Intra-household Nutritional Inequities in Rural Bangladesh[1]

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Abstract: Utilizing a novel data source from rural Bangladesh that reports individual-level food intake, we find substantial inequities in the intra-household distribution of calories and nutrients, with household heads consuming disproportionately large shares. Importantly, these results do not appear to be driven by assumptions regarding energy requirements. Due to the inequities, aggregate household-level data misclassify the nutritional status of a large share of the population. Additionally, we find that both women's disempowerment and economic stressors are associated with more inequitable calorie distributions. And we find that in households with more empowered spouses, either the spouse or the children, or both are less likely to be undernourished than in households with less empowered spouses. These findings have implications for food and nutrition program targeting, which often is based on using household-level data with strong assumptions regarding the equitable distribution of calories across household members.

JEL: D12; I15; O12; O53

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

1. Introduction

Despite substantial improvements in nutrition and health over the past few decades, high levels of undernourishment and malnourishment persist in Bangladesh (Headey, Hoddinott et al. 2015). In this article 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 individual undernourishment and on inequities in undernourishment. First, we examine potential misclassification of individual undernourishment based on household-level data. And second, we examine how inequities in the distribution of calories are related to household characteristics, such as women's disempowerment and economic stressors.

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 total available calories are distributed across individuals, and subsequently can provide misleading assessments of undernourishment (Barrett 2010). In particular, assessments based on household-level consumption data 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 populations that most need assistance.

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 those based on household-level data suggest that a significant portion of the country is undernourished (Ahmed, Ahmad et al. 2013 FAO 2013, Rosen, Meade et al. 2014).[2] Furthermore, studies have repeatedly demonstrated that household resources are not distributed equitably across members in Bangladesh. For example, studies have demonstrated that sons receive preferential treatment (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 (Quisumbing and Maluccio 2003), and that men consume significantly more calories than women (Pitt, Rosenzweig et al. 1990, D'Souza and Tandon 2015). More broadly, there is much evidence of gender biases within the household in South Asia (e.g., Jayachandran and Kuziemko 2011).

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 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 in a representative survey.

[2] High levels of undernourishment and malnourishment persist in Bangladesh despite substantial improvements in nutrition and health over the past few decades; 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. investigate these improvements and examine their drivers.

In the first part of the article, we estimate calorie intake using individual-level data 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. This procedure identifies individuals who would be misclassified when solely relying on aggregate household estimates. Understanding such misclassification is particularly important given that one of the primary benefits of utilizing household surveys, as opposed to more aggregate data, is more reliable identification of people suffering from undernourishment.

We find a significant number of individuals misclassified using household-level estimates of undernourishment. Overall, 27 percent of individuals are misclassified; 26 percent of individuals in adequately nourished households do not meet their MDER and 28 percent of individuals in undernourished households do meet their MDER. Looking across household members, we 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 very few of those who are undernourished in adequately nourished households.

Importantly, this pattern of misclassification is robust to a number of concerns. First, given the pattern of misclassification (regarding members) and the large share of population misclassified, it is unlikely that the misclassification of individual undernourishment is being driven by more measurement error in the consumption of individual household members than in total household consumption.[3] 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 sex and age. Third, the results are not an artifact of a higher MDER for the household head due to more strenuous activity since the pattern is identical for households in which the head is engaged in more sedentary forms of employment. Additionally, we find similar patterns of favoring the household head in the consumption several nutrients.

Overall the findings indicate that given the inequities in household consumption, household-level data used in standard household consumption surveys might be ill-equipped to identify the nutritional status of individual household members. Importantly, even in households in which it is possible to meet each member's energy requirement, there are still undernourished individuals.

In the second part of the article, we analyze the role of women's empowerment in relation to household inequities of calorie distribution (difference in percentage calorie shortfalls from MDER between non-heads and heads) and to an individual member's depth of undernourishment (percentage calorie shortfall from MDER). There is a large body of literature linking women's bargaining power, control over resources, and empowerment to a host of nutritional (and non-nutritional) outcomes for them, as well as their children (e.g., Thomas 1990, Duflo 2003, World

[3] The consumption of individual household members might be reported in error, but taking an average for the household could mute such errors and correctly classify each individual's nutritional status.

Bank 2011, van den Bold, Quisumbing et al. 2013). We also analyze the role of household economic stressors in relation to household inequities in calorie distribution.

We find that various measures of a spouse's empowerment are correlated with household calorie inequities and with individual undernourishment. Household inequities are smaller when a spouse is more empowered. And the depths of undernourishment for spouses, boys, and girls are smaller when a spouse is more empowered, though the head's depth of undernourishment is not generally associated.

Finally we find that household calorie inequities are worse in households experiencing economic stress, as measured by lower per capita non-food expenditure (which we use as a broad proxy for income). The latter finding is robust to focusing on the potentially exogenous variation in per capita expenditure with an indicator for having a daughter as the first-born child, since households in rural Bangladesh that have a girl first tend to have larger families in an attempt to have a boy; the indicator proxies for scarcer resources.

Our article contributes to several strands of literature that examine intra-household dynamics. While consistent with some findings, our results differ in several ways from earlier findings, suggesting that some household dynamics may be context specific. Most closely related to our findings, a number of researchers have focused on resource distribution that affects the nutritional status of household members.[4] Pitt, Rosenzweig et al. (1990), Harriss (1990), and Rahman (2013) find that household heads consume more calories than other members; they argue that this is due to higher energy requirements rather than a favoring of household heads. In contrast, we find that inequities in calorie consumption are unlikely to be driven solely by higher requirements or by different labor opportunities for men. First, we fail to find evidence of a correlation between the relative (to head) undernourishment of household members and an indicator for heads engaged in taxing agricultural labor (coefficient is statistically indistinguishable from zero, with a p-value of 0.788). Second, our main results are qualitatively identical when we restrict the sample to households in which heads are not engaged in taxing agricultural occupations. Lastly, we show that it would take implausibly large MDER for heads (holding other members' MDERs constant) to explain the observed patterns. Therefore we argue that in rural Bangladesh there exists a favoring of household heads.

[4] Our results are also consistent with a number of studies that demonstrate that household resources that do not directly affect nutrition are not equitably distributed across household members 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, 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, 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. and that the bargaining power of individual household members affects the distribution of household resources that do not directly affect nutrition 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, 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, Martínez, C. (2013). "Intrahousehold Allocation and Bargaining Power: Evidence from Chile." Economic Development and Cultural Change **61**(3): 577-605..

Our results are also similar to Haddad and Kanbur (1990), who demonstrate that undernourishment is significantly understated when utilizing household-level as opposed to individual-level data. They find that the relative ranking of undernourishment is quite stable amongst subsets of the population when using either household- or individual-level data. In contrast, we find that household-level data drastically overstate undernourishment among household heads relative to individual-level data, and that the incidence of undernourishment among other members is altered significantly.

Additionally, our results are also similar to a separate literature analyzing intra-household differences in the income elasticity of nutrition, which suggests that different household members might disproportionately bear the burden of shocks (e.g., Behrman 1988, Behrman and Deolalikar 1990, Dercon and Krishnan 2000). We find that the calorie-income relationship for boys and girls are similar and statistically indistinguishable in rural Bangladesh, which is contrary to findings in a number of other contexts (e.g., Behrman 1988, Behrman and Deolalikar , Mangyo). Additionally, we find that non-heads experience relatively lower consumption in households under economic stress in rural Bangladesh, whereas Villa, Barrett et al. (2011) find that household heads sacrifice for non-heads in response to shocks in Ethiopia and Kenya.[5] These differences across contexts suggest that it is important to supplement large household consumption surveys with smaller intra-household consumption surveys to more accurately analyze how households cope with food insecurity and economic stressors.

The rest of the article 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 when using aggregated household data; it includes sensitivity analyses and a discussion of reporting biases. Then we analyze variation in the intra-household distribution of calories based on empowerment of the spouse (section 4) and based on economic stressors (section 5). Section 6 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.[6] 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 administrative divisions in Bangladesh) was based on probability proportional to the total numbers of households in each stratum.[7] Then in the second stage, 20 households were selected from each village. Our sample includes 5,343 households.[8] Using sampling weights, the sample is representative of rural Bangladesh.[9]

[5] However, it is important to note that the authors cannot distinguish whether the decline in nutrition of household heads is due to heads having to work more during adverse shocks as herders (where they have less access to nutritious foods), or whether heads have access to nutritious foods but choose to sacrifice for the good of other members.
[6] The survey time frame does not include traditional lean seasons in Bangladesh, in which food insecurity is at its peak, nor does it include Ramadan, the Muslim holy month of fasting.
[7] The total number of households in each stratum was based on the 2001 population census.
[8] The final sample includes households in which calorie intakes of the household head is positive.
[9] The sample weights were adjusted using the 2011 population census sampling frame.

This article primarily uses a module that reports food consumption of each individual household member over the past 24 hours from the female in charge of charge of cooking, supervising and serving. 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.[10] 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 taken (e.g., the individual was sick or fasting). Data on leftovers, food given away and fed to animals were collected as well; these quantities are not used in the analysis. It is important to note that the short recall period for individual-level consumption might not accurately capture the true 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 believe that such measurement error is of the classical sense and would lead to attenuation bias.[11]

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 similarly calculate consumption of all nutrients separately reported in Gopalan, Rama Sastri et al. (1989) – protein, calcium, fiber, iron, and phosphorous. We also calculate a household-level measure of calorie consumption – 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 2,400 daily calories and incorporate information on the age and sex of members.[13,14] These MDER values are estimated by the Government of India (National Sample Survey Organization 2007).[15]

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[10] An example of a recipe is chicken curry; ingredients include chicken, onions, and tomatoes.

[11] 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 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, 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, 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..

[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 sex or age of the household members Subramanian, S. and A. Deaton (1996). "The Demand for Food and Calories." Journal of Political Economy **104 No.1**(Feb 1996): 133-162, Deaton, A. and J. Dreze (2009). "Food and Nutrition in India: Facts and Interpretations." Economic and Political Weekly **XLIV**(7): 42-65., while others partially account for differing calorie requirements by counting each child as half an adult household member Hicks, D. (forthcoming). "Consumption Volatility, Marketization, and Expenditure in an Emerging Market Economy." American Economic Journal: Macroeconomics.. 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, 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. for an application to U.S. income and consumption).

[14] Appendix A1 presents the MDER for each type of household member.

[15] 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 for

Table 1 displays rural population averages of key household characteristics. Consistent with the high prevalence of food insecurity in Bangladesh in global assessments (Food and Agricultural Organization (FAO) 2013 Meade et al. 2014), households in rural Bangladesh are relatively poor and at risk for a high prevalence of food insecurity. Daily calories per adult equivalent is 2,434, with households devoting a large share (58 percent) of their overall budget to food expenditures.[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; and approximately 3 percent of households do not include a spouse or children.[17] Most household heads are male and married, with an average age of 44. Less than half of the household heads ever attended school or are literate. Approximately 55 percent of heads are employed in the agricultural sector. (We provide analogous statistics for the spouses of household heads.[18])

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.[19] There is a vast literature on the intra-household allocation of goods, including food, which reveals (at times) large variation across household members.[20] 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, or activity levels (e.g., those working out in the field may require more calories than those at home). Additionally they may allocate food inequitably, that is, not based on nutritional requirements but rather based on cultural practices or 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).[21] 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 or small share of household calories by identifying members who are undernourished despite living in households in which total member MDER is met, and members who are adequately nourished despite living in households in which total member

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all of South Asia, including Bangladesh WHO Multicentre Growth Reference Study Group (2006). WHO Child Growth Standards. Geneva, World Health Organization..

[16] 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.

[17] Appendix A2 provides a tabulation of adults and children present in households in our sample.

[18] There are 12 households with two wives; we report characteristics for the older wife.

[19] We exclude consumption by guests since our focus is on differences across household members.

[20] See 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. for a summary.

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

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 household nourishment status (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 27 percent of the population is misclassified; this number ranges from approximately 22 to 31 percent, based on 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 2.7 percentage points larger in undernourished households than in adequately nourished households, suggesting that the misclassification is the worse among the subset of households that food security statistics are designed to track.

While the magnitudes of these shares are large when looking at all households together, these results mask important differences based on the household's nourishment status. Some striking patterns emerge. In adequately nourished households, it is rare that the household head is misclassified (and thus undernourished). Only 4.7 percent of household heads are misclassified in this way. In undernourished households, we find the other extreme; most misclassification is driven by household heads, 57.9 percent of whom are misclassified (and thus adequately nourished). In contrast, the share of non-heads that are undernourished in adequately nourished households ranges from 17.2 to 52.6 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.[22]

We further characterize the intra-household distribution of calories by analyzing the distributions of calorie shortfalls for heads and non-heads. Figure 2 displays the probability density and cumulative density functions of calorie shortfalls for heads and non-heads. Heads not only have significantly smaller average calorie shortfalls (p-value of 0.000), but for any given level of calorie shortfall, heads are less likely to experience a shortfall. And we can reject the hypothesis that the calorie shortfalls of the two groups are distributed identically at standard levels of significance (p-value of 0.000).

We further summarize the inequitable distribution of consumption within a household by calculating the *depth of undernourishment* for each individual, defined as the percentage calorie shortfall from his or her MDER:

[22] One might be concerned that this pattern of misclassification of individual undernourishment is simply due to measurement error, since individual-level data are likelier to be noisier than the aggregated household data and thus the patterns may be spurious. However, we argue that this explanation is unlikely. First, the magnitude of misclassifications is large and would imply a very high incidence of measurement error for a carefully designed and implemented survey. Second, Appendix Table A3 demonstrates that the likelihood of being misclassified is related to the type of household member (i.e., head), which is at odds with a pattern that is driven solely by measurement error.

$$Depth\ of\ undernourishment_{ih} = \begin{cases} \frac{MDER_{ih} - Calories_{ih}}{MDER_{ih}} & if\ Calories_{ih} < MDER_{ih} \\ 0 & otherwise \end{cases} \quad (1)$$

where *i* denotes an individual in household *h*, *MDER* denotes the minimum daily energy requirement, and *Calories* denotes daily calorie intake. In addition, we calculate analogs of the depth measure for key nutrients – protein, calcium, fiber, iron, and phosphorous.[23]

The estimates of the nutritional depth measures are presented in Table 3. Column (1) presents the average depth of all individuals in the sample, while columns (2)-(6) present average depths by household member. Consistent with our findings in Table 2, household heads have a much smaller depth of undernourishment than other household members. Furthermore, conditional on being undernourished, non-heads consume significantly below their MDER on average (between 9 and 22 percent). Lastly, in most cases, we observe that the head has smaller shortfalls of macro- and micro-nutrients than non-heads. However, the magnitude of the inequities are largest for calorie consumption (top panel), and thus in the second part of the article, we focus on these calorie inequities.

Sensitivity analysis

Before further characterizing these calorie inequities, we examine and discuss the sensitivity of the misclassification results. First, we might be concerned about aggregating a wide variety of households into a single analysis, with averages masking divergent consumption patterns. However, Table 4 demonstrates that the pattern of misclassification found in Table 2 is qualitatively identical when we restrict the sample to only male-headed households with spouses present.[24]

Second, we might be concerned that the misclassification patterns are sensitive to a head's employment in agricultural activities (a strenuous form of labor); in particular, those heads may have higher requirements than we use. Thus we estimate shares of misclassification for heads and non-heads in households in which heads do not work in agricultural activities; we summarize the misclassification shares in Figure 3. The patterns are qualitatively identical to the baseline results displayed in Figure 1.

Third, we might be concerned that measurement error in the MDER estimates is biasing our results. MDER estimates could be especially problematic for young children (under 18) who require relatively few calories, since small mistakes in their MDER could have significant impacts on the determination of undernourishment. And the estimates could be problematic for women of child-bearing age, whose requirements vary greatly based on their pregnancy and lactation statuses.[25]

To address these possibilities, we perform a series of sensitivity analyses to determine whether the misclassification of undernourishment is robust to perturbations in individual MDERs (specifically, by systematically varying nutritional requirements based on age and sex). For each perturbation, we

[23] Micronutrient deficiency, or "hidden hunger," is estimated to affect over two million people worldwide, Food and Agricultural Organization (FAO), U. N. (2013). The State of Food Insecurity in the World. Rome, FAO., and is prevalent in Bangladesh.

[24] The patterns in Table 3 also are qualitatively identical when restricted to a sample with male-headed households with spouses present. See Appendix Table A4.

[25] We take into account pregnancy and lactation status, however the estimates for these factors are based on averages rather than specific to number of months pregnant, age of breastfeeding infant, etc.

re-estimate rates of misclassification by household member and household undernourishment status (analogous to Table 2), holding constant the MDERs of all other members. 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.[26]

Figures 4a-4d display the misclassification shares under varying assumptions about nutritional requirements for children (comparing them to heads). Decreasing the requirements of children by 10, 20 or even 30 percent has little effect on the baseline pattern of misclassification. Rates of misclassification of children do not become similar to those of heads until we reduce their requirements by 37 percent (by 40 percent – Figure 4d – the pattern is reversed), which corresponds to MDERs far too small for children to be plausible (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, National Institute of Nutrition 2009). Analogously, when we decrease the requirements for women of childbearing age (comparing them to heads) (Figures 5a-5d), their rates of misclassification become similar to those of the head with a 32 percent reduction (by 40 percent – Figure 5d – the pattern is reversed); again, these requirements are too small to be plausible (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, National Institute of Nutrition 2009).

As an additional and more general exercise, we increase the requirements for heads, holding constant the requirements of other members (Figures 6a-6c); such an adjustment would necessarily reduce the inequity in household consumption between heads and non-heads. Once the MDER for the household head is increased by 30 percent, we see that the misclassification 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. The reversal occurs at approximately 25 percent. However, a 25 percent increase for a young, adult male would be an MDER of 3,000 daily calories, which is much larger than MDERs used by other policymakers and researchers (Food and Agricultural Organization (FAO) 2001, National Sample Survey Organization 2007, National Institute of Nutrition 2009).[27]

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.

Potential Reporting Biases

In addition to examining the sensitivity of our misclassification results to the assumptions above, we discuss possible biases in reporting that could alter the misclassification results. Specifically, we

[26] 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 adequately nourished (if requirements are decreased) or moving to being classified as undernourished (if requirements are increased).

[27] 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.

discuss reporting by the female in charge of food preparation in the key intra-household food module, as it relates to knowledge and culture.

One particularly tricky aspect of collecting food consumption data in household surveys is the reliance on one member to capture accurately the consumption of various members (given the administrative and respondent burden linked to interviewing numerous household members). Although the female respondent in the BIHS is likely to have good knowledge of what members eat inside the home, she may not have good knowledge of food consumed by all household members outside the home, e.g., food eaten at places of employment or at school. The BIHS reports where consumption of each household member took place – at home, at an employer's house, from an invitation, in a market place/hotel, or elsewhere – and so we are able to restrict the sample to households in which all individuals consumed all food at home. In those households, we would expect the female respondent to have the best knowledge of what each household member consumed. Table 5 replicates the main misclassification table for this restricted sample; the patterns are qualitatively identical.

Reporting could also be influenced by culture; for example, the female respondent may exaggerate the consumption of the head due to cultural biases specific to Bangladesh or South Asia. While this is possible, we argue that it is unlikely that the misclassification patterns are being driven solely by this bias and do not reflect actual intra-household inequities. The survey team executed exhaustive quality controls in gathering the data. This included utilizing a data collection agency with extensive experience conducting surveys in Bangladesh that is aware of potential cultural biases; also the survey was piloted on a small sample to ensure proper wording to best elicit the information required in each module.[28]

Additionally, we perform a robustness check looking at households in which the adequate consumption of the head does not preclude adequate consumption of non-heads, i.e., households with calorie consumption well above total MDER (based on the household food module, rather than the intra-household food module used to calculate undernourishment), and thus households in which the female respondent may have less incentive to exaggerate consumption.[29] In these well-nourished households, heads and spouses look more similar, but children are still much more likely to be undernourished (Appendix Table A5).

It is also important to note that we find a number of consumption patterns that are inconsistent with the cultural bias described above. In particular, it would be just as likely for the female respondent to exaggerate the consumption of her children at the expense of her consumption as it would be for her to exaggerate the consumption of the household head (e.g., Sen 1990). One might also expect her to exaggerate the consumption of boys relative to girls, given the evidence of

[28] Furthermore, survey enumerators were trained on how to handle unusual cases in which the respondent reported unusual levels of consumption. Oftentimes, survey supervisors oversaw interviews to ensure that the survey was being administered properly; they also checked completed surveys for consistency in reported answers. If inconsistencies were detected, the supervisors revisited individual households. In addition, supervisors made random checks of 10 percent of the sample and revisited the households to check the quality of the data collected. Thus, unusual levels of consumption of any individual household member would potentially be detected through these consistency checks.

[29] It is possible, however, that such reporting biases stem from cultural aspects that traverse socioeconomic boundaries and are not influenced by a household's ability to provide adequate food for all members. In such a case, respondents in households with more than enough food may be as likely as those in other households to overstate the consumption of the head relative to other members.

revealed preference of boys relative to girls (e.g., Jayachandran and Kuziemko 2011). But the data do not support such biases. In any case, respondents who are more likely to overstate consumption of heads in this way may potentially allocate a disproportionate share of available calories to the head.

4. Calorie Inequities and Women's Empowerment

In this section we examine whether intra-household calorie inequities are worse in households in which women (specifically, the spouse of head) are less empowered. Empowerment broadly encompasses concepts of agency, decision-making, influence, freedom, and control.[30] Van den Bold et al. (2013) review the literature on women's empowerment and nutrition, highlighting evidence from several countries that links increased empowerment to the improved nutritional status of women and children. In a recent example from Bangladesh, Bhagowalia, Menon et al. (2012) find empowerment influences infant and child dietary diversity, as well as child stunting. And in an example from Mexico, Djebbari (2005) finds that when women (including those in the extended family) start earning income (and thus are more empowered in household decision making), total household calorie consumption increases; the opposite occurs when men start earning income. This evidence is supported by a very large body of research on intra-household dynamics that demonstrates that women and men choose to allocate resources differently, with women having a preference for investing in children through education, nutrition, and health (e.g., Thomas 1994, Hoddinott and Haddad 1995, Duflo and Udry 2003).

We create various measures of women's empowerment based on the BIHS survey module, Women's Empowerment in Agriculture, devoted to capturing information on "the empowerment, agency, and exclusion of women in the agricultural sector" (Alkire, Meinzen-Dick et al. 2013). We measure the degree of women's empowerment within the household with (i) an empowerment score based on an empowerment index proposed by IFPRI[31], and indicators (equal to one) for women's empowerment in the following areas: (ii) power in decision-making regarding daily tasks, (iii) sole or joint ownership of major household assets, (iv) control over income and expenditure, (v) control over the purchase, sale or transfer of assets, and (vi) leadership in the community.[32] Finally, in the context of Bangladesh and South Asia more generally, mothers-in-law may reduce a woman's agency and authority in the household (e.g., Balk 1997, Robitaille and Chatterjee 2013); therefore we create an indicator for the absence of a mother-in-law in the household as an additional measure of women's empowerment.[33]

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[30] See Ibrahim, S. and S. Alkire (2007). "Agency and Empowerment: A Proposal for Internationally Comparable Indicators." Oxford Development Studies **35**(4): 379-403. for a review of the literature on agency and empowerment.

[31] The IFPRI sub-index for women's empowerment is the weighted sum of empowerment indicators in five domains: production, resources, income, leadership, and time. For details, see Alkire, S., R. Meinzen-Dick, A. Peterman, A. Quisumbing, G. Seymour and A. Vaz (2013). "The Women's Empowerment in Agriculture Index." World Development **52**: 71-91.. We use a modified version that excludes the production domain, which is specific to agricultural households. We modify the weights so each of the four domains has an additional weight of 0.25 so the range of the sub-index remains between zero and one.

[32] Indicator (ii) equals one if a women answers "medium" or "high" as to the extent that she can make decisions about the tasks she performs on a given day. Indicators (iii)–(v) equal one if the woman reports having sole or joint control in these areas. Indicator (vi) equals one if the women belongs to community groups (e.g., NGOs, microfinance, religious) or local government, or if the women feels comfortable speaking up in public. Details of indicators (iii)–(vi) are available in Alkire, et al. (2013).

[33] See Appendix Table A6 for summary statistics of the measures of women's empowerment.

We are interested in inequities in the distribution of calories both at the household level (between heads and non-heads) and at the individual level (based on the type of member). We use two dependent variables to examine the relationships with empowerment. At the household level, the dependent variable is household inequity in calorie distribution, which we define as the difference between the average depth of undernourishment of non-heads and the depth of undernourishment of heads. And at the individual level, the dependent variable is the individual depth of undernourishment, as defined in [1] above. We estimate the following specifications:

$$Household\ Inequity\ in\ Calorie\ Distribution_{hv} = \alpha_v + \beta Empowerment_{hv} + \pi HH_{hv} + \mu_{hv} \quad (2)$$

$$Individual\ Depth\ of\ Undernourishment_{ihv} = \sigma_v + \theta Empowerment_{hv} + \tau HH_{hv} + \delta IND_{ihv} + \rho Empowerment\ X\ IND_{ihv} + \varepsilon_{ihv} \quad (3)$$

for household *h* or individual *i* in village *v*; α and σ denote village dummies; *Empowerment* represents the empowerment score or an indicator equaling one if the head's spouse is empowered based on the measures above; *HH* includes the number of boys and girls and the following household head characteristics: sex, age, and indicators for marital status, literacy, education level, agricultural occupation; *IND* includes indicators for spouses, boys, girls and others (heads are the excluded category); and μ and ε are error terms (which allow for heteroskedasticity and are clustered at the village level in equation (2) and at the household level in equation (3)). We include the village dummy variables to absorb unobserved heterogeneity at the village level, such as food prices, that could affect simultaneously undernourishment and household inequities. We include *HH* and *IND* since they may contribute to undernourishment within a household.

In the individual level regressions, we use an interaction term to allow the statistical relationship between empowerment and undernourishment to vary based on the type of member. Thus we are able to observe whether certain household members are more or less likely to be undernourished in households in which the head's spouse is more empowered.

To aid in the interpretation of the results, we restrict our sample to male-headed households in which (female) spouses are present.[34] We also note that it is important to use caution when interpreting the results since the measures of women's empowerment are potentially endogenous. Households with more empowered spouses may differ systematically from those with less empowered spouses in unobservable ways. For example, household heads who choose to marry more empowered women could differ systematically from other heads in ways that affect the distribution of calories between members. Thus the following results provide supportive evidence but not definitive evidence. While we cannot identify causal relationships, we are interested in knowing how household inequities are statistically associated with women's empowerment given evidence of gender bias in South Asia (e.g., Jayachandran & Kuziemko, 2011) and the policies targeting women in Bangladesh (e.g., the National Women Development Policy 2011, Government of the Peoples' Republic of Bangladesh 2011)

Table 6 displays estimates of β from 24 separate regressions; each cell reports an estimate (and robust standard error) from a separate regression of the household inequity in calorie distribution on the measure of empowerment listed in the first column. The specifications in column (1) show the

[34] In the BIHS, a small share (13%) of households has a female head and less than one percent of those households has a spouse present (many are married without spouses at home; many are widowed).

bivariate relationship. The specifications in column (2) add in the control variables and the specifications in column (3) add in village dummy variables. For example, the estimate -0.029 in column (1) row 1 uses the empowerment score as the measure of empowerment, while the estimate -0.009 in column (1) row 2 uses an indicator of control in decision-making regarding daily tasks as the measure of empowerment.

Nearly all estimates are negative and the statically significant coefficients survive the inclusion of control variables and village dummies, suggesting that calories are more equitably distributed in households with a more empowered spouse. The one exception is that the absence of a mother-in-law increases the household inequity in calorie distribution. However household composition is endogenous and thus the decision to have a mother-in-law reside (or not reside) within a family may be correlated with other factors that are related to food consumption and distribution. While these results provide evidence of household-level patterns, we are more interested in understanding whether and how women's empowerment is related to individual-level undernourishment.

Table 7 displays estimates of θ and ρ, with each column representing one regression; all regressions include control variables and village dummies. The coefficients on each interaction term (ρ) are relative to the base coefficient (θ), which is for household heads – the omitted category. The depth of undernourishment of the male household head is not associated with the spouse's empowerment; however in most cases, undernourishment of the spouse, the children, or both is negatively associated with having a spouse who is empowered. Consistent with the literature described above, these results indicate the possible importance of a woman's empowerment in intra-household dynamics and her preference for the wellbeing of her children.

In nearly all cases, there is no association between the spouse's empowerment and the undernourishment of the "other" members; however when using absence of mother-in-law as the measure of empowerment, we observe a positive relationship between the spouse's empowerment and undernourishment for these "other" members (including the mother-in-law herself). These results suggest that a more empowered spouse is able to fulfill her dietary needs, perhaps to the detriment of members of the extended family.

5. Calorie Inequities and Economic Stressors

We examine whether the household inequity in calorie distribution is worse in households under stress by re-estimating equation [2] above after replacing the empowerment measure with the natural logarithm of per capita non-food expenditure, which we use as a proxy for household income.[35] Now, the coefficient of interest, β, captures how household inequities vary as a household becomes richer. We expect β to be negative since inequities may be worse in poorer households, i.e., more stressful situations.

The results are displayed in the first three columns of Table 8, according to whether control variables and village dummy variables are included in the models. As expected, as per capita non-food expenditure increases, inequities decrease. In the most complete specification (column 3), the

[35] Rather than using total expenditure as a proxy, we exclude food expenditure since undernourishment is related to the food consumption data, and thus measurement error could produce spurious correlations 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..

estimate suggests that the household inequity in calorie distribution is 0.21 percentage points lower in households with 10 percent more income. Non-food expenditure, however, is correlated with a number of omitted factors that also likely affect the distribution of household calories. Additionally, shocks could cause both non-food expenditure and the intrahousehold distribution of calories to co-move; for example, long-term illness of an earning member may increase the likelihood of poverty and affect how calories are distributed within the household. Thus, these estimates must be interpreted with caution, acknowledging the endogeneity of non-food expenditure.

As an alternative economic stressor, we examine an increase in family size since larger families likely place additional strain on scarce family resources. We utilize data on birth-order to estimate how scarcer resources associated with larger family size might affect household inequities in calorie distribution. Given the preference for sons in South Asia (Chen, Huq et al. 1981, Mannan 1988), 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).[36]

The specifications in columns (3)-(6) of Table 8 use an indicator for a first-born daughter instead of the log of per capita non-food expenditure as a measure of a economic stressor. Similar to the estimates presented in columns (1)-(3), households undergoing more stress have a more inequitable distribution of calories. The most complete specification in column (6) suggests that larger family size increases the household inequities in calorie distribution by approximately 1.8 percentage points.

These results provide 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, given the ability of households to detect the sex of a child before birth, households that have a first-born daughter might be self-selected, e.g., those who are least able to access ultrasound technology).

6. Conclusion

In this article, we utilize a novel data source - the Bangladesh Integrated Household Survey (2011-2012) - to estimate calorie consumption at both the household and individual levels. Our analysis utilizes data on 24-hour recall of consumption of finished recipes by each individual. First, we find that 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 and other nutrients 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 among households in which spouses are the least empowered and households that undergo economic stress.

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 underestimation of undernourishment of non-household heads when using aggregate household data. While such programs may not be

[36] Appendix Table A7 shows that households with a first-born daughter are larger than households with a first-born son.

sufficient to equalize the intra-household distribution of food if offsets occur, our findings underscore the importance of recognizing and accounting for intra-household dynamics by policymakers when identifying and targeting food-insecure populations.

In drawing conclusions from the results, it is important to recognize that our main result – heads consume a disproportionate share of household calories in rural Bangladesh – might not generalize to other contexts. For example, among pastoralists in Eastern Africa, household heads make nutritional sacrifices in the face of hardship (Villa, Barrett et al. 2011). However, the existence of inequities in household consumption has been corroborated in numerous other contexts (Chen, Huq et al. 1981 Strauss, Mwabu et al. 2000, Beaman and Dillon 2012).

Our research highlights the importance of survey design and its role in measuring and estimating undernourishment, consumption, and other household characteristics. Several survey attributes, including the definition of the household, the recall period, and the menu list, can have significant impacts on survey responses (e.g., Beaman and Dillon 2012, Beegle, De Weerdt et al. 2012). In the BIHS, we have a single respondent (female in charge of food preparation) reporting food consumption for each individual, which is very similar to typical household surveys in which a single respondent (often the household head) provides details about education, expenditure, labor, etc. for all individuals in the household.[37] However, Fisher, Reimer et al. (2010) demonstrate that there is little agreement between household heads and their spouses regarding the income of wives, which potentially contributes to misleading estimates of total expenditure. This difference in estimates could stem from a lack of information on the part of the head or from cultural reasons, e.g., the husband wanting to understate the spouse's contribution. Such variations in survey design underscore the importance of further research into survey design, with an emphasis on improved measurement of individual outcomes, such as undernourishment.

[37] However, more recently some surveys, such as the World Bank's Living Standards Measurement Study (LSMS), have begun to interview multiple adult household members Grosh, M. and P. Glewwe (2000). Designing Household Survey Questionnaires for Developing Countries: Lessons Learned from 15 Years of the Living Standards Measurement Study: Volume 1. Washington, D.C., World Bank..

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