How Well Do Household-Level Data Characterize Undernourishment? Evidence from Bangladesh[1]

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Abstract
Although undernourishment is characteristic of the individual, measurement has centered on household-level statistics that make strong assumptions regarding the equitable distribution of calories across household members. Utilizing a novel data source from Bangladesh that reports individual-level calorie intake, we investigate whether households distribute food equitably. We find substantial inequities in the intra-household distribution of calories, with household heads consuming inequitably large shares of total household calories. Furthermore, we find more inequitable calorie distributions among undernourished, poor households. Importantly, these results do not appear to be driven by assumptions about the energy requirements of household members. Due to the inequities, aggregate household-level data misclassify the nutritional status of a large share of the population. These findings have implications for food and nutrition program targeting, which often is based on household-level data.

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Keywords

Bangladesh, Food Consumption, Intra-household Allocation, Food Security, Undernourishment

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1. Introduction

Although undernourishment is a characteristic of the individual, much of its measurement has centered on national-level, and more recently, household-level statistics. The absence of individual-level food consumption data necessitates the identification of undernourished and food-insecure populations with aggregated data (i.e., household or national). These types of assessments have difficulty in precisely estimating how the total available calories are distributed across individuals, and subsequently can provide misleading assessments of undernourishment (e.g., Barrett (2010)). In particular, assessments based on household-level consumption make strict assumptions about the division of calories within a household such that all members share the same food security classification. Such assumptions can make it difficult to effectively target aid programs at the population that most needs assistance.

Although collecting individual-level data is costly (Fiedler, Carletto et al. 2012), there is a growing recognition of the importance of more accurately identifying the food security status of each individual within the household (Barrett 2010). Such measures may be particularly pertinent in countries where there is evidence of gender biases within the household, such as in South Asia (e.g., Jayachandran and Kuziemko (2011)).

In this paper we use data from the Bangladesh Integrated Household Survey (BIHS) to explore the intra-household allocation of food, with an emphasis on the measurement of undernourishment at both the individual and household levels. Bangladesh is an excellent setting in which to better characterize the intra-household distribution of calories. Assessments of undernourishment based on aggregate food availability and based on household-level data suggest that a significant portion of the country is undernourished (e.g., Ahmed, Ahmad et al. 2013, FAO 2013).[3] Furthermore, studies have repeatedly demonstrated that household resources are not distributed equitably across members in Bangladesh. For example, studies have demonstrated that households prefer to have more sons than daughters (e.g., (Mannan 1988)), that sons receive preferential treatment (e.g., (Chen, Huq et al. 1981)), that more bargaining power of women in the household leads to different patterns in household expenditure and investments in human capital (e.g., Quisumbing and Maluccio 2003), and that men consume significantly more calories than women (e.g., Pitt, Rosenzweig et al. 1990).

The BIHS covers over 5,000 households and is representative of rural Bangladesh. The salient component of the survey, for our purposes, is the food consumption data solicited from the female member in charge of cooking, supervising and serving. The module solicits detailed information on foods consumed over the past 24 hours based on free recall of finished food items. The female also provides information on how much each individual household member consumes. Such information

[3] High levels of undernourishment and malnourishment persist in Bangladesh despite substantial improvements in nutrition and health over the past few decades; Headey, et al. (2015) investigate these improvements and examine their drivers.

on the intra-household allocation is not typically solicited in standard household surveys and provides the opportunity to examine intra-household dynamics related to food.

Using this individual-level data, we estimate calorie intake for each household member and we aggregate these calories to the household level. We classify individual members who meet their minimum daily energy requirement (MDER) as adequately nourished, and those who do not as undernourished. Similarly we classify households in which total household calorie availability exceeds the sum of the individual MDERs as adequately nourished, and households in which availability falls short as undernourished. Therefore we can identify undernourished individuals living in adequately nourished households and adequately nourished individuals living in undernourished households – a procedure that allows identification of individuals who would be misclassified when solely relying on aggregated household estimates. Understanding such misclassification is particularly important given that one of the primary benefits of utilizing household-level surveys, as opposed to more aggregated data, is better identification of people suffering from undernourishment.

We find that a significant number of individuals are misclassified using household-level estimates of undernourishment. Overall, 26.4 percent of individuals are misclassified; approximately 24.5 percent of individuals in adequately nourished households do not meet their MDER and nearly 30.2 percent of individuals in undernourished households do meet their MDER. We look at misclassifications across households members and find that the misclassifications stem from household heads consuming inequitably large shares of calories at the expense of all other household members. Household heads make up nearly all those in undernourished households who meet their MDER, and make up a very small portion of those who are undernourished in adequately nourished households.

Importantly, this pattern of misclassification is robust to a number of concerns. First, given the identity of the household members that are misclassified and the large share of the population that is misclassified, it is unlikely that the misclassifications of individuals' nutritional status is being driven by potentially more measurement error in the consumption of individual household members than in the total household consumption.[4] Second, this pattern of misclassification is not an artifact of the MDER of each household member since we find qualitatively similar patterns when varying the MDERs based on employment activity, sex and age. Further, the results are not an artifact of a higher MDER for the household head due to more strenuous activity, as the pattern is identical for households in which the head is engaged in more sedentary forms of employment.

As our measure of household inequity in calorie distribution, we measure an individual's depth of undernourishment (short fall from achieving MDER, in percent) minus the depth of undernourishment of the household head, which we label *relative undernourishment*. We then analyze

[4] The consumption of any individual household member might be reported in error, but the average for the household might mute such errors in individual-level data and correctly classify each individual's nutritional status.

how this measure varies by household nutritional status and how it is associated with proxies for household income and household stressors.

We find that inequity in household food consumption is worse in undernourished and poorer households. In particular, we find that undernourishment of household members, relative to undernourishment of the head is approximately 14 percent larger in undernourished households, and that this pattern holds for all types of household members (boys, girls, spouses, and other members). Additionally we find that relative undernourishment is larger in households with lower non-food expenditure (which we use as a broad proxy for income) and in households that endure stress.

Importantly, given inequities in household consumption, these results suggest that household-level data might be ill-equipped to identify the nutritional status of individual household members. Furthermore, the results demonstrate that the level of inequity in the intra-household distribution of food is most severe for the poorest and most undernourished households. These results suggest that the depth of undernourishment for certain household members is greater than traditional household consumption surveys would suggest, and that even in households in which it is possible to meet each member's daily energy requirement, there are still undernourished individuals.

This paper contributes to the literatures on intra-household allocation and household survey measurement. It analyzes how using surveys that report intra-household consumption might deepen our understanding of food-insecure populations and aid in targeting resources to these most vulnerable individuals. The findings are consistent with a number of studies that demonstrate that resources are not equitably distributed across household members (e.g., Chen, Huq et al. 1981, Strauss, Mwabu et al. 2000, Beaman and Dillon 2012) and that the bargaining power of individual household members affects household expenditure (e.g., Thomas 1990, Udry 1996, de Mel, McKenzie et al. 2009, Martínez 2013).

This article is most closely related to Pitt, Rosenzweig et al. (1990), who find that men consume significantly more calories than women in a 1982 survey of 385 households in rural Bangladesh. The authors attribute this finding to differences in the returns to labor between men and women. Our results generalize their study in a number of ways. First, we demonstrate that the household inequity in consumption exists in a much larger and more representative sample of households. Second, we demonstrate that the asymmetry in calorie consumption between household members has persisted over the past 30 years despite significant increases in income and improvements in the earning power of women. Third, we find that children of both genders consume a disproportionately low share of household calories. And lastly, we find that the differences in calorie consumption cannot be fully explained by differences in labor productivity between household members (i.e., higher associated MDERs), since the differences persist in households in which the head is not engaged in strenuous forms of labor.

The rest of the paper is structured as follows. Section 2 describes the data. Section 3 examines the intra-household allocation of food and demonstrates inequity in calorie consumption within the household, emphasizing the misclassification of individual undernourishment using aggregated household data; section 4 analyzes how calorie inequity varies across households. And Section 5 concludes.

2. Data

Our data come from the Bangladesh Integrated Household Survey (BIHS), designed and supervised by the International Food Policy Research Institute (IFPRI). The survey was conducted between December 2011 and March 2012.[5] A male and female enumerator visited each household and collected very detailed information in 27 separate survey modules. Different modules of the survey used different enumerators depending on the sensitivity of the information requested and the knowledge of individual household members. The sample was selected based on a stratified, multi-stage design. In the first stage, the selection of primary sampling units (villages) within seven strata (the seven administrative divisions in Bangladesh) was based on probability proportional to the total numbers of households in each stratum.[6] Then in the second stage, 20 households were selected from each village. Our sample includes 5,319 households.[7] Using sampling weights, the sample is representative of rural Bangladesh.[8,9]

This paper primarily uses a module that reports food consumption of each individual household member over the past 24 hours.[10] In particular, the enumerator collected details (recipe, ingredients, raw and cooked weights) on foods consumed in the household in the previous day (morning, noon, and night, as well as snacks). The enumerator also collected data on the weight of each ingredient used in the recipe.[11] The female was then asked about the amount of each recipe eaten by individual household members, as well as guests, including information on why a meal might not have been

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[5] The survey time frame does not include traditional lean seasons in Bangladesh, in which food insecurity is at its peak. Thus our estimates of the population of individuals in rural Bangladesh who are food insecure are likely to be low compared to estimates done using data from the lean season. Ramadan, the Muslim holy month of fasting, is not included either.

[6] The total number of households in each stratum was based on the 2001 population census.

[7] The final sample includes households in which calorie intakes of the household head and at least one other member are positive.

[8] The sample weights were adjusted using the 2011 population census sampling frame.

[9] The BIHS also includes a survey of other zones of the country, which are targeted to receive assistance from a U.S. Government-led program to reduce global hunger (Feed the Future). In this paper, we only include the households that are representative of rural Bangladesh, and exclude other surveyed households.

[10] To capture individual-level consumption, nutritionists prefer to utilize observed-weighed food records (OWFR) or individual 24-hour recall surveys to more accurately characterize food consumption to enable more evidence-based nutrition policies (Fiedler, et al. 2012). OWFR's are a recordation of the food an individual consumed over a specified time period that is precisely weighed so as to more accurately capture food consumption; 24-hour recall surveys elicit what an individual consumed over the past 24 hours.

taken (e.g., the individual was sick or fasting). Data on leftovers, food given away and fed to animals were collected as well, though we do not utilize this information in the analysis.

To calculate total daily household calories, we map nutritional information from Gopalan, Rama Sastri et al. (1989) to quantities for each of the 300 individual ingredients included in the module.[12] Using this information, we calculate an individual-level daily calorie measure. We also calculate a household measure – daily calories per adult equivalent, which is calculated by dividing total daily household calories by total household "young adult equivalents". The adult equivalents are based on a requirement of 2,100 daily calories and incorporate information on the age and gender of members.[13] (Appendix Table 1 presents the MDER for each type of household member.) These MDER values are estimated by the Government of India based on age and gender (as described in National Sample Survey Organization (2007)).[14]

Table 1 displays rural population averages of key characteristics of the households. Consistent with the high prevalence of food insecurity in Bangladesh in global assessments (e.g., FAO 2013, Rosen, Meade et al. 2014), households in rural Bangladesh are relatively poor and at risk for a high prevalence of food insecurity. The rural population in Bangladesh exhibits significant signs of undernourishment, which we define as falling short of minimum daily energy requirement (i.e., daily calories per adult equivalent less than 2100). Daily calories per adult equivalent is 2,434, with 33 percent of the rural population of Bangladesh classified as undernourished. Households devote a high share (58 percent) of their overall budget to food expenditures, are primarily involved in agriculture, and nearly 50 percent of adults are illiterate and have never attended school.[15]

Most household heads are male, with an average age of 44, and the vast majority married. Less than half of the household heads ever attended school, and less than half are literate. Approximately 55 percent of heads are employed in the agricultural sector. (We provide analogous statistics for the

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[11] An example of a recipe is chicken curry, which includes the ingredients chicken, onions, and tomatoes.
[12] We convert liquid amounts to grams using the density of each liquid.
[13] In the literature some studies report per capita calories regardless of the gender or age of the household members (e.g., Subramanian and Deaton (1996); Deaton and Dreze (2009)), while others partially account for differing calorie requirements by counting each child as half an adult household member (e.g., Hicks (forthcoming)). Still others create household equivalence scales using data to estimate parameters associated with the resource cost of children relative to adults and household economies of scale; see Cutler and L. Katz (1992) for an application to U.S. income and consumption.
[14] We use MDERs calculated by the Government of India because we were unable to find similarly detailed MDERs used by the Government of Bangladesh. The MDERs used by the Government of India are likely a good approximation for energy requirements in Bangladesh given similar genetic and socio-economic makeups of the two countries. Similarly, the World Health Organization uses a sample of Indian children to construct anthropometric benchmarks (to determine the prevalence of stunting and wasting) for all of South Asia, including Bangladesh (WHO Multicentre Growth Reference Study Group (2006)).
[15] The value of food expenditure is the sum of the value of food purchased outside the home and the value of food produced at home and gifts. To value food produced at home and gifts, we use median unit-value prices taken from the nearest geographical area, given a minimum of three unit-price observation. The minimum of three price observations helps to insure that the price represents the area and to guard against potential outliers. The value of non-food expenditure is the sum of all reported expenditures on non-food items. Items were either reported for the previous month or the previous year; annual expenditure was divided by 12 to get monthly figures.

spouses of household heads.[16]) The average household size is 4.55. Approximately 81 percent of households contain a household head, a spouse, and at least one child. Alternatively, approximately 17 percent of households in the sample do not include a spouse but include children; whereas approximately 3 percent of households do not include a spouse or children. (Appendix Table 2 provides a detailed breakdown of the 5,319 households based on number of adults and children.)

3. Calorie Inequities within the Household and the Misclassification of Individual Undernourishment

The BIHS data provide a window into intra-household dynamics between men and women, boys and girls, and household heads and their spouses in rural Bangladesh.[17] There is a vast literature on the intra-household allocation of goods, including food, which reveals (at times) large variation across household members.[18] There are many reasons for an unequal distribution of food within a household. Households may allocate food based on age, sex, pregnancy or lactation status, and activity levels (e.g., those working out in the field may require more calories than those staying at home). Additionally they may allocate food based on cultural practices and preferences, for example, favoring one sex over another, favoring the household head relative to other members, or favoring children relative to adults.

We use the BIHS data to examine whether interesting and informative patterns of food consumption emerge when looking across groups of individuals, i.e., household heads and their spouses, and boys and girls (under the age of 18).[19] We take into account the individuals' calorie requirements based on age, sex, and pregnancy or lactation status. Specifically, we examine whether some members receive a inequitably large share of household calories by identifying members who are undernourished despite living in households where total member MDER is met, and members who are more adequately nourished despite living in households where total member MDER is not met. We label these individuals as *misclassified*. Knowing the degree of individual misclassification of undernourishment based on household-level measures is important since aid programs often target households, implicitly assuming that all individuals within a household share the same food security classification.

Table 2 displays the shares of individuals who are misclassified, by type of household member, and by type of household (i.e., adequately nourished versus undernourished). The last row reports the statistical differences between the estimates for adequately nourished and undernourished households. Overall, the results demonstrate that approximately 26.4 percent of the population is

[16] There are 12 households with two wives; we have included characteristics from the older wife.

[17] We exclude consumption by guests since our focus is on differences across household members. We also exclude food given to animals.

[18] See Strauss, Mwabu, and Beegle (2000) for a summary.

[19] The patterns for men and women are extremely similar to the patterns for household heads and their spouses, respectively; thus we do not show the results for men and women, but they are available upon request.

misclassified; this number ranges from approximately 18 to 33 percent, based on the type of member. This finding underscores the value of individual-level food consumption data. Simply looking at total daily calories and total daily MDER requirements for a household would miss important differences across individuals, many of whom could be potentially mistargeted by a program or policy designed to reach vulnerable groups. Further the share of misclassified individuals is 6 percentage points larger in undernourished households than in adequately nourished households.

While the magnitudes of these shares are large when looking at all households together, these results mask important differences based on whether the household has enough total calories to cover total nutritional requirements. Therefore, we estimate these shares for adequately nourished and undernourished households. Some striking patterns emerge. In the adequately nourished households, it is rare that the household head is misclassified (and thus undernourished). Only 3 percent of household heads are misclassified in this way. In the undernourished households, we find the other extreme; most misclassification is driven by household heads, 68.5 percent of whom are misclassified (and thus adequately nourished). In contrast, the share of non-household heads that are undernourished in adequately nourished households ranges between 9 and 38 percent. These patterns suggest that household heads are consuming an inequitably large share of household calories at the expense of other household members. Figure 1, which presents the share of individuals misclassified based on household type and household head status, shows this pattern in a stark way.

Sensitivity analysis

Before further characterizing these calorie inequities, we examine and discuss the sensitivity of the misclassification results. First, we might be concerned that the misclassification of individual undernourishment is simply due to measurement error. In particular, the individual-level data are likely to be noisier than the aggregated household data since aggregating to the household level may cancel out individual-specific measurement errors. Therefore assuming that the household data correctly identify households that are undernourished and those that are not, we might expect to observe (spuriously) a certain degree of misclassification at the individual level even if none exists.

We argue that this explanation is unlikely. First, the magnitude of the misclassifications (over a quarter of individuals) would imply a very high incidence of measurement error for a very carefully and thoroughly conducted survey. Second, the likelihood of being misclassified is related to the type of household member; Table 3 presents results from a model estimating whether being a household head affects the probability of misclassification in either an adequately nourished or an undernourished households.[20] Columns (1)-(3) demonstrate that heads are more likely to be misclassified in undernourished households; and columns (4)-(6) demonstrate that heads are less

[20] Table 3 reports the p-values from a test of overall significance for each specification. In all instances, the p-value is significant at the one percent level and is approximately equal to zero. We use a linear probability model; results using a Probit model are qualitatively similar and are available upon request.

likely to be misclassified in adequately nourished households. If our results were being driven by measurement error alone, we would expect no correlation between the identity of the household member and the probability of misclassification.

We might also be concerned that measurement error in the MDER estimates biases our results. MDER estimates could be especially problematic for individuals employed in agricultural activities (such as the household head or spouse) who may be performing more strenuous forms of labor and could have higher requirements than we are estimating. It could also be problematic for young children who require relatively few calories, since small mistakes in their MDER could have significant impacts on the determination of undernourishment.

We perform a series of sensitivity analyses to determine whether the misclassification of undernourishment is robust to perturbations in individual MDERs based on employment status, sex and age. For each perturbation, we re-estimate rates of misclassification by household undernourishment status and household member (comparable to Table 2). It is important to note that when varying the MDERs, the numbers of households that are classified as undernourished and adequately nourished can (and do) slightly change. Therefore even members whose requirements stay the same may change misclassification status relative to the baseline results.[21]

First we increase the nutritional requirements for all individuals engaged in agricultural activities by a factor of 1.14 (or 2400/2100), a convention used by the Government of India (top panel of Table 4). The patterns across households and across members are qualitatively similar to the original results. (The results – not shown – are qualitatively identical if we simply exclude households in which the head is engaged in agricultural labor, which suggests the inequitable distribution of calories is present in households where the household head is engaged in more sedentary occupations.) The results are also robust to a more extreme assumption, under which we increase the requirements only for household heads engaged in agricultural labor (by a factor of 1.14) and simultaneously reduce the requirements of all the other members by 10 percent (bottom panel of Table 4). Such an adjustment would necessarily reduce the inequity in household consumption between the household head and other household members. However, since undernourished household members are consuming significantly below their MDER, and adequately nourished household members are consuming significantly above their MDER, the pattern of misclassification is qualitatively identical to the baseline results presented in Table 2.

Next we systematically vary the nutritional requirements of household heads, children under the age of 15, and women of child-bearing age. For household heads, we increase the MDERs and for the children and women, we decrease the MDERs, in each case holding constant the requirements of other members; as above, these assumptions would dampen the strong pattern of misclassification

[21] For small changes in the MDER, there are few households that change undernourishment status. However, as the perturbations get larger and larger, a significant number of households change their classification status, moving to being classified as undernourished (as we increase the requirements of household heads) and moving to being classified as adequately nourished (as we decrease the requirements of women or children).

we find above. Table 5 displays the shares of misclassification across households and members, under varying assumptions about nutritional requirements for heads. Increasing the MDER of heads by 10 percent has little effect on the patterns found above. Increasing by 20 percent causes the misclassification of heads to look more similar to the misclassification of spouses and other members; however children continue to do poorly relative to heads. As we continue to increase the requirements, the differences in misclassification diminish; however heads display an advantage relative to non-heads until their MDERs are increased by over 30 percent. These basic patterns can be seen in Figures 2a – 2d, which display results for heads and non-heads (and is comparable to Figure 1). Once the MDER for the household head is increased by 40 percent, we see that the pattern is reversed and that heads are more likely to be undernourished in an adequately nourished household and less likely to be adequately nourished in an undernourished household. However, a 40 percent increase for a young, adult male would be an MDER of nearly 3000 daily calories, which is far larger than MDERs used by other policymakers and researchers (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, and National Institute of Nutrition 2009).[22]

Next we decrease the nutritional requirements of children, again focusing on the misclassification relative to household heads (Figures 3a – 3e). We find that the rates of misclassification of children do not become similar to those of the head until we reduce their requirements by 50 percent, which correspond to MDERs far too small for children to be plausible (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, and National Institute of Nutrition 2009). Analogously, when we decrease the requirements for women of childbearing age (Figures 4a – 4e), we find that their rates of misclassification become similar to those of the head with 40 to 50 percent requirement reductions; again, there requirements are too small to be plausible (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, and National Institute of Nutrition 2009).

While MDERs are unobservable and relate to physical characteristics and activity levels, the sensitivity analysis shows that the strong patterns of misclassification found above hold except under very extreme (and largely implausible) assumptions. Therefore the robustness of the main results on misclassification, both qualitatively and in relative magnitudes, suggest that the measure of misclassification detects relatively large inequities in the distribution of calories and that these inequities are not artifacts of the specific MDERs utilized in this analysis.

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[22] There are some MDERs for adult males doing very rigorous work which could reach 3000 daily calories (e.g., National Institute of Nutrition 2009). However it is implausible to assume that all household heads are engaged in such rigorous work, given that approximately half of the household heads are employed outside of agricultural production.

4. Calorie Inequities and Household Stressors

In this section we examine the intra-household calorie inequities in further detail and look at whether they are worse for households under stress. We characterize the inequitable distribution of calories within a household by calculating the undernourishment of non-head household members, relative to the undernourishment of the household head. We begin by calculating undernourishment at the individual level, defined as a shortfall in MDER in percentage terms and labeled as the *depth of undernourishment*.

$$Depth\ of\ undernourishment_{ih} = \begin{cases} \dfrac{MDER_{ih} - Calories_{ih}}{MDER_{ih}} & if\ Calories_{ih} < MDER_{ih} \\ 0 & otherwise \end{cases}$$

where *i* denotes an individual in household *h*, *MDER* continues to denote the minimum daily energy requirement, and *Calories* denotes daily calorie intake. We then define *relative undernourishment* for all non-head members as:

$$Relative\ Undernourishment_{ih} = Depth\ of\ undernourishment_{ih} - Depth\ of\ undernourishment_{head\ h}$$

where *head* indicates the household head and all symbols are as above. The results show a stark pattern (see Table 6). While the average depth of individual undernourishment is 11 percent, the estimates vary greatly across household members.[23] Strikingly the average depth of undernourishment for household heads is only 3 percent, whereas the average depth is magnitudes larger for all other members. And spouses and other adults have smaller depths of undernourishment than children.

We hypothesize that the household food distribution may be more inequitable in more stressful situations, such as in households that are undernourished or poor, or in households that have recently experienced negative economic shocks. To test this hypothesis, we first estimate the following specification:

$$Relative\ Undernourishment_{ihv} = \alpha_v + \beta Undernourished_{hv} + \pi HH_{hv} + \pi IND_{ihv} + \mu_{ihv} \quad [1]$$

where *v* denotes the village; α denotes village dummies; *Undernourished Household* denotes an indicator equaling one if the household is undernourished; *HH* include the number of boys and girls and following household head characteristics: sex, age, and indicators for marital status, literacy, education level, agricultural occupation; *INDs* include spouse, boy, and girl indicators (other members is the excluded category); and μ is the error term (which allows for heteroskedasticity and is clustered at the household-level). (Other symbols are as above.) We include the village dummy variables to absorb unobserved heterogeneity at the village level, such as food price increases, that

[23] Note that these estimates are based on all individuals, not just those who are undernourished.

could affect simultaneously undernourishment and household inequities. We include *HH* and *IND* since they may contribute to undernourishment within a household.[24]

The coefficient of interest, β, captures how relative undernourishment at the individual level varies between undernourished and adequately nourished households. If β is positive, it indicates that the inequity in the distribution of calories is larger in undernourished households, and would be consistent with inequity in household calorie consumption being worse in more stressful situations.

The results are displayed in Table 7. Column (1) estimates a sparse specification; column (2) adds the additional household and individual variables; and column (3) adds village dummy variables. All estimates suggest that the inequity in household consumption is worse for undernourished households than for adequately nourished households. The most complete specification in column (3) demonstrates that the depth of undernourishment for non-head members relative to the household head is 13.8 percentage points larger in undernourished households than in adequately nourished households. Importantly, the estimate hardly varies between columns (1) and (3), even after a variety of other variables and village dummies are included in the model.

In the last section, we saw that relative undernourishment varied across household members, so in column (4) we introduce interactions between the indicator for undernourished households and the indicators for spouse, boy, and girl. Therefore in these specifications, the coefficient on Undernourished Household represents how much relative undernourishment varies between undernourished and adequately nourished households for Other Members (the excluded category), while the coefficients on each interaction term represent how much larger the difference in relative undernourishment is for that type of member than the difference for Other Members.

The results demonstrate that in undernourished households, relative undernourishment is worse among spouses, boys, and girls relative to other members. The p-value of a test of the coefficients on all interaction terms equaling zero is equal to 0.00. These results suggest that household heads consumed a disproportionate share of household calories compared to all non-head members, and that this inequity is worse in households where total MDER is not met.

To analyze further these patterns, we look at the relationship between relative undernourishment and income. We use non-food expenditure as a proxy for household income. In surveys conducted in developing countries, total expenditure or consumption is often used as a proxy for income since income data are often less reliable; here we use non-food expenditure alone and exclude food expenditure since undernourishment is related to the food consumption data, and thus measurement error in the data could produce spurious correlations (e.g., Borjas (1980)).

[24] Results are qualitatively identical if we include characteristics of the spouse of the head, though our sample shrinks slightly because not all household heads are married.

We replace the indicator for Undernourished Household with the natural logarithm of household non-food expenditure and re-estimate specification [1]. Now, the coefficient of interest, β, captures how relative undernourishment varies with non-food expenditure. We expect β to be negative if inequity in household calorie consumption is worse in more stressful situations.

The results are displayed in the top panel of Table 8. Each regression coefficient comes from a separate regression with specifications analogous to columns (1) – (3) in Table 7. We find that if non-food expenditure increases by 10 percent, relative undernourishment decreases by 0.23 percentage points, suggesting that in richer households, food is more equitably distributed. Non-food expenditure, however, is correlated with a number of omitted factors that also likely to affect the distribution of household calories (e.g., bargaining power of women in the household). Or there could be an unobserved shock that is driving the changes in both non-food expenditure and calorie inequities. Therefore we explore other household stressors.

We estimate specification [1], replacing Undernourished Household with an indicator for whether the household lost assets due to flooding over the past five years. β will be positive if a negative shock (i.e., flood) to the household stresses resources and increases inequity in household consumption. The estimates (shown in the middle panel of Table 8) suggest that losing assets due to flooding increases relative undernourishment (though the coefficients are not as precisely estimated as those in the top panel.) The most complete specification demonstrates that the depth of undernourishment for each household member relative to the household head is 5 percentage points larger in households that lost assets due to flooding, relative to households that did not lose assets due to flooding.

Finally we look at an increase in family size as an alternative household stress. Larger family sizes likely place additional strain on scarce family resources. We utilize data on birth-order to estimate how family size might affect relative undernourishment. Given the preference for sons in South Asia (e.g., Mannan (1988) Chen, Huq et al. (1981)), having a girl as a first child is likely to lead to a larger total number of children since couples may continue having children to try for a male (e.g., Rosenzweig and Wolpin (2000)).[25] The specifications in the bottom panel of Table 8 replace Undernourished Household in specification [1] with an indicator for household with a female first child as the stressor. The estimates suggest that having a female first child increases relative undernourishment by approximately 0.015 percentage points based on the most complete specification.

The uniformity of results across different household stressors in Table 8 provides supportive evidence that inequities in household food consumption are more likely in poorer, more stressed households. However, there may be unobservable factors that are leading to spurious correlations. For example, the worst-off households (e.g., socially discrimination, etc.) may occupy the worst land

[25] Appendix Table A3 demonstrates that households with a first-born daughter are larger than households with a first-born son.

(i.e., most susceptible to flooding). And given the ability of households to detect the gender of children before birth, households that have a girl as the first child might be self-selected (e.g., those who are least able to access ultrasound technology).

6. Conclusion

In this paper, we utilize a novel data source to estimate calorie consumption at both the household and individual level. We use data from the Bangladesh Integrated Household Survey (2011-2012). In particular, our analysis utilizes data on 24-hour recall of consumption of finished recipes by each individual. First, we find aggregate household consumption data misclassify over a quarter of the population of rural Bangladesh compared to individual data on calorie intake. Second, we find significant inequity in the distribution of calories within the household, with the head of the household consuming a disproportionate share of calories relative to other members. Third, we find the worst inequities in the distribution of calories amongst undernourished, poor households.

These results are potentially informative in the targeting of food aid programs. In particular, there are a sizable number of individuals who are adequately nourished who might be targeted to receive food aid, and there are a sizable number of individuals who are undernourished who might not receive aid. Potentially targeting children outside the household (e.g., school lunch programs) or females in charge of food preparation might be important tools in combating persistent malnourishment in Bangladesh given our findings on the underestimate of undernourishment of non-household heads when using the aggregate household data. While such programs may not be sufficient to equalize the intra-household distribution of food if offsets occur, our findings underscore the importance of accounting for intra-household dynamics by policymakers when identifying and targeting food-insecure populations.

In drawing conclusions from the results, there are a number of issues to note. First, our calorie estimates are based on information gathered from one respondent (a proxy) about other household members. It is possible that the female respondent misreports the food consumed by other members. If systematic, e.g., reporting that the head consumes a lot or that boys and girls consume equal shares, such measurement error could bias our results. Although this is possible, some of the reported patterns in household consumption make this explanation unlikely to be driving all the results. Specifically, the reported pattern where the head's spouse consumes closer to her MDER than the household children is in direct contradiction with social pressures in South Asia, which would put pressure on the spouse to sacrifice her consumption for the well-being of her children (e.g., Sen (1990)).

Second, the short recall period for individual-level consumption might not accurately capture the intra-household allocation of food. For example, inter-day variation in food consumption among members in a short time frame could exaggerate or understate the true distribution of calories;

however we argue that such measurement error is of the classical sense and would lead to attenuation bias.[26]

Lastly, it is difficult to understand how well the specific patterns we observe in rural Bangladesh, where household heads consume a disproportionate share of household calories, might generalize to other contexts. In particular, it has been found in pastoralists in Eastern Africa that the household head makes nutritional sacrifices in the face of hardship (Villa, et al. (2012)). However, the existence of inequity in household consumption has been corroborated in numerous contexts (e.g., Chen, Huq et al. 1981, Strauss, Mwabu et al. 2000, Beaman and Dillon 2012).

References

Ahmed, A. U., K. Ahmad, V. Chou, R. Hernandez, P. Menon, F. Naeem, F. Naher, W. Quabili, E. Sraboni and B. Yu (2013). The Status of Food Security in the Feed the Future Zone and Other Regions of Bangladesh: Results from the 2011–2012 Bangladesh Integrated Household Survey. Washington, D.C., International Food Policy Research Institute.

Barrett, C. B. (2010). "Measuring Food Insecurity." Science 327(5967): 825-828.

Beaman, L. and A. Dillon (2012). "Do household definitions matter in survey design? Results from a randomized survey experiment in Mali." Journal of Development Economics 98(1): 124-135.

Borjas, G. J. (1980). "The Relationship between Wages and Weekly Hours of Work: The Role of Division Bias." The Journal of Human Resources 15(3): 409-423.

Chen, L. C., E. Huq and S. D'Souza (1981). "Sex Bias in the Family Allocation of Food and Health Care in Rural Bangladesh." Population and Development Review 7(1): 55-70.

Cutler, D. and L. Katz (1992). "Rising Inequality? Changes in the Distribution of Income and Consumption in the 1980s." American Economic Review 82(2): 546-551.

Dary, O. and Z. R. Jariseta (2012). "Validation of dietary applications of Household Consumption and Expenditures Surveys (HCES) against a 24-hour recall method in Uganda." Food Nutr Bull 33(3 Suppl): S190-198.

de Mel, S., D. McKenzie and C. Woodruff (2009). "Are Women More Credit Constrained? Experimental Evidence on Gender and Microenterprise Returns." American Economic Journal: Applied Economics 1(3): 1-32.

Deaton, A. and J. Dreze (2009). "Food and Nutrition in India: Facts and Interpretations." Economic and Political Weekly XLIV(7): 42-65.

FAO (2013). The State of Food Insecurity in the World. Rome, FAO.

Fiedler, J. L., C. Carletto and O. Dupriez (2012). "Still waiting for Godot? Improving Household Consumption and Expenditures Surveys (HCES) to enable more evidence-based nutrition policies." Food & Nutrition Bulletin 33(3): 242S-251S.

[26] Further some studies find little difference between calorie estimates from 24-hour recall periods for each individual surveyed and from 7-day recall periods for an entire household (e.g., Sekula, et al. (2005); Dary and Jariseta (2012); Jariseta, et al. (2012)).

Food and Agricultural Organization (FAO), U. N. (2001). Human Energy Requirements- Report of a Joint FAO/WHO/UNU Expert Consultation. Food and Nutrition Technical Report Series. Rome, Food and Agricultural Organization (FAO), United Nations.

Gopalan, C., B. V. Rama Sastri and S. C. Balasubramanian (1989). Nutritive Value of Indian Foods. I. C. o. M. R. National Institute of Nutrition. Hyderabad, India.

Headey, D., J. Hoddinott, D. Ali, R. Tesfaye and M. Dereje (2015). "The Other Asian Enigma: Explaining the Rapid Reduction of Undernutrition in Bangladesh." World Development 66(0): 749-761.

Hicks, D. (forthcoming). "Consumption Volatility, Marketization, and Expenditure in an Emerging Market Economy." American Economic Journal: Macroeconomics.

Jariseta, Z. R., O. Dary, J. L. Fiedler and N. Franklin (2012). "Comparison of estimates of the nutrient density of the diet of women and children in Uganda by Household Consumption and Expenditures Surveys (HCES) and 24-hour recall." Food & Nutrition Bulletin 33(3): 199S-207S.

Jayachandran, S. and I. Kuziemko (2011). "Why Do Mothers Breastfeed Girls Less than Boys? Evidence and implications for Child Health in India." The Quarterly Journal of Economics.

Mannan, M. A. (1988). "Preference for Son, Desire for Additional Children and Contraceptive Use in Bangladesh." The Bangladesh Development Studies 16(3): 31-57.

Martínez, C. (2013). "Intrahousehold Allocation and Bargaining Power: Evidence from Chile." Economic Development and Cultural Change 61(3): 577-605.

National Institute of Nutrition, G. o. I. (2009). Nutrient Requirements and Recommended Dietary Allowances for Indians. Report of the Expert Group of the Indian Council of Medical Research. Hyderabad, National Institute of Nutrition.

National Sample Survey Organization (2007). Nutritional Intake in India 2004-2005, Ministry of Statistics and Programme Implementation. Report No. 513.

Pitt, M. M., M. R. Rosenzweig and M. N. Hassan (1990). "Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries." The American Economic Review 80(5): 1139-1156.

Quisumbing, A. R. and J. A. Maluccio (2003). "Resources at Marriage and Intrahousehold Allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa*." Oxford Bulletin of Economics and Statistics 65(3): 283-327.

Rosen, S., B. Meade, K. Fuglie and N. Rada (2014). International Food Security Assessment, 2014-2024. Washington, D.C., U.S. Department of Agriculture, Economic Research Service.

Rosenzweig, M. R. and K. I. Wolpin (2000). "Natural "Natural Experiments" in Economics." Journal of Economic Literature 38(4): 827-874.

Sekula, W., M. Nelson, K. Figurska, M. Oltarzewski, R. Weisell and L. Szponar (2005). "Comparison between household budget survey and 24-hour recall data in a nationally representative sample of Polish households." Public Health Nutr 8(4): 430-439.

Sen, A. (1990). Gender and Cooperative Conflict. Persistent Inequalities: Women and World Development. I. Tinker. New York, Oxford University Press: 123-149.

Strauss, J., G. Mwabu and K. Beegle (2000). "Intrahousehold Allocations: a Review of Theories and Empirical Evidence." Journal of African Economies 9(Supplement 1): 83-143.

Subramanian, S. and A. Deaton (1996). "The Demand for Food and Calories." Journal of Political Economy 104(1): 133-162.
Thomas, D. (1990). "Intra-Household Resource Allocation: An Inferential Approach." The Journal of Human Resources 25(4): 635-664.
Udry, C. (1996). "Gender, Agricultural Production, and the Theory of the Household." Journal of Political Economy 104(5): 1010-1046.
WHO Multicentre Growth Reference Study Group (2006). WHO Child Growth Standards. Geneva, World Health Organization.

Table 1. Household Characteristics

Average Daily Calories per Adult Equivalent	2434	(26.11)
Share of Population that is Undernourished	0.33	(0.69)
Per Capita Weekly Non-Food Expenditure (in Taka)	300.3	(20.18)
Per Capita Weekly Food Expenditure (in Taka)	331.8	(12.95)
Share of Expenditure Devoted to Food	0.58	(0.38)
Household Size	4.55	(1.30)
Adult Equivalents	4.22	(1.27)
Number of Boys	0.96	(0.94)
Number of Girls	0.98	(0.98)
Observations	5,319	
Characteristics of the Household Head		
Share of Household Heads that are Male	0.87	(0.58)
Average Age of Household Head	44.2	(3.66)
Share of Household Heads that are Married	0.94	(0.48)
Share of Household Heads that are Literate	0.46	(0.71)
Share of Household Heads that Never Attended School	0.50	(0.71)
Share of Household Heads that Finished Secondary School	0.08	(0.53)
Share of Household Heads that are Employed in Agriculture	0.55	(0.71)
Observations	5,319	
Characteristics of the Household Head's Spouse		
Average Age of Spouse	37.1	(3.40)
Share of Spouses that are Male	0.005	(0.27)
Share of Spouses that are Literate	0.47	(0.71)
Share of Spouses that Never Attended School	0.49	(0.71)
Share of Spouses that Finished Secondary School	0.04	(0.44)
Share of Spouses that are Employed in Agriculture	0.53	(0.71)
Observations	4,294	

Notes: Population-weighted means, with standard deviations in parentheses. Source: Bangladesh Integrated Household Survey.

Table 2. Share of Individuals Misclassified with Household-level Measures

Full Sample	Heads	Spouses	Boys	Girls	Other Members
(1)	(2)	(3)	(4)	(5)	(6)
All Households					
0.264	0.245	0.182	0.325	0.322	0.235
(0.004)	(0.008)	(0.007)	(0.008)	(0.009)	(0.008)
21,795	5,319	4,281	4,345	4,306	3,544
Adequately Nourished Households					
0.245	0.030	0.149	0.465	0.429	0.190
(0.005)	(0.003)	(0.007)	(0.011)	(0.012)	(0.009)
14,679	3,617	2,950	2,690	2,696	2,726
Undernourished Households					
0.302	0.685	0.251	0.094	0.141	0.384
(0.005)	(0.013)	(0.014)	(0.008)	(0.011)	(0.018)
7,116	1,702	1,331	1,655	1,610	818
Differences between Adequately Nourished and Undernourished Households					
-0.062***	-0.630***	-0.079***	0.368***	0.295***	-0.200***
[0.006]	[0.009]	[0.012]	[0.013]	[0.014]	[0.016]

Notes: Population-weighted means, with standard errors in parentheses, and number of observations listed below. In adequately nourished households total calorie availability exceeds total household MDER; in undernourished households total calorie availability is less than total household MDER. The fourth row presents the differences between the second and third rows, where *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level. Source: Bangladesh Integrated Household Survey.

Table 3. Probability of Misclassification

Dependent Variable:	Indicator if Individual is Undernourished in an Adequately Nourished Household			Indicator if Individual is Adequately Nourished in an Undernourished Household		
	(1)	(2)	(3)	(4)	(5)	(6)
Indicator for Head	-0.176***	-0.101***	-0.100***	0.153***	0.110***	0.108***
	[0.004]	[0.006]	[0.006]	[0.005]	[0.007]	[0.007]
Control Variables	N	Y	Y	N	Y	Y
Village Dummies	N	N	Y	N	N	Y
R^2	0.04	0.09	0.11	0.05	0.08	0.11
P-value of test of all coefficients equaling zero	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Observations	21,795	21,795	21,795	21,795	21,795	21,795

Notes: Population-weighted regression coefficients with heteroskedastic-robust standard errors in brackets. Control variables include number of boys, number of girls, age of household head and indicators for household head being male, married, literate, working in agriculture, having no formal schooling, and having secondary schooling. *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level. Source: Bangladesh Integrated Household Survey.

Table 4. Misclassification under Varying Nutritional Requirements based on Employment

Full Sample	Heads	Spouses	Boys	Girls	Other Members
(1)	(2)	(3)	(4)	(5)	(6)
Higher requirement for all individuals engaged in agricultural labor					
All Households					
0.259	0.267	0.196	0.292	0.291	0.242
(0.004)	(0.007)	(0.006)	(0.009)	(0.009)	(0.008)
21795	5319	4281	4345	4306	3544
Adequately Nourished Households					
0.239	0.045	0.165	0.435	0.401	0.187
(0.005)	(0.004)	(0.008)	(0.012)	(0.013)	(0.010)
13385	3309	2671	2411	2450	2544
Undernourished Households					
0.291	0.613	0.244	0.110	0.146	0.380
(0.005)	(0.012)	(0.012)	(0.008)	(0.010)	(0.015)
8410	2010	1610	1934	1856	1000
Higher requirement for heads engaged in agricultural labor and lower requirements for all other members					
All Households					
0.232	0.188	0.163	0.308	0.294	0.202
(0.004)	(0.006)	(0.006)	(0.008)	(0.009)	(0.008)
21795	5319	4281	4345	4306	3544
Adequately Nourished Households					
0.208	0.075	0.118	0.373	0.338	0.154
(0.004)	(0.005)	(0.006)	(0.011)	(0.011)	(0.008)
16228	3959	3228	3044	3063	2934
Undernourished Households					
0.302	0.513	0.297	0.149	0.184	0.433
(0.007)	(0.016)	(0.016)	(0.011)	(0.014)	(0.021)
5567	1360	1053	1301	1243	610

Notes: Population-weighted means, with standard errors in parentheses, and number of observations listed below. In adequately nourished households total calorie availability exceeds total household MDER; in undernourished households total calorie availability is less than total household MDER. Source: Bangladesh Integrated Household Survey.

Table 5. Misclassification under Varying Nutritional Requirements for Household Heads

Full Sample	Heads	Spouses	Boys	Girls	Other Members
(1)	(2)	(3)	(4)	(5)	(6)
		10% Increase in MDER			
		All Households			
0.255	0.243	0.179	0.300	0.303	0.242
(0.004)	(0.007)	(0.006)	(0.008)	(0.010)	(0.008)
21795	5319	4281	4345	4306	3544
		Adequately Nourished Households			
0.238	0.057	0.128	0.441	0.413	0.184
(0.005)	(0.005)	(0.007)	(0.011)	(0.013)	(0.010)
13861	3413	2788	2503	2548	2609
		Undernourished Households			
0.284	0.564	0.271	0.103	0.140	0.403
(0.005)	(0.013)	(0.013)	(0.008)	(0.009)	(0.017)
7934	1906	1493	1842	1758	935
		20% Increase in MDER			
		All Households			
0.250	0.237	0.186	0.288	0.292	0.240
(0.003)	(0.007)	(0.007)	(0.008)	(0.010)	(0.008)
21795	5319	4281	4345	4306	3544
		Adequately Nourished Households			
0.236	0.106	0.111	0.424	0.398	0.172
(0.005)	(0.006)	(0.007)	(0.012)	(0.013)	(0.010)
13179	3226	2647	2360	2412	2534
		Undernourished Households			
0.271	0.434	0.304	0.121	0.153	0.411
(0.005)	(0.012)	(0.013)	(0.008)	(0.010)	(0.016)
8616	2093	1634	1985	1894	1010
		30% Increase in MDER			
		All Households			
0.246	0.230	0.197	0.272	0.278	0.252
(0.003)	(0.006)	(0.007)	(0.008)	(0.009)	(0.008)
21795	5319	4281	4345	4306	3544
		Adequately Nourished Households			
0.241	0.178	0.101	0.409	0.376	0.166
(0.005)	(0.009)	(0.007)	(0.012)	(0.013)	(0.009)
12388	3021	2496	2204	2237	2430
		Undernourished Households			
0.253	0.297	0.327	0.124	0.168	0.444
(0.005)	(0.011)	(0.013)	(0.008)	(0.010)	(0.015)

9407	2298	1785	2141	2069	1114
40% Increase in MDER					
All Households					
0.250	0.243	0.212	0.259	0.273	0.260
(0.003)	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)
21795	5319	4281	4345	4306	3544
Adequately Nourished Households					
0.252	0.280	0.087	0.388	0.363	0.163
(0.005)	(0.011)	(0.006)	(0.012)	(0.014)	(0.010)
11602	2818	2332	2047	2077	2328
Undernourished Households					
0.246	0.201	0.360	0.137	0.186	0.454
(0.005)	(0.010)	(0.013)	(0.009)	(0.010)	(0.016)
10193	2501	1949	2298	2229	1216
50% Increase in MDER					
All Households					
0.253	0.251	0.233	0.248	0.259	0.275
(0.003)	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)
21795	5319	4281	4345	4306	3544
Adequately Nourished Households					
0.261	0.381	0.079	0.374	0.334	0.147
(0.005)	(0.013)	(0.006)	(0.013)	(0.014)	(0.009)
10942	2656	2206	1914	1963	2203
Undernourished Households					
0.245	0.124	0.390	0.143	0.195	0.485
(0.005)	(0.008)	(0.013)	(0.009)	(0.010)	(0.014)
10853	2663	2075	2431	2343	1341

Notes: Population-weighted means, with standard errors in parentheses, and number of observations listed below. In adequately nourished households total calorie availability exceeds total household MDER; in undernourished households total calorie availability is less than total household MDER. Source: Bangladesh Integrated Household Survey.

Table 6. Undernourishment by Household Member

All Members	Heads	Spouses	Boys	Girls	Other Members
		Depth of Undernourishment			
0.11	0.03	0.09	0.18	0.17	0.10
(0.002)	(0.002)	(0.003)	(0.005)	(0.005)	(0.004)
21795	5319	4281	4345	4306	3544
		Relative Undernourishment			
0.11	-	0.07	0.15	0.15	0.07
(0.003)	-	(0.003)	(0.004)	(0.005)	(0.005)
16476		4281	4345	4306	3544

Notes: Population-weighted means, with standard errors in parentheses, and number of observations below. Depth of Undernourishment is defined as the percentage shortfall of calories from individual MDER. Relative Undernourishment is defined as the average depth of undernourishment of the subset of members minus the depth of undernourishment for the household head. Source: Bangladesh Integrated Household Survey.

Table 7: Inequality in the Distribution of Calories

	Dependent Variable: Relative Undernourishment			
	(1)	(2)	(3)	(4)
Indicator for Undernourished HH	0.147***	0.140***	0.138***	0.126***
	[0.005]	[0.006]	[0.006]	[0.013]
Indicator for Undernourished HH X				0.031**
Indicator for Spouse				[0.013]
Indicator for Undernourished HH X				0.01
Indicator for Boy				[0.015]
Indicator for Undernourished HH X				0.006
Indicator for Girl				[0.014]
Indicator for Spouse		-0.026***	-0.026***	-0.034***
		[0.005]	[0.004]	[0.004]
Indicator for Boy		0.068***	0.069***	0.067***
		[0.005]	[0.005]	[0.005]
Indicator for Girl		0.060***	0.061***	0.061***
		[0.005]	[0.005]	[0.005]
Control Variables	N	Y	Y	Y
Village Dummies	N	N	Y	Y
R^2	0.103	0.147	0.177	0.178
Observations	16476	16476	16476	16476

Notes: Population-weighted regression coefficients with heteroskedastic-robust standard errors clustered at the household level in brackets. Control variables include number of boys, number of girls, age of household head and indicators for household head being male, married, literate, working in agriculture, having no formal schooling, and having secondary schooling. *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level. Source: Bangladesh Integrated Household Survey.

Table 8: Non-Food Expenditure and Household Stressors

	Dependent Variable: Relative Undernourishment		
	(1)	(2)	(3)
Log Non-Food Expenditure	-0.029***	-0.018***	-0.023***
	[0.003]	[0.003]	[0.003]
Indicator for Lost Assets due to Flood	0.055*	0.046*	0.050*
	[0.029]	[0.028]	[0.028]
Indicator for First Born Girl	0.022***	0.012***	0.015***
	[0.005]	[0.005]	[0.004]
Control Variables	N	Y	Y
Village Dummies	N	N	Y
Observations	16476	16476	16476

Notes: Each result is from a separate regression. Population-weighted regression coefficients with heteroskedastic-robust standard errors clustered at the household level in brackets. Control variables include number of boys, number of girls, age of household head and indicators for household head being male, married, literate, working in agriculture, having no formal schooling, and having secondary schooling. *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level. Source: Bangladesh Integrated Household Survey.

Table A1: Adult Equivalence Scales

Age	Male	Female
Below 1 yr	0.43	0.43
1 - 3 yrs	0.54	0.54
4 -6 yrs	0.72	0.72
7 - 9 yrs	0.87	0.87
10 - 12 yrs	1.03	0.93
13 - 15 yrs	0.97	0.80
16 - 19 yrs	1.02	0.75
20 - 39 yrs	1.00	1.71, 1.00 *
40 - 49 yrs	0.95	0.68
50 - 59 yrs	0.9	0.64
60 - 69 yrs	0.8	0.51
Above 70 yrs	0.7	0.5

Notes: For women ages 20 to 39, we use 1.71 if she is pregnant or lactating, and 1.00 otherwise. Source: Gopalan, et al. (1989)

Table A2: Household Composition

Number of Adults	*Number of Children* 0	1	2	3	4	5	6	7	8	Total
1	0	141	200	108	34	10	1	0	0	494
2	336	666	822	379	146	43	9	2	0	2,403
3	139	200	119	44	19	9	1	0	0	531
4	188	262	273	113	40	13	3	0	0	892
5	62	60	34	18	9	4	0	0	0	187
6	92	138	108	61	13	4	2	1	0	419
7	34	27	21	13	2	1	0	0	0	98
8	35	43	45	25	6	1	2	2	0	159
9	13	15	13	4	1	0	0	0	0	46
10	6	10	12	10	1	2	0	1	0	42
11	3	4	8	1	2	2	0	0	0	20
12	1	1	4	5	0	0	0	2	0	13
13	1	1	0	0	0	0	0	0	0	2
14	0	1	1	1	0	0	0	0	1	4
15	0	2	0	0	1	1	0	0	0	4
16	0	0	0	1	0	1	1	0	0	3
17	0	0	0	0	1	0	0	0	0	1
20	0	0	0	0	1	0	0	0	0	1
Total	910	1,571	1,660	783	276	91	19	8	1	5,319

Notes: Children are defined as less than 18 years old. Source: Bangladesh Integrated Household Survey.

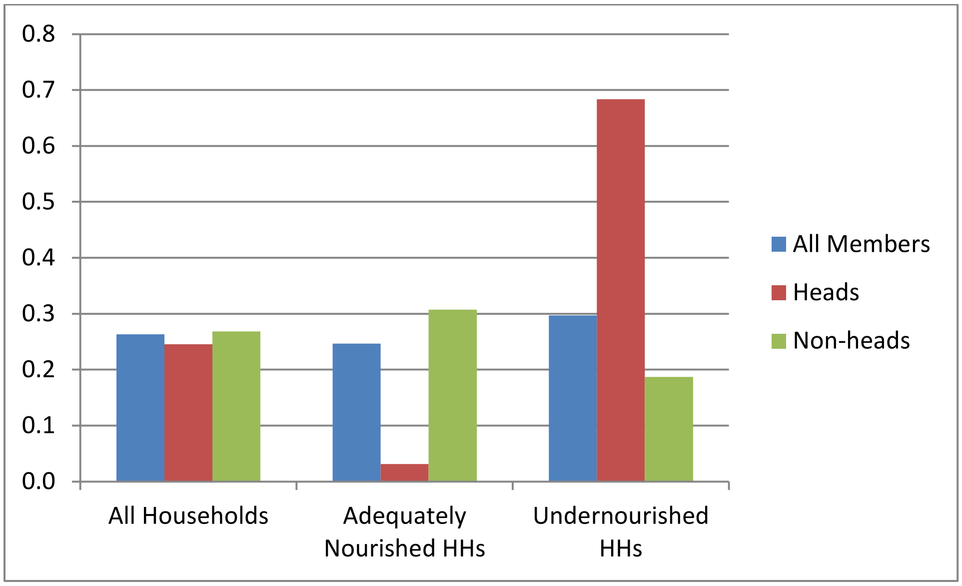
Table A3: Correlates of First Born Girl

	Dependent Variable: Household Size		
	(1)	(2)	(3)
Indicator for First Born Girl	0.226***	0.309***	0.275***
	[0.041]	[0.038]	[0.037]
Indicator for Male Head		0.775***	0.851***
		[0.051]	[0.054]
Age of Head		0.010***	0.009***
		[0.002]	[0.002]
Indicator for Married Head		0.261***	0.444***
		[0.081]	[0.090]
Indicator for Literate Head		-0.006	-0.098
		[0.124]	[0.122]
Indicator for Head with No Schooling		-0.01	-0.059
		[0.123]	[0.121]
Indicator for Head with Secondary Schooling		-0.057	0.01
		[0.075]	[0.078]
Indicator for Head Working in Agriculture		0.092**	0.185***
		[0.045]	[0.042]
Village Dummies	N	N	Y
R^2	0.005	0.067	0.189
Observations	5319	5319	5319

Notes: Population-weighted regression coefficients with heteroskedastic-robust standard errors clustered at the household level in brackets. *** denotes statistical significance at the 1% level, ** denotes statistical significance at the 5% level, and * denotes statistical significance at the 10% level. Source: Bangladesh Integrated Household Survey.

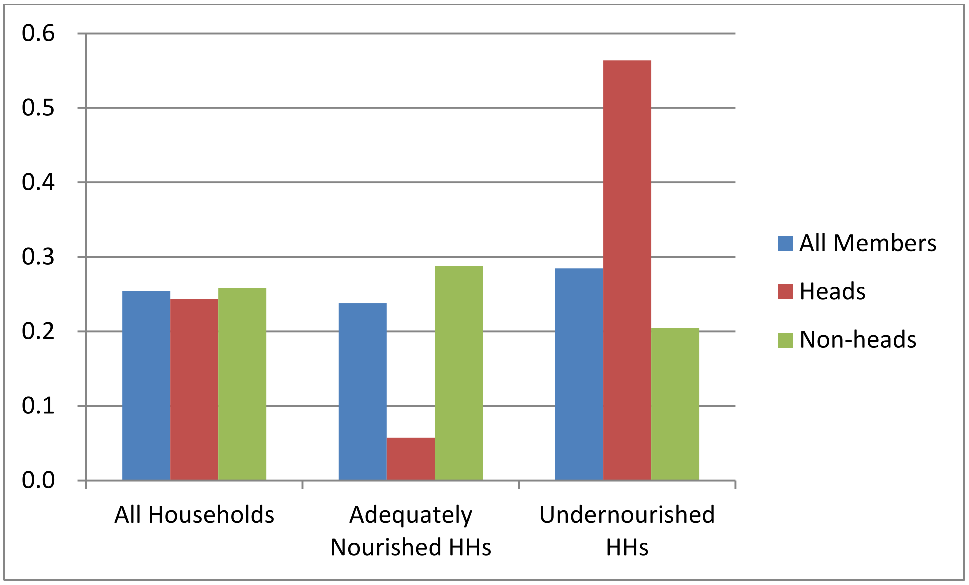
Figures:

Figure 1: Share of Individuals Misclassified by Household Type and by Household Head Status

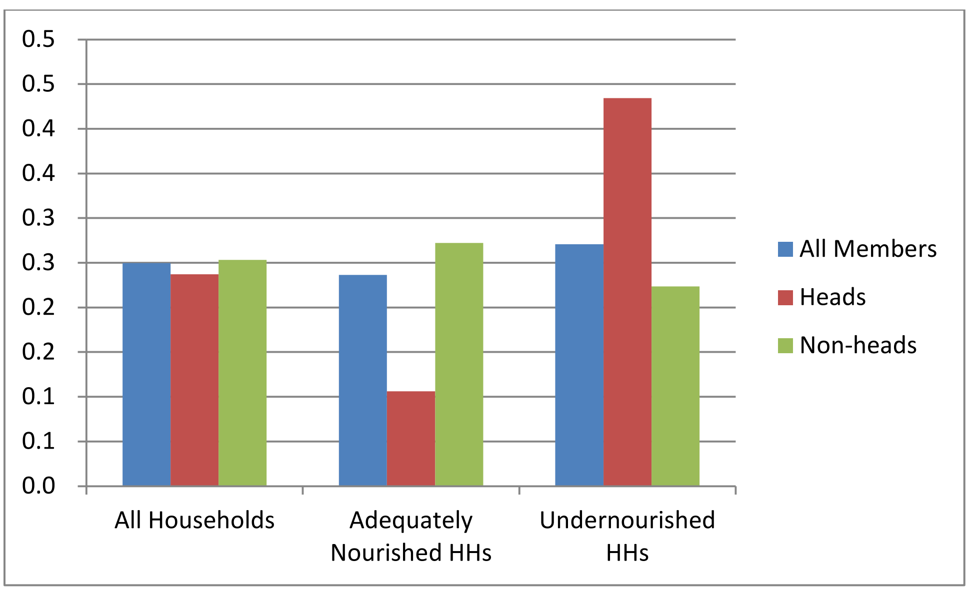


Figures 2a – 2d: Share of Individuals Misclassified Under Varying MDERs for Heads

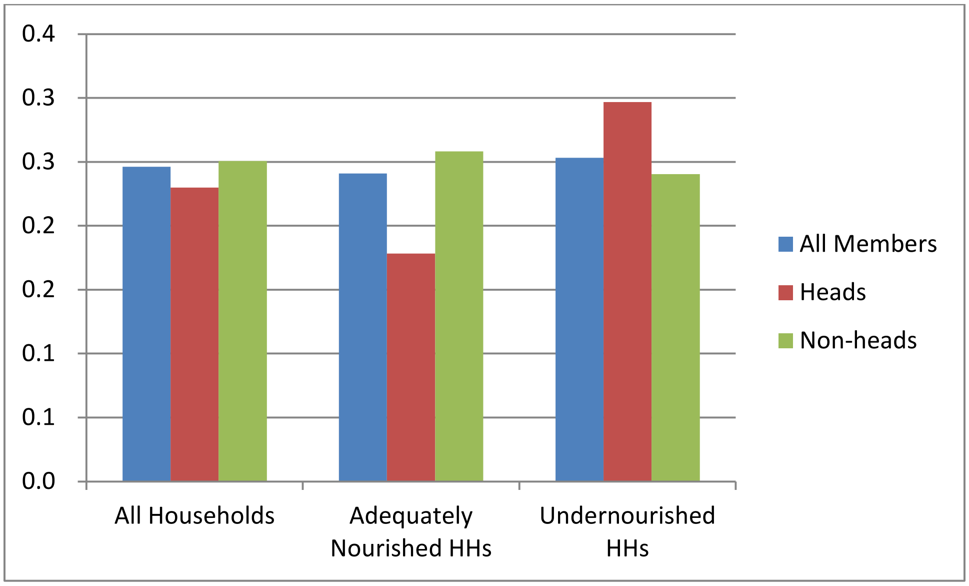
Figures 2a: 10 % Increase in MDERs for Head



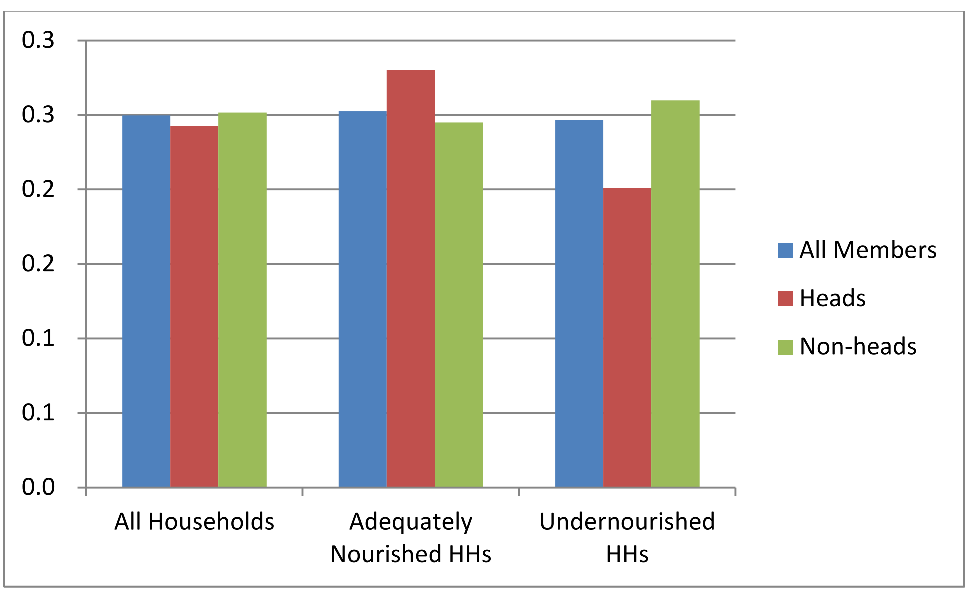
Figures 2b: 20 % Increase in MDERs for Head



Figures 2c: 30 % Increase in MDERs for Head

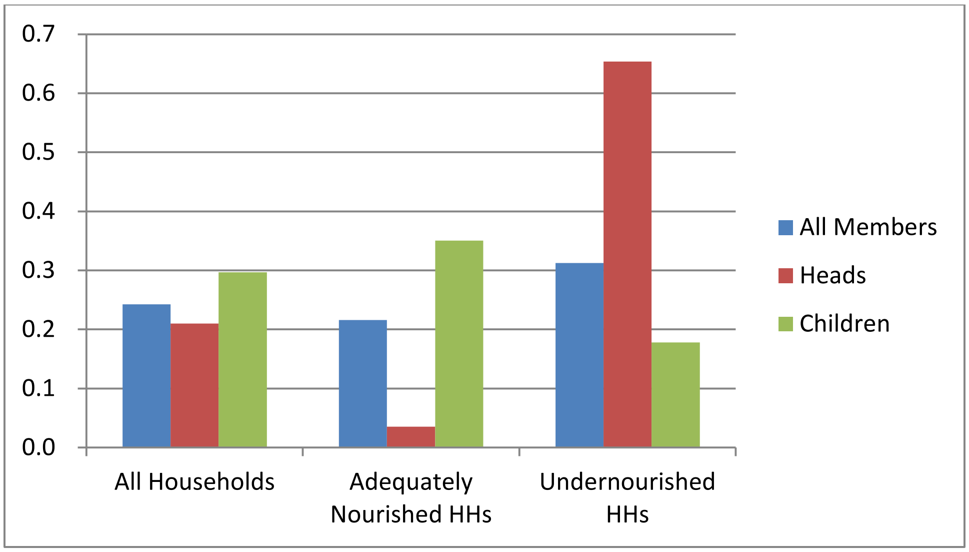


Figures 2d: 40 % Increase in MDERs for Head

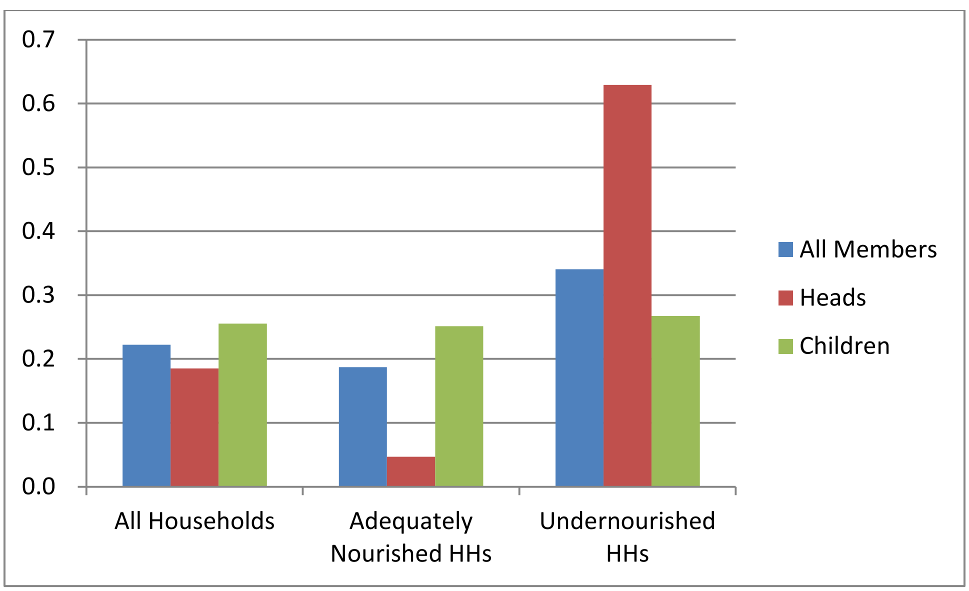


Figures 3a – 3e: Share of Individuals Misclassified Under Varying MDERs for Children

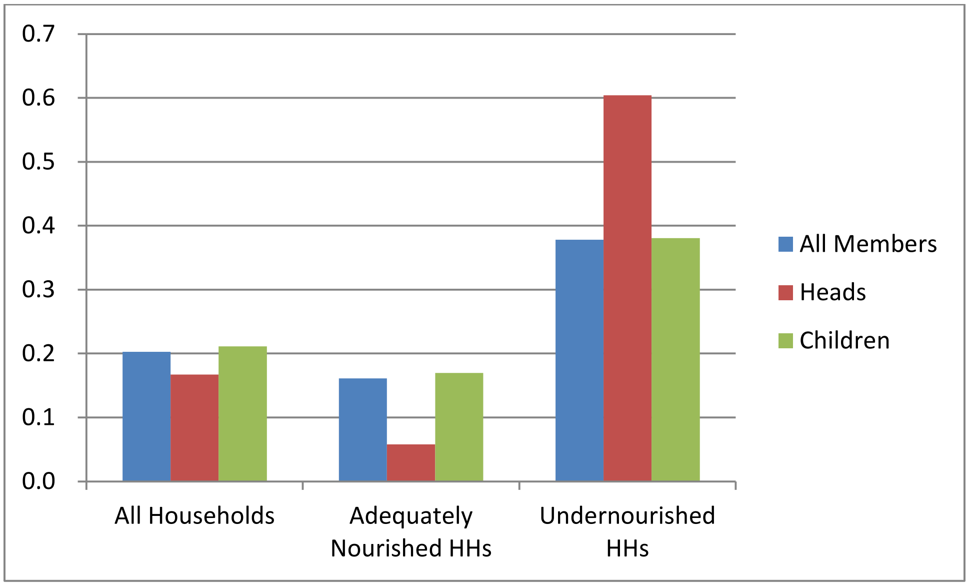
Figures 3a: 10 % Decrease in MDERs for Children



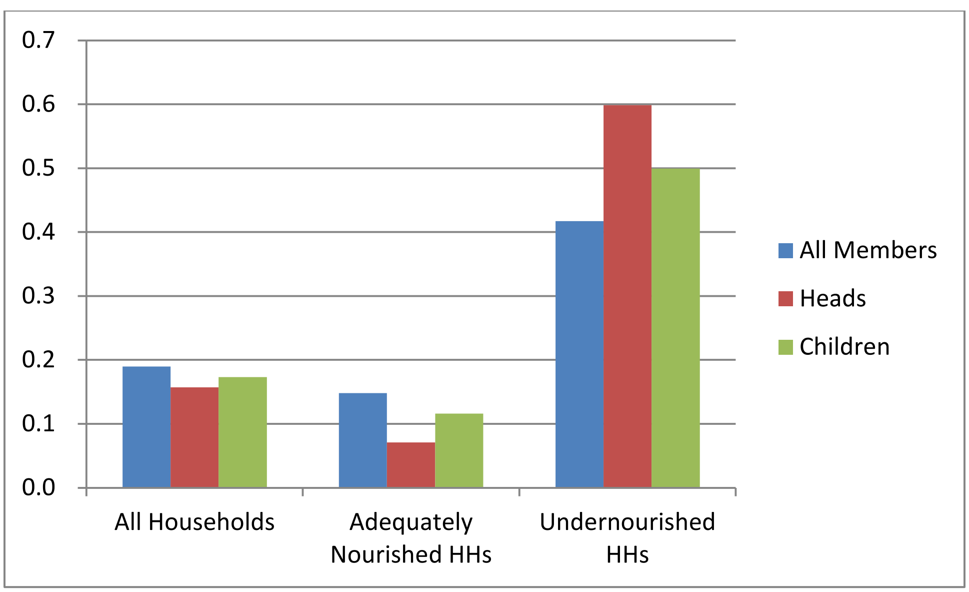
Figures 3b: 20 % Decrease in MDERs for Children



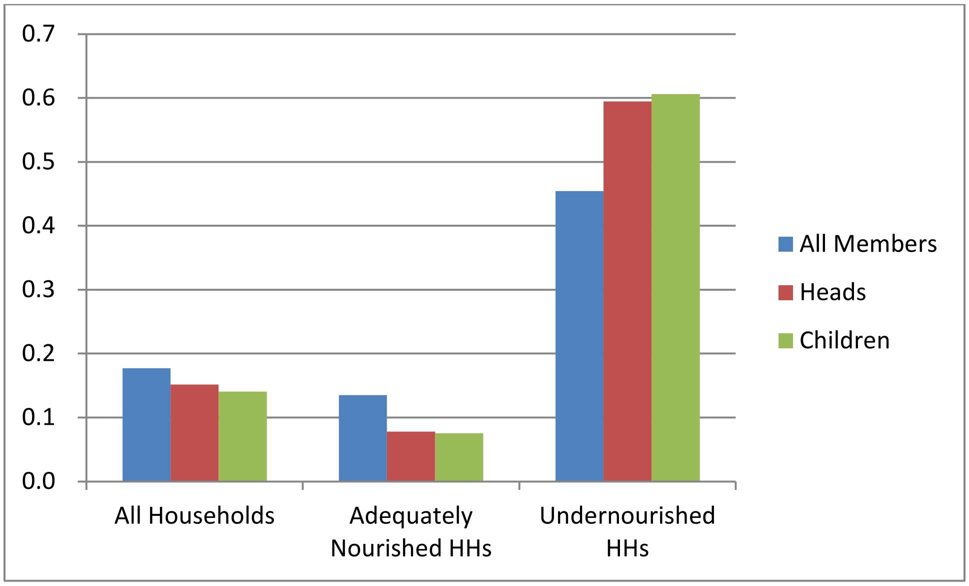
Figures 3c: 30 % Decrease in MDERs for Children



Figures 3d: 40 % Decrease in MDERs for Children

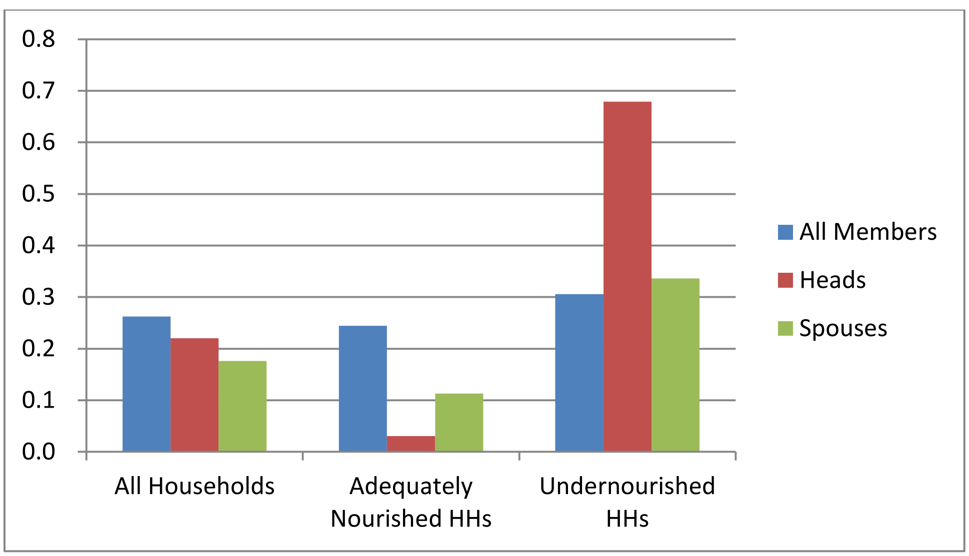


Figures 3e: 50 % Decrease in MDERs for Children

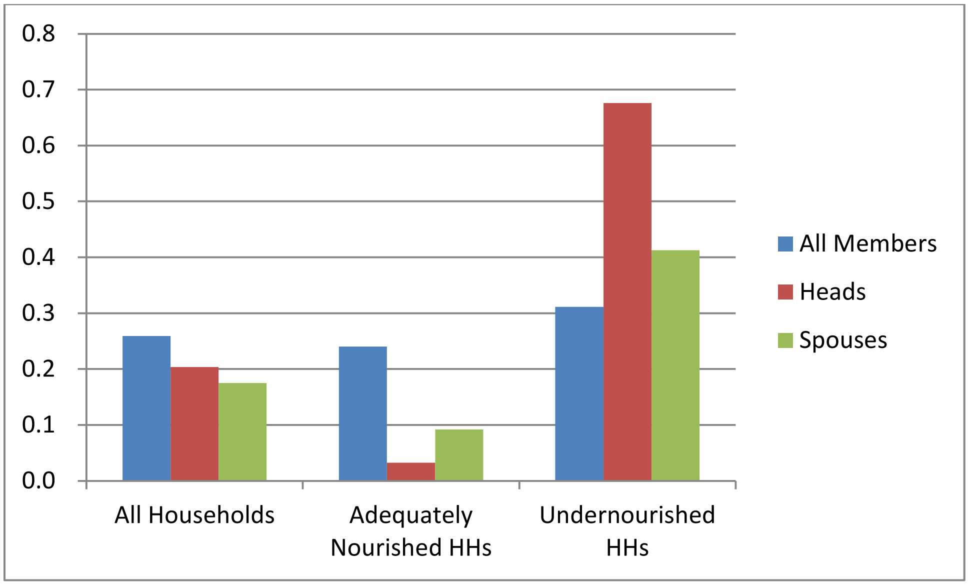


Figures 4a – 4e: Share of Individuals Misclassified Under Varying MDERs for Women

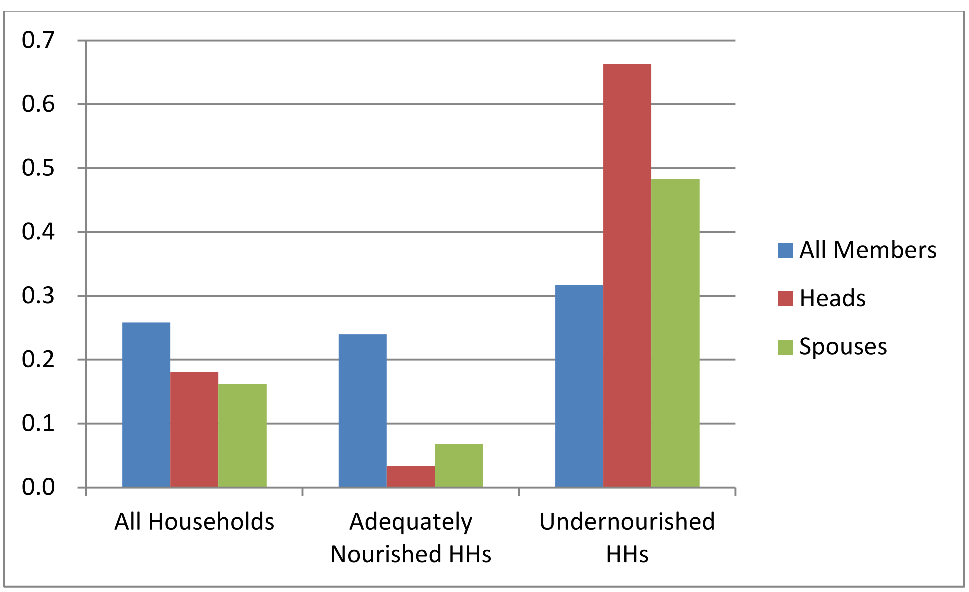
Figures 4a: 10 % Decrease in MDERs for Women of Child-bearing Age



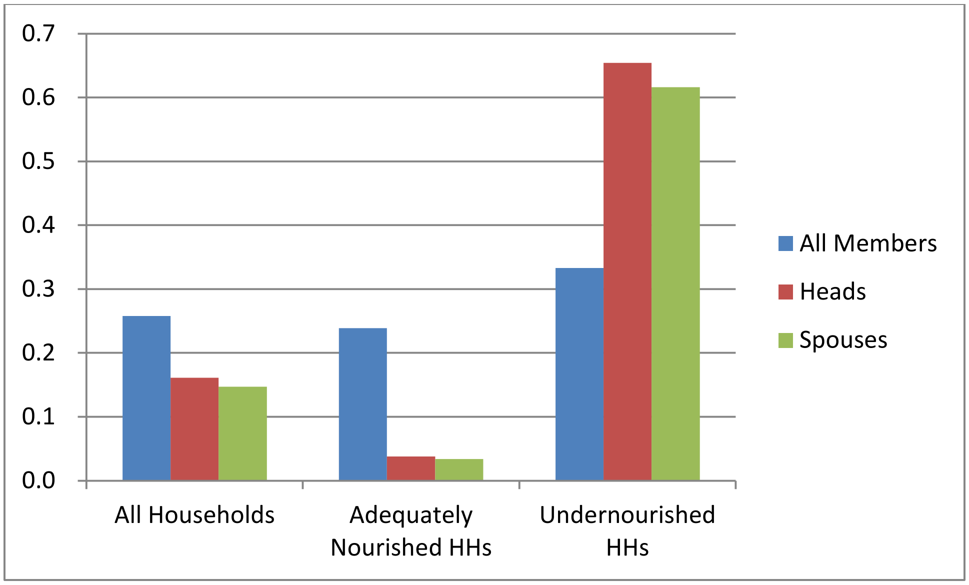
Figures 4b: 20 % Decrease in MDERs for Women of Child-bearing Age



Figures 4c: 30 % Decrease in MDERs for Women of Child-bearing Age



Figures 4d: 40 % Decrease in MDERs for Women of Child-bearing Age



Figures 4e: 50 % Decrease in MDERs for Women of Child-bearing Age