components of the entire food basket households consume. That is, using the Household Income and Expenditure Survey (HIES), the same nationally representative survey which is used to produce the official poverty estimates for Bangladesh, we estimate the *dietary diversity scores* (DDS) of households for two survey years, 2005 and 2010. This exercise allows us to analyze the dietary diversity scores of the Bangladeshi population over time, going beyond short-term expenditure-based measures of nutritional status. Moreover, as a higher dietary diversity is also associated with better socio-economic outcomes (see

[2]The cost of basic needs is comprised of two parts: the cost of a minimum food basket or food poverty line and an allowance for non-food expenditures. The food poverty line provides the minimal nutritional requirements for a diet corresponding to 2,122 kcal per day per person. For a detail description of the methodology underlying the estimation of the official poverty estimates for Bangladesh, see Giménez *et al.* (2013).

Hatloy, Torheim, and Oshaug, 1998, Hoddinott and Yohannes, 2002), the same exercise also allows us use the same underlying population to test whether the DDS conveys similar welfare information as the expenditure-based measures of welfare used to compute the official poverty estimates for Bangladesh.

We define DDS as the number of distinct food groups consumed by a household during the week prior to being surveyed by the HIES. Each food group represents a special class of nutrients, and a higher DDS indicates greater diversity of food intake and better quality diets. A higher DDS implies a more diversified portfolio of food intake and a higher quality diet.[3] Thus, this measure can be used as a relatively simple indicator for the micronutrient adequacy of households' diets. Moreover, as the dietary patterns and dietary quality of a household are important inputs into the production of anthropometric outcomes, either measure can be used as a proxy for such outcomes. For example, Rah *et al*. (2010) find that good dietary diversity is strongly negatively associated with stunting among children aged less than five years. Therefore, in the absence of anthropometric measures of nutritional deficiency and malnutrition, the DDS can shed light into a household's food in-take patterns and its likelihood of facing food insecurity, nutritional deficiency and malnutrition (see Ruel, 2003 for different measurement issues pertaining to dietary diversity scores and their implications for development among children).[4]

Our results show that the relationship between poverty and dietary diversity is both non-linear and sometimes non-monotonic. While there is a strong negative association between absolute poverty status and dietary diversity, in general, the dietary diversity of all households has remained surprisingly stagnant between 2005 and 2010, highlighting the lack of improvements in the dietary quality of the average Bangladeshi household. As dietary diversity is a strong predictor of energy availability, food security and long-term outcomes, our findings suggest the importance of looking beyond traditional poverty measures

[3]The literature showing that the DDS is systematically associated with dietary quality, macro- and micro-nutrient intake and the prevalence of infectious diseases among children, and households' food security is vast (see Waterlow 1994, Steyn, Nel, Nantel, Kennedy, and Labadarios 2006, and Kennedy, Pedro, Seghieri, Nantel, and Brouwer 2007).

[4]The DDS is a useful measure of dietary diversity when detailed consumption data is either too difficult or too expensive to collect (collecting detailed consumption data often requires higher technical skills and/or more time, see FAO 2007). The HIESs collect detailed consumption data for each household.

in order to gain a more insightful and systematic understanding of households' welfare.

The paper is organized as follows. In Section II, we provide a brief description of the HIES data and of the various measures of nutritional status used in this study. In Section II, we also discuss the statistical methods we use to describe the dietary patterns of households. Section III discusses the main findings and Section IV concludes the paper.

II. METHODS

2.1 Data

Our analysis is based on the Household Income and Expenditure Surveys (HIES), carried out in 2005 and 2010. The detailed consumption module of the HIES allows us to compute household-level DDSs. Moreover, this survey also allows us use the same underlying population to test whether the DDS conveys similar welfare information as the expenditure-based measures of welfare used to compute the official poverty estimates for Bangladesh. Due to its reliability, the HIES is currently considered the most important source of income and expenditures information available in Bangladesh. The design and coverage of the HIES allows us to compute estimates of dietary diversity that are nationally representative as well as estimates of dietary diversity that are representative at the division-level.

For each household included in the analysis, food consumption information is collected over a period of 14 days. During this period, enumerators visit the interviewed household on each alternate day, resulting in a total of seven visits per household. During the interview each household is asked about the total food consumption on the previous day and the day before.[5] This data collection process results in a 14-day panel for each household. Using these data, we construct 14 daily-DDSs for each household. We also measure both the number of days a household's DDSs fall within specific cut-off points of its 0-11 range and the number of days a household exhibits a DDS that falls above a specified threshold level. With these measures, explained in more detail below, we generate a comprehensive picture of food security and nutritional adequacy, thus we analyze a dimension of households' welfare that is overlooked by the traditional consumption based poverty measures.

[5]We checked whether there was any discrepancy which can be attributed to recall bias between these two sets of days. This exercise show that no discernible differences exist between these two sets of days; therefore, we assume that the recall bias is minimal.

2.2 Measuring HDDS and Dietary Vulnerability

The DDS estimates a household's economic ability to consume a set of nutritionally diverse food items. Customarily, food consumption is recorded over a period of 24 hours, and the food tally is used to calculate the household dietary diversity score (FAO 2007). However, as HIES collects detailed consumption data over a period of fourteen days[6], the information required to measure the diversity score, as suggested by Food and Agriculture Organization (2007)[7], can be replicated up to fourteen times for each household. For the purposes of our analysis, food items consumed on each of the fourteen days for which data is available were categorized into one of twelve food groups.[8] If a household consumed an item from a particular food group, the household was assigned a value of "1" for that food group and "0" otherwise. Hence, for each household, a set of twelve parameters indicates whether or not a certain food group was consumed by any member of the household on each day during the 14-day period. The last food group, "other", is dropped, restricting the DDS's range to be between 0 and 11.[9] Summing over the eleven indicators for each household and for each of the fourteen days yields the household-day DDS. Household-day is the primary unit of analysis.

We use two additional nutritional diversity measures. First, we count the number of households consuming food items from a specific food group on a specific day for survey years, 2005 and 2010. Then, we further measure the total number of food groups (as defined by Food and Agriculture Organization 2007, see Table I) consumed by a household on a specific day. As we are also interested in gauging the level of nutritional vulnerability households face (that is, inability of households to maintain a reasonable level of dietary diversity), we also measure the number of days a household reports consuming above a threshold number of food groups. Selecting the proper benchmark for identifying nutritionally vulnerable households is not trivial (see Ruel 2003). We chose the

[6]In particular, the HIES revisits the same household seven times over the given period on alternate days to record all food items consumed over the previous two days.

[7]See, also Arimond, Tornheim, Wiesmann, Joseph, and Carriquiry (2009).

[8]The entire per-capita consumption distribution is estimated for each food item for each day of positive consumption. If a household's food consumption of a particular food item belongs to the bottom one percentile of the respective food item distribution (that is, when the food item was consumed in trace amount), the household is assigned a zero for that particular food group.

[9]The "other" category includes novelty items such as cigarettes, tea, and spices. The contributions of overall nutrition of these items are small (both in terms of quantity and quality). Including them in DDS does change the central premise of this paper and we have not counted this category to measure the household's DDS.

average DDS for the households in the lowest income decile as a threshold for identifying households that have a low DDS. Under this benchmark, a household is said to be nutritionally vulnerable if its DDS is less than five.[10]

TABLE I
CLASSIFICATION OF FOOD GROUP

Food Group Name	Examples	Group Number
CEREALS	bread, noodles, biscuits, cookies or any other foods made from millet, sorghum, maize, rice, wheat and other local foods	1
WHITE TUBERS AND ROOTS	white potatoes, white yams, cassava, or foods made from roots.	2
VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrots, squash, or sweet potatoes that are orange inside and other locally available vitamin-A rich vegetables (e.g. sweet pepper)	
DARK GREEN LEAFY VEGETABLES	dark green/leafy vegetables, including wild ones and locally available vitamin-A rich leaves such as cassava leaves etc.	
OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) , including wild vegetables	3
VITAMIN A RICH FRUITS	ripe mangoes, cantaloupe, dried apricots, dried peaches and other locally available vitamin A-rich fruits	4
OTHER FRUITS	other fruits, including wild fruits	
ORGAN MEAT (IRON-RICH)	liver, kidney, heart or other organ meats or blood-based foods	5
FLESH MEATS	beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds	
EGGS		6
FISH	fresh or dried fish or shellfish	7
LEGUMES, NUTS AND SEEDS	beans, peas, lentils, nuts, seeds or foods made from these	8
MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	9
OILS AND FATS	oil, fats or butter added to food or used for cooking	10
SWEETS	sugar, honey, sweetened soda or sugary foods such as chocolates, sweets or candies	11
OTHER (includes SPICES, CONDIMENTS, BEVERAGES)	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages OR local examples	12

Source: FAO 2007; also see Arimond and Ruel (2004) and Arimond, Tornheim, Wiesmann, Joseph, and Carriquiry (2009).

[10]While, in the same spirit, this method is different from stratifying households by DDS and choosing the lowest quartile or tercile as a benchmark. See Ajani (2010) for further discussion on this.

2.3 Statistical Analysis

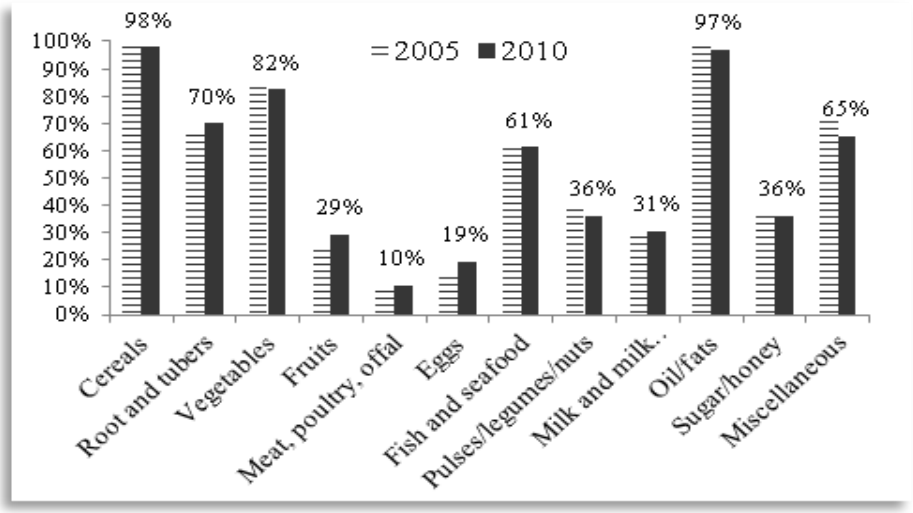
The analysis presented in this paper relies on descriptive statistics to generate a profile of the changes in the dietary patterns of Bangladeshi households taking place in a period of five years, between 2005 and 2010. For the purpose of the analysis, households are stratified into three groups based on their poverty status: (1) the ultra-poor (sometimes referred to as severely poor); (2) the moderately poor; and (3) the non-poor. Ultra-poor households are those whose real per-capita consumption falls below the lower poverty line; poor households are those whose real per-capita consumption falls between the lower and upper poverty line; and non-poor households are those whose real per-capita consumption falls between the lower and upper poverty line.

III. FINDINGS

Figure 1 compares the dietary patterns of Bangladeshi households in 2005 and 2010. Overall, the figure describes a very typical pattern: nearly all households primarily consume from the "cereals" and "oil/fats" group. While many households consume roots and tubers (for example, potatoes), starchy cereals (namely, rice) remain the main source of energy for most households on any given day. With regard to protein, households primarily rely on fish; in 2005, about 63 percent of households consumed fish on any given day compared to 61 percent in 2010. In general, households' consumption of meat products (about 10 percent in both years) and eggs (about 14 percent and 19 percent in 2005 and 2010, respectively) was relatively low. Pulses and similar food items provide only limited respite from low protein consumption of meat products. While 80 percent of households, on average, consumed vegetables, consumption of fruits was relatively low in both years (about 25 percent of households).

Figure 2 compares the dietary consumption patterns of three groups of households (the ultra-poor or severely poor, the poor, and the non-poor) over time. This figure reveals some striking patterns. First, the dietary components that distinguish the diets of the poor from the non-poor were milk, sugar products, and eggs. Consumption of eggs among the non-poor was about 20 percent compared with 8 percent among extremely poor households. Similarly, consumption of milk products was 38 percent among non-poor households and 9 percent among the extremely poor. Second, fish and seafood consumption was also more prevalent among the non-poor. While fish remained the dominant source of protein for all three groups (about 65 percent of households consumed fish), only one-half of extremely poor households consumed fish on a daily basis, indicating a 15 percentage point gap in consumption between the poor and the non-poor.

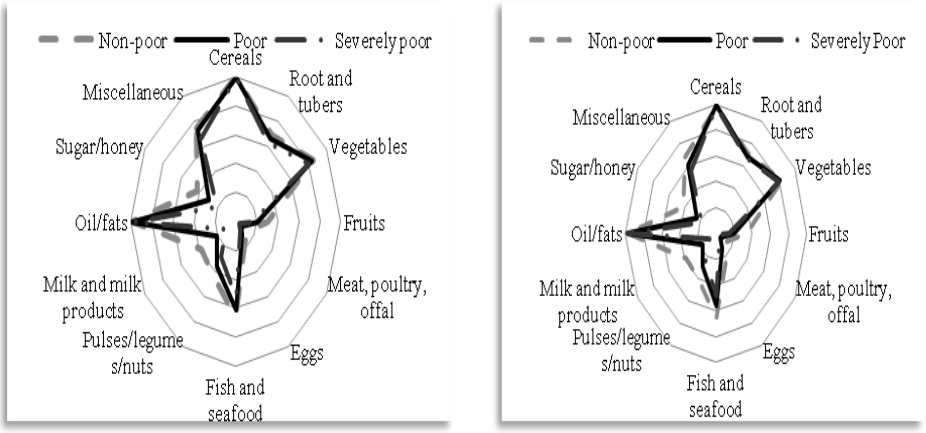
Figure 1: **Percent of Households Consuming a Particular Food Group in 2005 and 2010**



Source: *Household Income and Expenditure Survey* 2005 and 2010.
Note: The trace amount of consumption for each food item was not counted toward a food group.

Figure 2: **Fraction of Households Consuming Food Items from a Specific Group**

A. HIES 2005 (N = 139,505) B. HIES 2010 (N = 171,360)

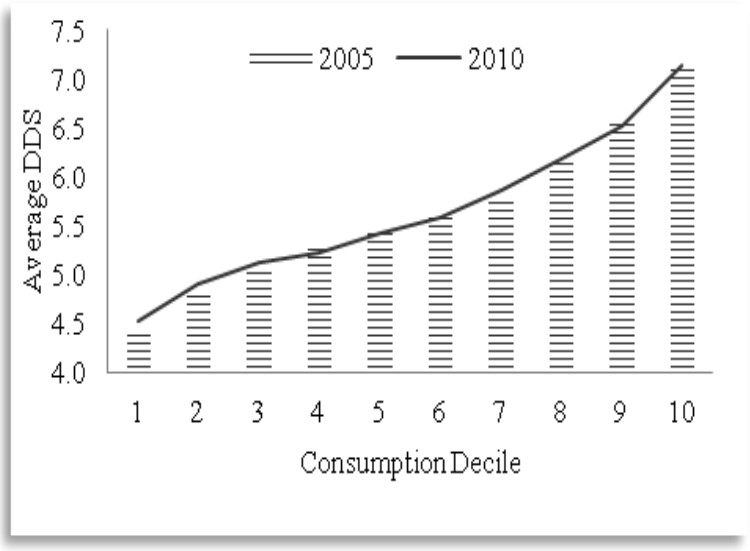


Source: *Household Income and Expenditure Survey 2005 and 2010.*
Note: Households are stratified into three groups according to poverty status: "*Non-poor*": households with per-capita consumption levels above the upper poverty line; "*Poor*": households with per-capita consumption levels between the lower and the upper poverty lines; "*Severely poor*": households with per-capita consumption levels below the lower poverty line.

Consumption of meat products was relatively low for the overall population, and especially low among extremely poor households. Only three percent of households reported consuming meat on a given day in 2005 or 2010; for non-poor households, the rate was about 13 percent; for poor households, about 6 percent. For three food groups, cereals, oil/fat, and vegetables, no discernible differences exist between the three groups. On any given day, nearly all households consumed food items from the cereals and oil/fat groups, and four out of five households consumed at least one vegetable food item.

Figure 3 shows average household DDS by consumption decile. The figure demonstrates a positive relationship between consumption and DDS. While higher consumption does not necessarily translate into greater dietary diversity, consumption expenditure is nevertheless positively related to better diversity. In particular, for both 2005 and 2010, households in the lowest deciles reported dietary diversity scores ranging from 4.5 to 5, suggesting that the diets of relatively poor households barely meet basic energy requirements. The estimates suggest that poorer households primarily consumed rice and fats, which were likely complemented with some vegetables and, to a lesser extent, fish. Households in the top decile, however, consumed as many as seven food groups, on average, suggesting that their diets were more nutritionally diverse.

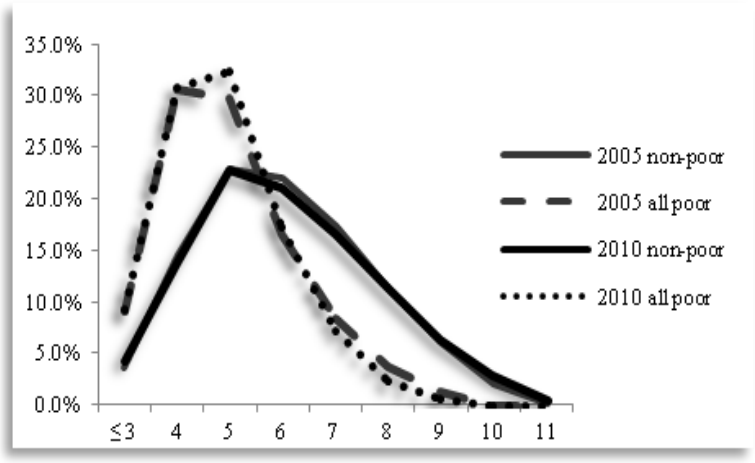
Figure 3: **Average Household Dietary Diversity Score by Consumption Deciles**



Source: *Household Income and Expenditure Survey* 2005 and 2010.

Next, we focus on the distribution of households' DDSs across poverty groups and time. In this part of the analysis, we rely on *cumulative distribution function (CDF)* which allows us to measure the mass or fraction of households falling below a certain DDS value in the distribution.[11] This analysis also allows us to infer whether the CDF of one group one stochastically dominates that of another. The distributions of households' DDS indicate that overall dietary diversity remained fairly static between 2005 and 2010 (Figure 4 and Figure 5). Average household DDS was 5.65 in 2005 and 5.70 in 2010. Moreover, the cumulative distribution functions for 2005 and 2010 show no evidence of stochastic dominance for one distribution over the other, suggesting that no significant welfare changes related to dietary diversity occurred over this period (Figure 6 and Figure 7).

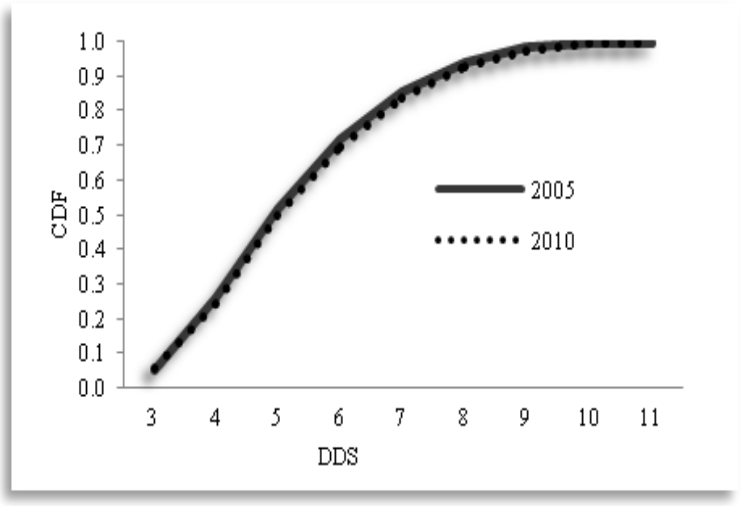
Figure 4: **Frequency Distribution of HDDS in 2005 and 2010**



Source: *Household Income and Expenditure Survey* 2005 and 2010.
Note: Total number of observations: 139,505 for 2005 and 171,360 for 2010.

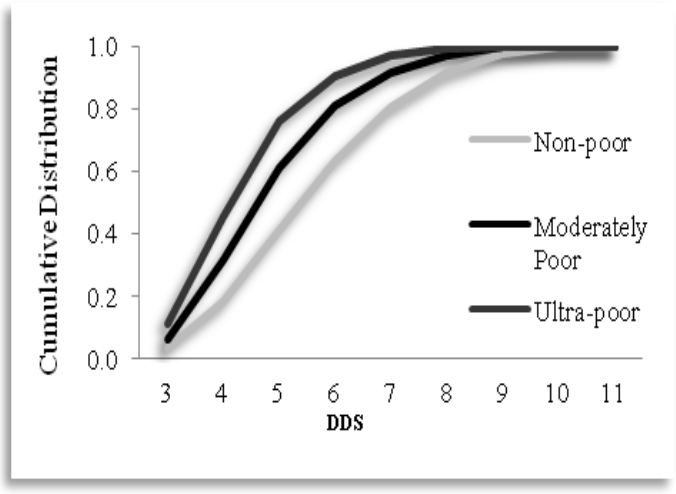
[11]More technically, if we define X_i as the household i's dietary diversity score (we suppress the time subscript here) which assume values from a feasible support of discrete values (e.g. for our case $X_i \in \{0,1,\cdots,11\}$). If we further define that the density function as $f(X=x)$ then we can define the distribution function as$F(K)=\sum_{i=0}^{K} f(X=i)$, where K is chosen from the feasible support of X. We estimate the distribution function non-parametrically.

Figure 5: **Cumulative Distribution of HDDS in 2005 and 2010**



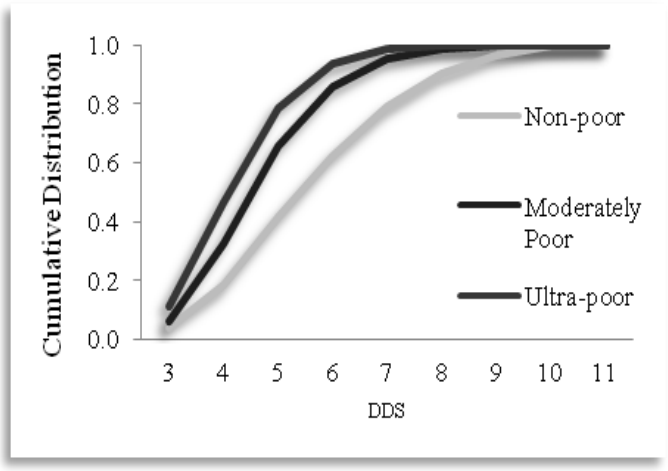
Source: *Household Income and Expenditure Survey* 2005 and 2010.
Note: Total number of observations: 139,505 for 2005 and 171,360 for 2010.

Figure 6: **Cumulative Distribution Function for HDDS by Poverty Status in 2005**



Source: *Household Income and Expenditure Survey* 2005.

Figure 7: **Cumulative Distribution Function for HDDS by Poverty Status in 2010**



Source: *Household Income and Expenditure Survey* 2010.

The average dietary diversity and its persistence can also vary by poverty status. HIES allows us to estimate point-in-time as well as long-term measures of dietary diversity. This estimate provides us with a unique opportunity to measure the prevalence of acute dietary diversity deprivation and that of chronic dietary diversity deprivation, the latter of which may have important implication for long term nutritional outcomes and labor productivity. For our purposes, a household is said to suffer from acute dietary diversity deprivation when its DDS from a randomly selected day is less than five.[12] Similarly, a household is said to suffer from chronic dietary diversity deprivation when its DDS is less than five in more than seven days out of the 14-day interviewing period.[13] Households are stratified by poverty status. The results are presented in Figure 8.

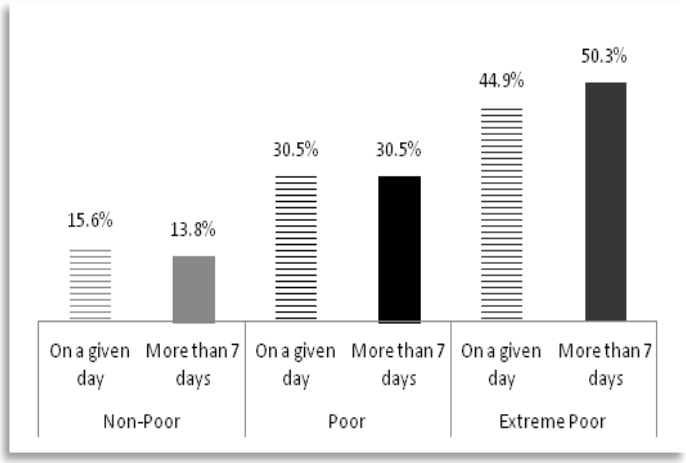
While 15.6 percent of the non-poor households have a low diversity diet, 13.8 percent of the same households also suffer from chronic dietary diversity deprivation. For the poor households there is no difference in the prevalence of acute and chronic dietary diversity deprivation; 30.5 percent of these households suffer from both. For the severely poor households, the estimates show that the

[12]The "index" measuring the households' lack of dietary diversity is robust to the choice of the day. The household count is insensitive to repeated random selection or choosing the first day of the survey.

[13]It is possible to have high serial-autocorrelation between the days surveyed. However, such repeated observation for a nationally representative sample is yet to be carried out.

prevalence of acute dietary diversity deprivation (45 percent) is lower than that of chronic dietary diversity deprivation (50.3 percent). This finding suggests that point-in-time measures of dietary diversity deprivation are likely to underestimate long-term dietary diversity deprivation.[14]

Figure 8: **Sensitivity of DDS based Vulnerability to Choice of Number of Days**

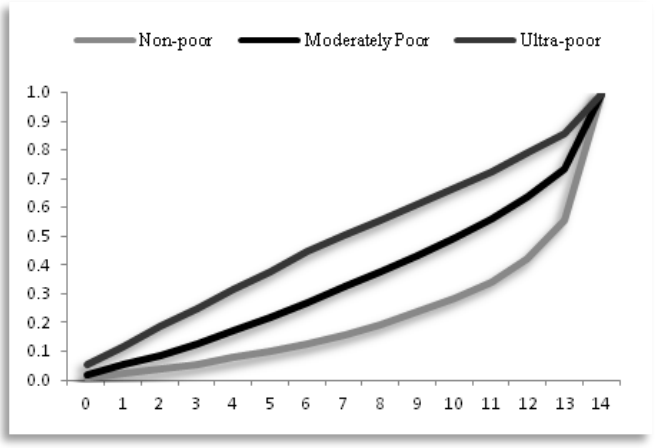


Source: *Household Income and Expenditure Survey* 2010.
Note: "On a given day" refers to a day randomly selected over two weeks when a household was interviewed for detailed consumption data during the survey.

Both the level of DDS and its distribution have remained somewhat unchanged over the 2005 to 2010 period; however, Figure 9 and Figure 10 show that the cumulative distribution functions (CDFs) differ significantly by poverty status. In particular, the DDS-CDF corresponding to the non-poor stochastically dominates that of the poor, which, in turn, stochastically dominates that of the extremely poor. As expected, non-poor households have greater dietary diversity relative to poor households.

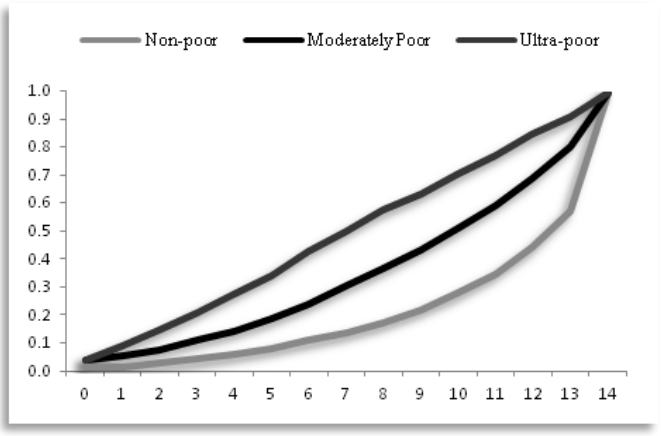
[14]This additional 5 percentage point's difference among the extreme poor households signifies about 650 thousand households.

Figure 9: **Cumulative Frequency Distribution - Dietary Diversity Secured Number of Day(s) in 2005**



Source: *Household Income and Expenditure Survey* 2005.

Figure 10: **Cumulative Frequency Distribution–Dietary Diversity Secured Number of Day(s) in 2010**

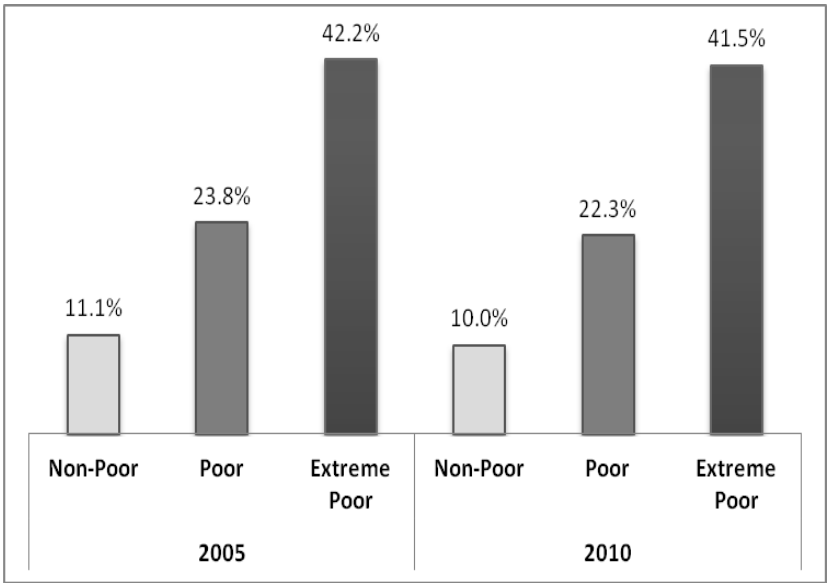


Source: *Household Income and Expenditure Survey* 2010.

We now turn to analyzing the risk of having a low DDS at the household-level, rather than the household diversity score on a given day. For our purposes, a reported diversity score of five (or more) implies that a household consumes beyond the basic set of food items and is not vulnerable from a dietary point of view. We measured the number of days a household fails to report to be diet secured and a household reporting number of days with DDS less than five as "diet vulnerable." The results are shown in Figure 11. For both years, about 42

percent of households are unable to secure a DDS of five or more during at least eight of the fourteen days when the HIES consumption data is collected. When considering only the non-poor, the picture improves significantly; 11 percent and 10 percent, in 2005 and 2010, respectively, face a relatively a much lower risk of having low dietary diversity scores.

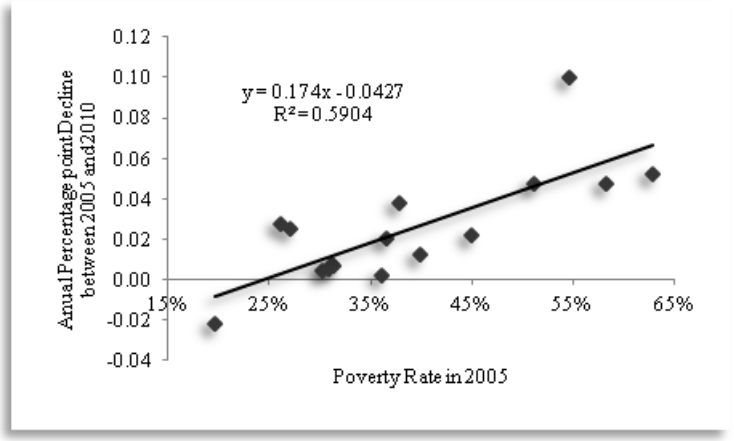
Figure 11: **The Dietary Vulnerability of Households**



Source: *Household Income and Expenditure Survey* (2005 and 2010).
Note: The diet vulnerability is measured as households reporting a dietary diversity score of less than five for eight days or more over last two weeks.

It is also interesting to look at the changes in HDDS and how they relate to spacio-temporal "convergence" between 2005 and 2010 at the aggregate level. Figure 12 explores the relationship between 2005 levels of poverty (DDS) and changes in poverty (DDS) between 2005 and 2010. For each survey year, poverty rates and DDSs are stratified according to 16 primary sampling units (PSUs), corresponding to the urban, rural, and metropolitan statistical area of each division. The PSU-level change in poverty rates between 2005 and 2010 is plotted against the corresponding PSU-level poverty prevailing in 2005 (Figure 12). This figure shows a positive relationship between poverty rates in 2005 and changes in poverty between 2005 and 2010, suggesting that PSUs with greater poverty rates in 2005 also registered higher poverty declines between 2005 and 2010. Interestingly, Figure 13 reveals no such relationship between the 2005 DDS and DDS changes between 2005 and 2010.

Figure 12: **Decline in Poverty Rates between 2005 and 2010 by PSUs**

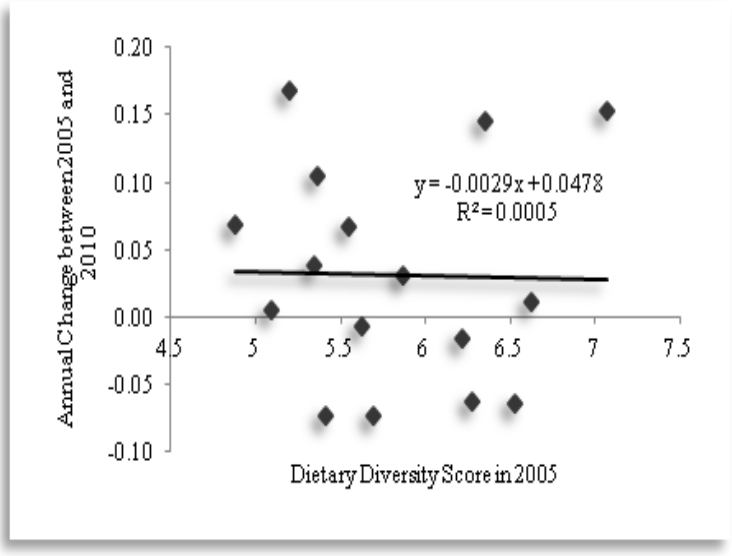


Source: *Household Income and Expenditure Survey* 2005 and 2010.

Lastly, we measure how each of the 11 food groups that comprise the Bangladeshi diet contributes toward the average total energy consumption per household. As Figure 13 and Figure 14 suggest, cereals (rice in particular) provide more than 70 percent of households' total energy intake. The oil/fats group constitutes the second biggest source of households' energy (about 8 percent of households' total energy intake). Moreover, while more than 60 percent of households report consuming roots and tubers (see Figure 1), this food group contributes toward a relatively small proportion of the total household calorie needs (3 percent of households' total energy intake). Comparing the average food mix of the Bangladeshi plate to the food mix suggested by the United States Department of Agriculture (USDA) highlights the chronic level of low dietary diversity in Bangladesh relative to what is considered a healthy diet.[15] For example, while the USDA recommended food mix is composed of approximately 30 percent grains, 30 percent vegetables, 20 percent fruits, 20 percent protein, and a side of dairy food, in Bangladesh cereals and oil/fats provide more than 80 percent of the total energy intake of households.

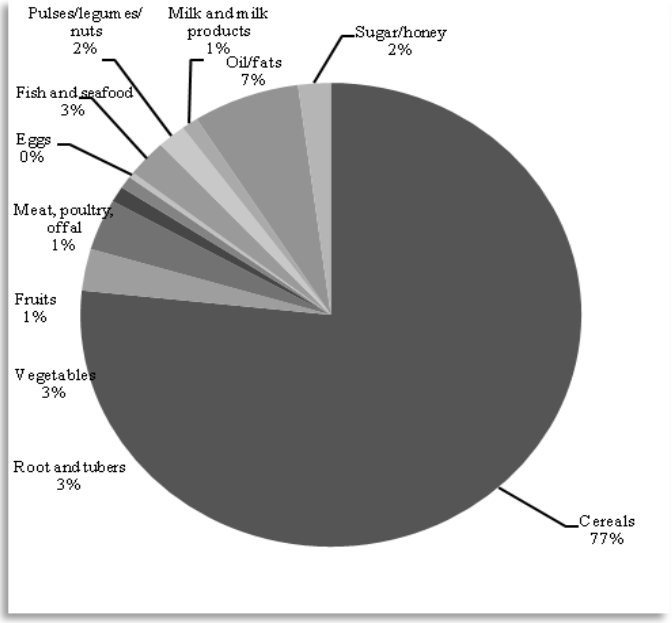
[15]The USDA's recommended food mix is a plate composed of five food groups that are said to be the building blocks for a healthy diet. See http://www.choosemyplate.gov/food-groups/.

Figure 13: **Annual Changes in DDS between 2005 and 2010 by PSUs**



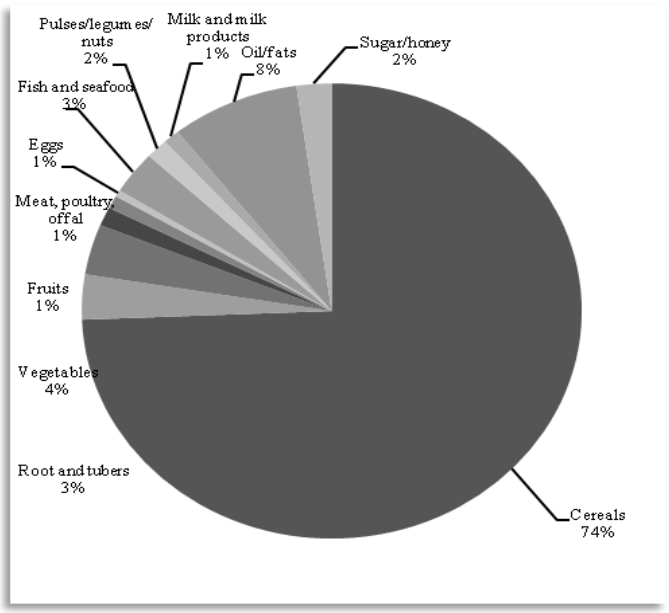
Source: *Household Income and Expenditure Survey* 2005 and 2010.

Figure 14: **Energy Consumption by Food Groups in 2005**



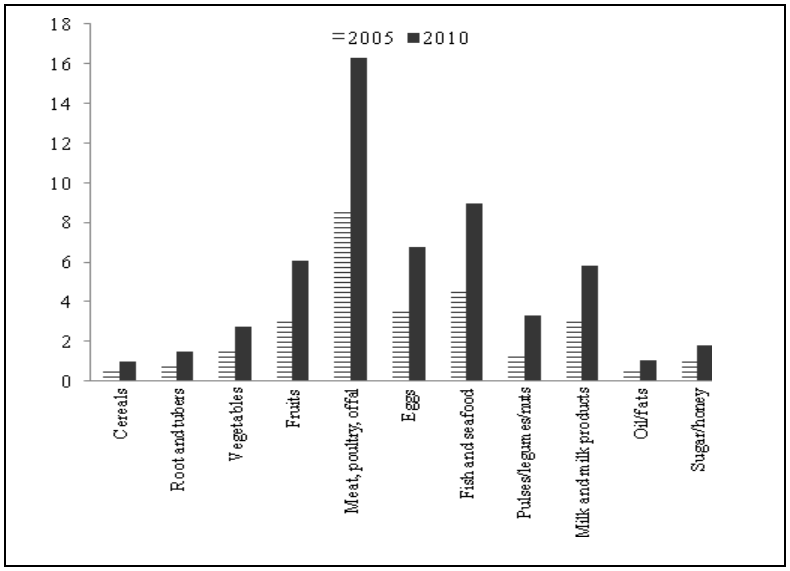
Source: *Household Income and Expenditure Survey* 2005.

Figure 15: **Energy Consumption by Food Groups in 2010**



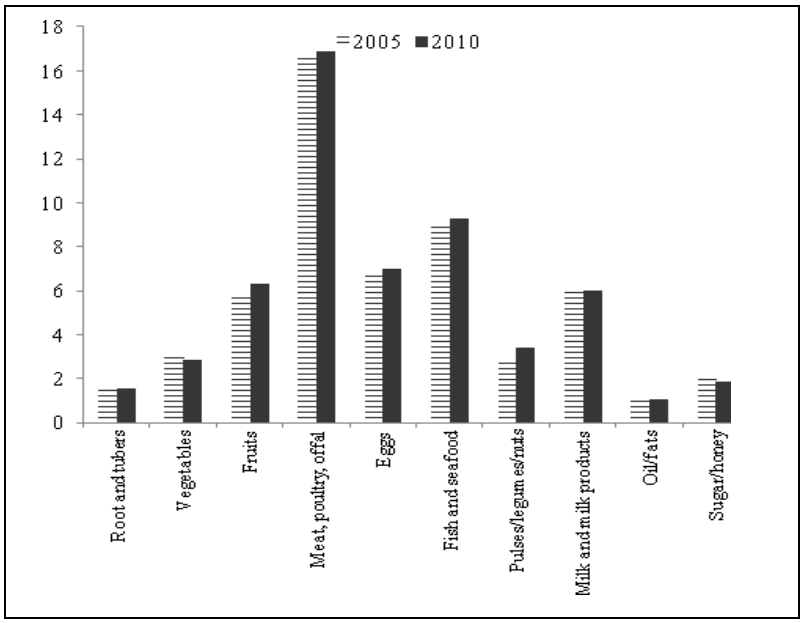
Source: *Household Income and Expenditure Survey* 2010.

Figure 16: **Prices (Nominal) per 100 kcal from Different Food Groups in 2005 and 2010**



Source: *Household Income and Expenditure Survey*, 2005 and 2010.

Figure 17: **Prices relative to Cereals per 100 kcal from Different Food Groups in 2005 and 2010**



Source: *Household Income and Expenditure Survey*, 2005 and 2010.

We also measure the cost (or household spending) per 100 kcal from different food groups. We find households spend on average 0.97 taka for 100 kcal from cereals while they have to spend 1.51 taka per 100 kcal of energy if such energy is coming from the food group of roots and tubers (about 50 percent more than cereals). Perhaps one can conclude there is a lack of incentive for the household to diversify among different food groups even for energy for the households which are otherwise resource constrained.

IV. CONCLUSION

The analysis presented in this paper suggest that a large fraction of households limit their consumption to a small number of food groups, namely cereals (primarily, rice), oil or fat, vegetables, and fish. The consumption of this food basket is insensitive to poverty status, that is, households across all poverty strata consume a similar mix of food groups. In general, while households' consumption of meat products, milk, and eggs is limited, higher income groups are more likely to consume fruits and meat products. Moreover, the DDS-CDF

corresponding to the non-poor stochastically dominates that of the poor, which, in turn, stochastically dominates that of the extremely poor, suggesting that higher income affords households a relatively better dietary diversity. Similarly, higher income households also face lower risk of experiencing chronic dietary diversity deprivation. With regard to spacio-temporal "convergence" in welfare indicators, we find that higher absolute poverty declines, between 2005 and 2010, were associated with higher PSU-level poverty rates in 2005 over the same period. Such relationship does not exist for households' DDS. Finally, the analysis of sources of energy reveals that cereals (rice in particular) provide more than 70 percent of households' total energy intake, a statistic that is true for both 2005 and 2010. This is not surprising, given that cereals remain the cheapest source of energy per unit (for example, the same amount of energy from roots and tubers such as potato cost about 50 percent more).

A vast body of literature shows that dietary diversity is important for health, nutrition, and human capital formation. Our analysis is unique in that we use several measures of dietary diversity to study changes in the dietary diversity of households of an entire population over time. While chronic dietary diversity deficiency is more pronounced among the severely poor households, our most significant finding is that a marginal increase in household income alone will not necessarily lead to improvements in the nutritional status of the population. In fact, irrespectively of their poverty status, households in Bangladesh limit their food consumption to an inadequate number of food items. The chronic feature of low dietary diversity in Bangladesh raises the need for continues monitoring of nutritional practices in Bangladesh as well as for public policy interventions.[16]

A vast body of empirical evidence raises concerns about the disassociation between improvement in dietary quality and economic development in South Asia.[17] Bangladesh is no exception to this puzzle. For example, Bangladesh Demographic and Health Survey (2012) suggests high prevalence of stunting and underweight among children under five over the last decade, indicating nutritional defficiency has remained a cause for concern amidst impressive

[16]For example, policy innovations such as lifestyle interventions (see Sarafzadegan *et al.* 2009) or distribution of certain food items for free (see Lachat *et al.* 2009) have been shown to contribute toward higher dietary diversity. Our findings suggest that public policies and development efforts should experiment with such innovations with more vigour.

[17]See, for example, http://go.worldbank.org/YKEOSEOAQ0.

reduction in poverty in Bangladesh.[18] Our analysis, based on the Household Income and Expenditure Surveys (HIES) carried out in 2005 and 2010, allows us to analyze changes in the DDS of the Bangladeshi population over time as well as to use the same underlying population to test whether the DDS conveys similar welfare information as the expenditure-based measures of welfare used to compute the official poverty estimates for Bangladesh. Our results provide further evidence on the weak association between dietary quality and poverty reduction. Our most salient finding is that a marginal increase in household income alone will not necessarily lead to improvements in the nutritional status of the population. Given the importance of dietary adequacy and vulnerability, particularly among women and children, we conclude that the policy dialogue should pay special attention to the dietary patterns of the Bangladeshis population, going beyond the focus on short-term expenditure-based measures of nutritional status. For example, safety net programs focusing on infant and maternal health and nutrition services may play important roles in linking improvement in poverty reduction to human development and human capital formation in the near future.

[18]For example, anthropometric measures from these surveys reveal persistently high levels of stunting and undernutrition prevalence in the population. Similarly, Giménez *et al.* (2013) estimates suggest that, despite the large poverty declines taking place in Bangladesh between 2000 and 2010, the country is unlikely to meet its Millennium Development Goal of reducing moderate food deficiency (access to fewer than 2,122 kilocalories per person per-day) to 24 percent.

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