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CHILD POVERTY AND INTRAHOUSEHOLD ALLOCATION: ANALYSIS OF A BANGLADESHI HOUSEHOLD SURVEY WITH INDIVIDUAL CONSUMPTION DATA

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CHILD POVERTY AND INTRAHOUSEHOLD ALLOCATION: ANALYSIS OF A BANGLADESHI HOUSEHOLD SURVEY WITH INDIVIDUAL CONSUMPTION DATA[1]

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Abstract

Poverty is a concept that concerns the individual. However, the most common poverty indicator – income (or expenditures) – is generally measured at the household level and then divided by the number of "adult equivalents". The resulting income per adult equivalent is then attributed to all household members. If it is below (above) a specified poverty line, all the household members will be considered poor (non-poor). This way of measuring poverty assumes that all members share the fortunes and misfortunes of the household equally. This is particularly problematic in the case of children. Furthermore, recent theoretical and empirical research indicate that family members have different preferences concerning the intrahousehold allocation of resources, particularly with respect to children, and that so-called distribution factors, by influencing their respective bargaining power, will change the individual outcomes.

This paper uses a very recent and innovative Bangladeshi household survey that includes detailed information on the intrahousehold allocation of consumption and time, as well as information on potential distribution factors to shed light on two questions. First, what is the role played by intrahousehold allocation in mitigating or exacerbating child poverty? Second, what is the scale of measurement error resulting from the neglect of intrahousehold allocation in the measurement of child poverty in a country such as Bangladesh? The results of this research can be expected to contribute to our understanding of the extent and nature of child poverty, to help target children who are in particular risk and to help design policies to efficiently combat child poverty.

[1] This study is an outgrowth of the IDRC-funded "Capturing Intra-Household Distribution and Poverty Incidence: A Study on Bangladesh" and is also part of the research activities of the Poverty and Economic Policy (PEP; www.pep-net.org) research network, which is also financed by the IDRC. We thank participants at the University of Sherbrooke economic department seminar series for their useful comments.

1. Introduction

Poverty is a concept that concerns the individual. However, with the exception of basic health and education data, which are collected at an individual level, poverty indicators are generally calculated on the basis of household-level variables. The most common poverty indicator – income (or expenditures) – is generally measured at the household level and then divided by the number of "adult equivalents". The resulting income per adult equivalent is then attributed to all household members. If it is below (above) a specified poverty line, all the household members will be considered poor (non poor). This way of measuring poverty assumes that all members share the fortunes and misfortunes of the household equally.

This is particularly problematic in the case of children. Many studies have shown that inequity in the intrahousehold allocation of resources is frequent[2]. In particular, it is possible that parental altruism will lead adults to sacrifice part of their resources in favor of their children (Gordon et al 2003). It is also possible that there will be a gender bias in this allocation of resources, typically in favor of male children (Haddad et al 1996, Sen 1990). Furthermore, recent theoretical and empirical research indicate that family members have different preferences concerning the intrahousehold allocation of resources, particularly with respect to children, and that so-called distribution factors, by influencing their respective bargaining power, will change the individual outcomes[3]. Another problem with that way of measuring poverty is that adult equivalent scales are often estimated based on how household expenditures are observed to vary with household size and composition. The weights attributed to the household members therefore reproduce the intrahousehold allocation of resources, and will thus be inequitable when households are inequitable.

To shed some light on these questions, we make use of a very recent and innovative Bangladeshi household survey that includes detailed information on the intrahousehold allocation of food, non food and time, as well as information on potential distribution factors and other individual, household and community characteristics. The main objectives of this paper are to improve our understanding (i) of the role played by intrahousehold allocation of resources in mitigating or exacerbating child poverty and (ii) of the scale of the measurement errors implied by the neglecting of intrahousehold allocations in the measurement of child poverty in a country such as Bangladesh.

We achieve these two objectives by answering a set of key questions. Do standard poverty indices provide a significantly different picture of child poverty when they are based on individual-level assessment rather than household-level assessment? Are the patterns of child poverty different when poverty is measured at the individual level? How far is the identification of poor children based on household data from one based on individual data? For children for whom we are getting a contradiction between the two levels of identification, who within the household is benefiting or suffering from the negative or positive discrimination experienced by these children. What are the keys factors, including distribution factors, making households more equitable toward children? In particular, what would be needed to bring poor children belonging to non poor households out of poverty? Indeed, if we argue that poverty is more detri-

[2] See Haddad et al (1996) and Behrman (1992) for a review of empirical studies on intrahousehold food allocation bias.
[3] For a summary of these developments, see Alderman et al (1995)

mental to children than to adults since children are in a development stage[4], we may even want to seek ways of bringing poor children belonging to poor households out of poverty.

There is a vast empirical literature on intrahousehold inequalities and an equally vast empirical literature on child poverty, but to our knowledge there is no study linking the two, at least not the way we do it. The closest is the seminal paper of Haddad and Kanbur (1990). Using a dataset reporting individual calorie intakes in Philippines, they assess the effect of neglecting intrahousehold inequalities on levels and patterns of measured poverty and inequality. They find that the levels of poverty and inequality are off by 30 percent, but that the patterns of poverty and inequality are not dramatically different. Our paper differs from Haddad and Kanbur in four aspects. First, we limit our analysis to children, whereas they treat children and adults together, without distinction. This is important since there is evidence of some pro-adult bias in South Asia (Haddad et al 1996). Our results can thus be expected to differ from theirs. Second, we study in greater depth the role and the impact of intrahousehold allocation on poverty.[5] They only look at its effect on poverty indexes and poverty patterns, while we also look at its effect on the identification of poor individuals. Furthermore, we investigate the characteristics of households with positive or negative discrimination towards their children. We also study the factors making households more equitable toward children. Third, we do not limit ourselves to calorie intake. We look at other measures of food consumption as well as at non food consumption. Fourth, instead of using only one poverty line, we use a poverty dominance approach.

Apart from the paper of Haddad and Kanbur, the papers of Findlay and Wright (1996), Phipps and Burton (1995), Borooah and McKee (1993) and Davis and Joshi (1992) are, to our knowledge, the only others looking at the impact of intrahousehold allocations on poverty measurement. These four studies, however, are based on micro-data simulations scenarios where intrahousehold inequality varies from low to high according to a certain number of hypothetical rules instead of on real data.

The absence of empirical studies looking at the effect of intrahousehold allocation of resources on child poverty measurement is very surprising since many child poverty studies are acknowledging the importance of taking intrahousehold inequality into account[6]. This paper is surely a first step in fulfilling this gap. After conceptual discussions on individual-level poverty measurement issues (section 2) and the theoretical framework for our analysis (section 3), we present our sources of data and the calculation of our key variables (section 4). We then turn our attention to the empirical results: a comparison of individual- and household-level poverty assessments (section 5) and an analysis of level and determinants of positive and negative discrimination towards children (section 6).

2. Assessing poverty at the individual- and household-level

Among attempts to collect consumption data at the individual level, with the exceptions of education and health data, most efforts have concentrated on food consumption. In poor countries, food consumption can take up the majority of the household budget, sometimes more than three-quarters of it (Deaton, 1997). So, food consumption is clearly a key determinant, and possibly the main determinant of individual economic well-being in developing countries. This is

[4] See Alderman, Hoddinott and Kinsey (2003) for an estimation of long-term consequences of childhood malnutrition.
[5] We don't study inequality however.
[6] See for example Corak (2005), Gordon et al (2003), Harpham (2003) and Save the Children (2001) to name only those.

likely to be particularly true for children, and even more for poor children, given the importance of their nutritional requirements for growth and physical development. An analysis of the role of intrahousehold allocations in terms of food consumption is thus crucial to improve our understating of its role in mitigating or exacerbating child poverty.[7]

If the intrahousehold distribution of food consumption was representative of the intra-household distribution of non food consumption, having information on the first would be sufficient. This is however a highly debated question (Fuwa, 2005). Bouis and Pena (1997), for example, argue that it is reasonable to assume that necessities are more equitably distributed within household than are non necessities. So, while it may be crucial to look at food consumption, it may not be enough. The ideal would be to have information on total individual consumption including both private and household goods, but this is extremely difficult to measure and subject to important measurement errors. If information on total individual consumption is not available, information on individual consumption of private goods, or even information on individual consumption of some specific private goods, could still be useful. To shed light on the role played by the intrahousehold allocation of resources in the determination of child poverty, these specific private goods must nevertheless be equally relevant for the children and the rest of the household members. Consumption of education services is not, for example, a good candidate. Nor is the consumption of health services unless individual needs are known.

The survey that we use here provides information on individual food consumption as well as individual consumption of the some of the most important non food goods, thus allowing us to construct different variables of individual consumption. More specifically, we construct three variables. The first one is individual calorie intake, the second is individual food consumption, and the third is individual private non food consumption.[8]

3. Presentation of the survey and the consumption variables

This paper takes advantage of a unique survey of Bangladeshi households, with a special emphasis on intrahousehold issues, which was conducted by the Bureau of Economic Research (BER) at Dhaka University under a research project entitled, “Capturing Intra-Household Distribution and Poverty Incidence: A Study on Bangladesh”.

3.1 Survey

The survey, administered during November 2004 – February 2005, covered 1039 households in 64 districts in Bangladesh, of which about 70 percent were located in rural areas while the rest belonged to urban communities. Like any other household survey, the BER survey collected data on a wide variety of subjects including household characteristics, demography, educational attainment, and the economic activities of household members, as well as consumption and expenditures on food and non-food items. However, there were several unique features of this survey.

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[7] Collecting consumption data at the individual level is not the only way to get information on individual consumption. Another approach, followed for example by Seitz and Lise (2004), is to use the collective framework developed by Chiappori and his collaborators to estimate a sharing rule. However, the rule in question can only be estimated up to a constant and therefore can only be used to allocate household consumption between its members up to a constant. For a general presentation of the collective framework and the sharing rule interpretation, see Chiappori (1997).

[8] Details on the construction of these variables are provided in the section 4.

First, unlike the most widely used technique of obtaining information on consumption through the 'recall method', the BER survey, by using specially trained enumerators, recorded the actual individual specific dietary intake by directly weighing the consumption of food items by household members. To reduce the measurement errors associated with recording of food intake, and to minimize the problem of distorted food intake behavior due to the presence of enumerators, data on dietary intake for each household was collected for three days during the survey period. The food preparation techniques were also keenly observed and all the ingredients used during cooking were recorded to work out the food nutrients available at the household level. Apart from measuring the food consumption, the survey also considered the amount of food sent outside home and plate wastes in order to not overestimate the food intake.

The BER survey also generated information on non-food consumption by individual household members. The information on non-food expenditure had to be collected by the recall method. In most cases, this information was obtained by interviewing the head of the household or the person who took the decision on such expenditures. The survey gathered data on expenditures on health, education, household essentials, clothing, footwear, cosmetics and toiletries, personal items, utilities and other durables. Because of the public good nature of many of these items, not all the expenses could be disaggregated amongst the individual members of each household. However, in other cases, the respondents could specify the expenses incurred for a particular individual, and, based on such information, we were able to measure private non-food consumption.

Another important feature of the survey was to record the time spent by individual household members on different types of activities. In order to avoid the problem of an atypical time allocation pattern, a 24-hour time allocation chart on individual members was filled in for three days. A large number of activities were listed in the chart so that the corresponding energy levels could be identified.

3.2 Constructing individual-level consumption variables

To construct individual calorie intake, we first computed, for each food item, the average of the quantities consumed by the individual over the three days. We then calculated the calorie intake associated to the average daily consumption of each food item for the individual by using the calorie content chart in different types of food prepared by the Institute of Nutrition and Food Science at Dhaka University. Taking the sum of calorie intake over the food items, we obtained the average daily calorie intake of the individual.

To construct the value of the food consumed of an individual, we used the market prices to compute the value of the quantity daily consumed on average of each food item. The value of the food consumed is just the sum of the values over the food items. For short, we will call this variable *individual food consumption*.

Once we have an individual consumption variable, the next step is to make it comparable across individuals. Standardization is required because individuals differ by their needs, by the consumption economies of scale realised by the household to which they belongs and by the prices that they are facing. The practice for standardizing household-level consumption for needs and economies of scale is to use household equivalent scale. The Cutler and Katz (1992) scale is one example:

$$E = (A + cK)^e$$

where E is the number of equivalent adults in the household, A is the number of adults, K the number of children, c the needs of a child relatively to an adult and e the economies of scale in household size. If for example a certain household comprises one adult and one child, its consumption will be divided by $(1+c)^e$. The parameters c and e are usually estimated based on how household expenditures are observed to vary with household size and composition. They therefore reproduce the intrahousehold allocation of resources, and will be inequitable when households are inequitable. One possible way of avoiding that could be to base the estimation on equitable households only. Another way could be to use the needs defined by experts, such as calorie requirement defined by nutritionists, to compute the parameter c. This is the approach we adopt here, defining c on an individual-by-individual basis according to sex, age and the energy expenditures of the individual.

In this paper, we are concerned by the standardization of individual-level consumption instead of household-level consumption. When household economies of scale are absent (e=1), it seems logical to standardize individual consumption by dividing by the individual's calorie requirements. This variable is commonly referred as the calorie adequacy ratio (CAR). Defining calorie requirements for an individual, however, is not a simple task. A variety of factors are related to calorie requirements, some of which are individual specific. However, some generalizations have been done over the years with rigorous experiments. An approximation to calorie requirements can be achieved with the following widely acceptable definition:

> …that level of energy intake from food which will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long term good health; and which will allow for the maintenance of economically necessary and socially desirable physical activity. In children and pregnant or lactating women the energy requirement includes the energy needs associated with the deposition of tissues or secretion of milk at rates consistent with good health (WHO, 1985).

The calorie requirement that we use are those provided by nutrition experts and are adjusted for the sex, the age and the energy expenditures of the individual. A detailed explanation on how requirements were obtained is presented in Appendix B.

Regarding the standardization of individual food consumption for needs, the logical way would be to divide it by the food consumption needs of the individuals. The problem is that we do not know what they are. The needs of individuals are only known in terms of calorie requirement. How can we put a monetary value on them? To overcome that problem, we assume that individual needs in terms of food consumption are a constant proportion of individual needs in terms of calorie intake. Under this assumption, dividing individual food consumption by individual calorie requirement is sufficient to make the variable comparable across individuals[9]. Is this a reasonable assumption? Unless there are biological restrictions on the kind of food that individual of different age and sex can eat, it is hard to see why some type of individuals should have food consumption needs that represent a greater proportion of their calorie needs than other. Is there such biological restrictions? The only case where it seems reasonable to have food restrictions is for young children. Young children (less than 4 years old) are known to be prone to food allergies and it is recommended that they avoid highly allergen food (eggs, fish,

[9] If $\hat{y}i_h{}^*=\alpha y_{ih}{}^*$ where $y_{ih}{}^*$ is the calorie requirement on individual i for household h and $\hat{y}i_h{}^*$ is his food consumption requirement, than dividing all individual food consumption $\hat{y}i_h$ by $\alpha y_{ih}{}^*$ or $y_{ih}{}^*$ will both do the job of making the variable comparable across individuals.

nuts, etc.)[10]. If food restrictions exist but have an origin other than biological, cultural for example, than this is simply reflecting institutionalized discrimination and therefore should not be taken it account.

For lack of a better alternative, we also normalize non-food consumption by individual calorie requirements.

3.3 Constructing household-level consumption variables

Since we have to compare individual consumption variables with their household counterpart to achieve the objectives of the paper, we also need to construct household-level consumption variables. Denote the individual-level consumption variable for individual i by y_i. The needs required by individual i to attain a certain well-being deemed to be sufficient to be considered non poor is represented by y_i*. Standardized individual consumption is thus given by (y_i/y_i*).[11] What should be the household-level counterpart of this variable? Obviously it must by a function the variables y and the levels y* of the different household members, but what function?

The two functions used in the literature on intrahousehold food intake are $\Sigma_j y_j/\Sigma_j y_j^*$ and $\Sigma_j(y_j /y_j^*)/S$, where j=1,…i,…,S with S being the size of the household. In terms of the calorie intake, for example, the first ("ratio of sums") function represents the sum of individual calorie intakes divided by the sum of individual calorie requirements, whereas the second ("sum of ratios") function is the sum of individual CARs divided by household size. Our choice between these functions should be based on the objectives pursed in comparing individual-level and household-level poverty. Recall that the purpose is to reveal, first, the role played by intrahousehold allocation in the poverty experienced by children and, second, the scale of the measurement errors implied by the neglecting of intrahousehold allocation in the measurement of child poverty.

A function serving the first objective would be one providing a different poverty measurement only when there is intrahousehold inequality. Here, in line with the literature on intrahousehold inequality, we define this as a situation where a member's needs are not proportionately satisfied, that is, $y_j/y_j^* \neq y_k/y_k^*$ for some j and k[12]. It is easy to show that both functions possess this property. When there is no intrahousehold inequality, all members will have the same individual standardized consumption and this will be equal to the household standardized consumption. Thus individual- and household-level assessments will lead to the same conclusions.

Regarding the second objective, since we have individual-level data, we are able to calculate the sum of individual standardized consumptions, but if we were observing only household-level data, as we usually do, we would only be able to calculate the "ratio of sums" function. Moreover, the ratio of sums, like any household-level poverty indicator simply shows if the household has a level of consumption sufficient to satisfy the needs of its member. It is not affected by intrahousehold inequalities. This is not true for the sum of ratios. A simple numerical example can be used to illustrate:

[10] It is true that infants do not eat solid food, but our analysis excludes children aged less than one.
[11] We are assuming for the moment that individual consumption does not have to be adjusted for economies of scale and regional variation in prices.
[12] This definition may not correspond to the conception that parents have of equity or inequity, but it seems the most appropriate one to use given the objectives of this research. See Farmer and Tiefenthaler (1995) for a presentation of different concepts of intrahousehold equity.

	Calorie intake	Calorie requirement	Standardized consumption
Individual 1 (adult)	1700	2000	0.85
Individual 2 (child)	1200	1000	1.20
Household	2900	3000	0.97

The "ratio of sums" function indicates that the household is poor, whereas the "sum of ratios" function indicates that it is non-poor: (0.85+1.20)/2 = 1.025. This is due to the fact that the "ratio of sums" is function of the distribution of y across the household members, but not the sum of ratios. The function $\Sigma_i y_i / \Sigma_i y_i^*$ thus appears to be more appropriate to assess the scale of the measurement errors implied by the neglecting of intrahousehold allocations.[13] The analysis in the rest of the paper is based on it.

The notation used to represent household-level variables is the following. Household-level consumption of individual i is denote by by $Y_i \equiv \Sigma_j y_j$ and the needs of the household to which individual i belongs by $Y_i^* \equiv \Sigma_j y_j^*$. Standardized household consumption is thus given by (Y_i/Y_i^*).

4. Comparing Child Poverty with Individual and Household Measurements

We ask four questions in this section. First, do standard poverty indices provide a significantly different picture of child poverty when they are based on an assessment at the individual level rather than at the household level? Second, how different is the identification of poor children based on a household level assessment from one based on an individual level assessment? Third, for children who are identified as poor by an individual level assessment but non-poor by a household level assessment, or vice versa, what is the intrahousehold distribution of poverty among adults, among children and between adults and children? Fourth, are the patterns of child poverty different when poverty is measured at the individual level? The answers given to these questions will shed light on the role played by intrahousehold allocations in mitigating or exacerbating child poverty and on the scale of the measurement errors implied by the neglecting of intrahousehold allocations in the measurement of child poverty.

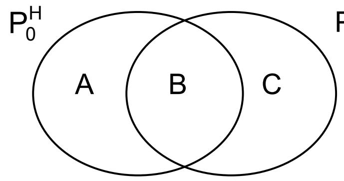
4.1 Aggregate Picture of Child Poverty

The first question we address is whether standard poverty indices provide different pictures of aggregate child poverty when they are based on household-level measurements instead of individual-level ones. The standard poverty indices that we consider are the headcount index, the poverty gap index and the squared poverty gap index.

The child headcount poverty index (P_0) is given by the following expression: $P_0 = Q/N$ where Q is the number of children identified as poor and N is the total number of children. If x_i is the (standardized) consumption variable of child i and if x* is the (absolute) poverty line, the child i will be identified as poor if $x_i < x^*$. According to the notation used in the section 3, $x_i = y_i/y_i^*$ when the consumption variable is assessed at the individual level, while $x_i = Y_i/Y_i^*$ when it is instead assessed at the household level.

[13] Haddad and Kanbur (1990) use both functions.

To distinguish the P_0 calculated with household-level data from the one using individual-level data, we denote the first by P_0^H and the second by P_0^I. The relation between P_0^H and P_0^I can be illustrated like this:



The set {A ∪ B} corresponds to P_0^H. It contains the children that are identified as household-poor. The set {B ∪ C} includes all the children identified as individual-poor and corresponds to P_0^I. If there were no intrahousehold inequalities, the sets A and C would be empty so that {A ∪ B ∪ C} = { B }. The greater are intrahousehold inequalities the greater will be the number of children contained in the set {A ∪ C}. This indicates the number of children for whom we get a poverty identification mismatch between household and individual approaches. In particular, the set A represents the children identified as household-poor, but not individual-poor. If there were no intrahousehold inequalities in the households of these children, they would be individual-poor. Therefore, one or several persons within the household is "sacrificed" to the point where the children's poverty status is reversed. In contrast, the set C corresponds to the percent of children identified as individual-poor, but not as household-poor. If the intrahousehold allocation of consumption was equitable, these children would not be individual-poor. One or several household members are thus getting a disproportionate share such that the poverty status of the child is reversed.

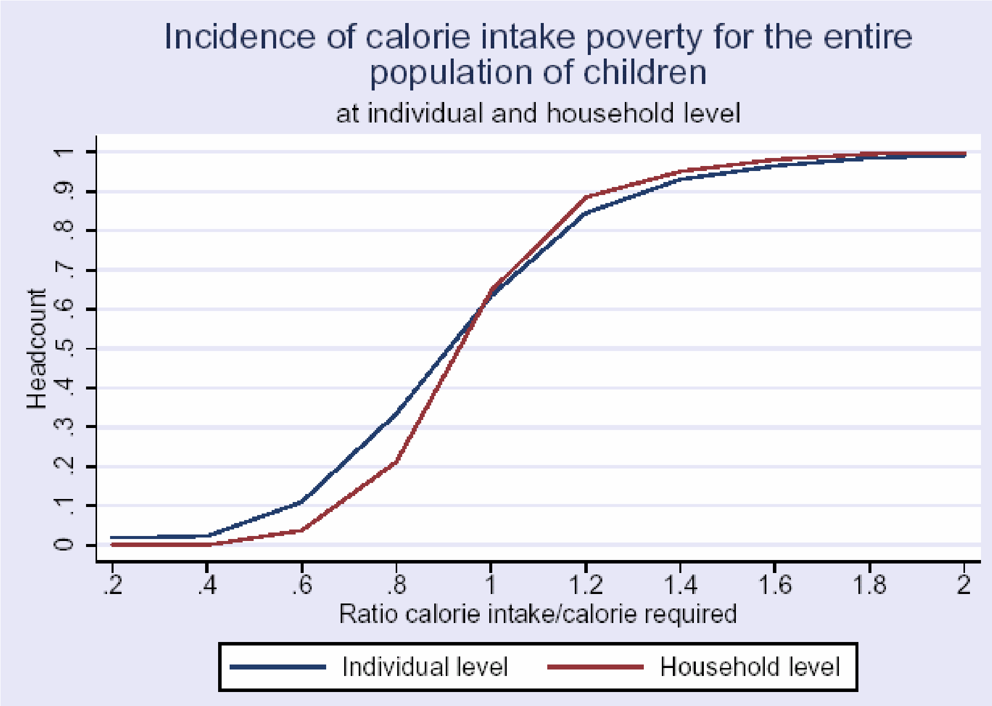
The mathematical relationship between P_0^H and P_0^I can be written as:

$$P_0{}^H = P_0{}^A + P_0{}^B = P_0{}^I + (P_0{}^A - P_0{}^C)$$

where P_0^Z denotes the percent of all children belonging to the set Z. The child headcount poverty index assessed at the household level is thus equivalent to the child headcount poverty index assessed at the individual level plus an expression summarizing the gap between the percent of children benefiting from intrahousehold inequalities and the percent of those suffering from it. If the percent benefiting from intrahousehold inequalities is higher than the percent of those suffering from it, P_0^H will be higher than P_0^I. In the opposite situation, P_0^H will be lower than P_0^I. The two poverty indices will be equal when $P_0^A = P_0^C$.

Figure 1 presents the incidences of child poverty as measured by P_0^H and P_0^I when the consumption indicator is the calorie adequacy ratio (CAR). Each CAR on the horizontal axis represents a possible poverty line. The curve labeled "individual level" reports P_0^I for each possible poverty line. The same logic applies to the curve labeled "household level" which shows P_0^H. The two curves are simply cumulative distribution functions of the incidence of poverty.

Figure 1: Incidence curves for calorie intake (entire population of children)



The information provided by this graph is very interesting and merits several remarks. The first thing to note is that there is no first-order dominance between child individual poverty and child household poverty for the range of poverty lines considered. To have first-order dominance, the curves P_0^I and P_0^H must not cross. Since they are crossing, some poverty lines will rank P_0^I and P_0^H differently. For example, a poverty line corresponding to a CAR of 1.05 would indicate that the incidence of child poverty is slightly overestimated when measured at the household level, but a poverty line corresponding to a CAR equal to 0.95 would indicate the opposite. Since the two curves cross around a CAR equal to one, which corresponds to the most reasonable poverty line, we do not even have first-order dominance for a restrained range of reasonable poverty lines. Therefore, we cannot say that the incidence of child poverty when measured at the household level is different from the incidence we obtain when we measure poverty at the individual level.

The fact that the two curves cross around a CAR equal to one casts doubts on the robustness of the results obtained by Haddad and Kanbur (1990) since they were precisely using a CAR equal to one as their poverty line. They found that P_0^H is overestimating P_0^I by 9.4%. F

The gap between P_0^H and P_0^I for a given poverty line corresponds to the expression $(P_0^A - P_0^C)$. What we observe in the graph, is that $(P_0^A - P_0^C)$ starts negative for low poverty lines and gradually shrinks as it approaches a poverty line roughly equal to one. It then turns positive and gradually expands until it reaches a CAR of 1.2 before shrinking once again. This behavior of the gap $(P_0^A - P_0^C)$ is striking. There is no reason a priori to expect that. It implies that there is a critical level of CAR, below which negative discrimination against children increasingly predominates, and above which discrimination is predominantly positive with respect to children.

And, this critical level of CAR corresponds to the level of calorie intake required to satisfy minimal household requirements. This is important because it implies that the majority of children living in poor households are in fact more poor than one would expect, especially among the poorest. We will explore this more carefully when comparing the child poverty gap index.

Since we do not observe first-order poverty dominance, we can try to impose more structure on the poverty measure by restricting our attention to measures that reflect the depth of poverty such as the poverty gap and the squared poverty gap. The child poverty gap index (P_1) is given by the following expression:

$$P_1 = \sum_{i=1}^{Q} \frac{(1 - x_i / x^*)}{N}$$

where the x_i are arranged in ascending order: the poorest as x_1, the next poorest x_2, etc., with the least poor having x_Q. This is the mean poverty gap of all children, where non poor children have a zero poverty gap. Again, to distinguish the P_1 based on household-level data from the one based on individual-level data, we denote the former by P_1^H and the latter by P_1^I. The link between P_1^H and P_1^I is given by:

$$\begin{aligned}
P_1^H &= \sum_{i\in\{A\cup B\}} \frac{1}{N}\left(1 - \frac{Y_i / Y_i^*}{x^*}\right) \\
&= \sum_{i\in\{B\}} \frac{1}{N}\left(1 - \frac{Y_i / Y_i^*}{x^*}\right) + \sum_{i\in\{A\}} \frac{1}{N}\left(1 - \frac{Y_i / Y_i^*}{x^*}\right) + \sum_{i\in\{C\}} \frac{1}{N}\left(1 - \frac{y_i / y_i^*}{x^*}\right) - \sum_{i\in\{C\}} \frac{1}{N}\left(1 - \frac{y_i / y_i^*}{x^*}\right) \\
&= \sum_{i\in\{B\}} \frac{1}{N}\left(1 - \frac{Y_i / Y_i^*}{x^*} + \frac{y_i / y_i^*}{x^*} - \frac{y_i / y_i^*}{x^*}\right) + P_1^A + \sum_{i\in\{C\}} \frac{1}{N}\left(1 - \frac{y_i / y_i^*}{x^*}\right) - P_1^C \\
&= \sum_{i\in\{B\cup C\}} \frac{1}{N}\left(1 - \frac{y_i / y_i^*}{x^*}\right) - \sum_{i\in\{B\}} \frac{1}{N}\left(\frac{Y_i / Y_i^*}{x^*} - \frac{y_i / y_i^*}{x^*}\right) + P_1^A - P_1^C \\
&= P_1^I + R^B + (P_1^A - P_1^C)
\end{aligned}$$

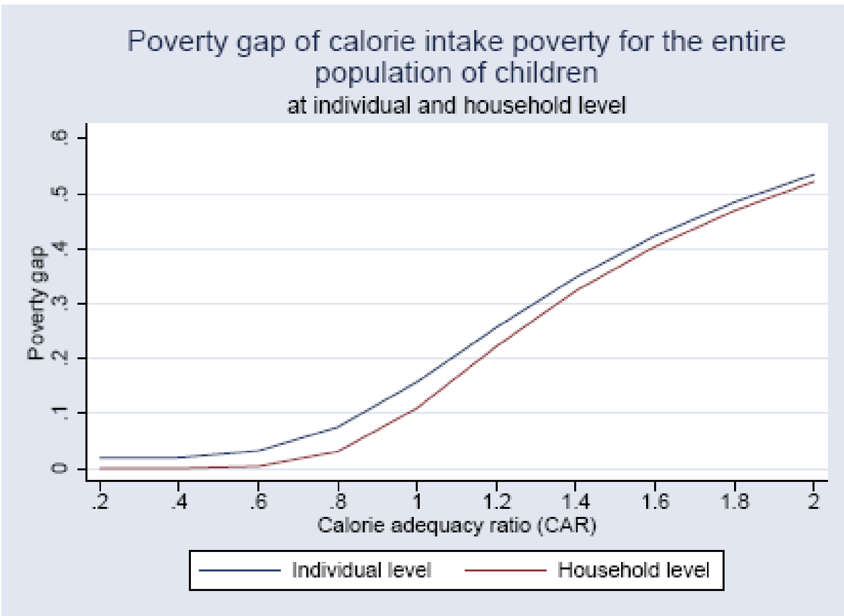
$$R^B \equiv \sum_{i\in\{B\}} \frac{1}{N}\left(\frac{(y_i / y_i^*) - (Y_i / Y_i^*)}{x^*}\right)$$

where R^B corresponds to average intrahousehold discrimination toward individuals belonging to the set B and P_1^Z is the "poverty gap" of children belonging to the set Z using the corresponding level of assessment. When there is no intrahousehold inequity, we have $R^B = 0$ and since the sets A and C are empty, the term $(P_1^A - P_1^C)$ disappears. When there are intrahousehold inequities however, P_1^I must be adjusted in two ways. First, because the sets A and C may now be non empty, we must add the poverty gap of children that are household-poor but not individual-poor since they are not included in P_1^I. We must also deduct the poverty gap of the children that are individual-poor but not household-poor since they are not included in P_1^H. This is accomplished by the expression $(P_1^A - P_1^C)$. Finally, even if the children belonging to the set B are both included in P_1^I and P_1^H, they may still suffer or benefit from intrahousehold discrimination. If on average, these children face negative (positive) discrimination, R^B will be negative (positive).

The difference between P_1^I and P_1^H is thus a measure of "aggregate" discrimination, where intrahousehold positive discrimination cancels out with negative discrimination. It should not be interpreted as an indication of the extent of intrahousehold discrimination. Imagine that intrahousehold equity is completely absent, so that the set B is empty. Suppose also that the household poverty gap of the children belonging to the set A is equal to the individual poverty gap of the children belonging to the set C. We would then observe $P_1^H = P_1^I$ even if all households are inequitable.

The cumulative distribution function of the poverty gap associated with the two levels of measurement is presented in Figure 2. The curve labeled "Individual level" reports P_1^I and "household level" reports P_1^H. We see that the individual level curve is higher than the household level curve for the full range of poverty lines. So while we do not have first-order dominance, we do have second-order dominance. For all possible poverty lines and measures sensitive to the depth of poverty, such as the squared poverty gap, we know that child poverty will be underestimated when poverty is measured at the household level. The extent of the underestimation corresponds to the expression $R^B + (P_1^A - P_1^C)$ which is turning out to be negative here. It means that on the whole, negative discrimination toward children is more important than positive discrimination.

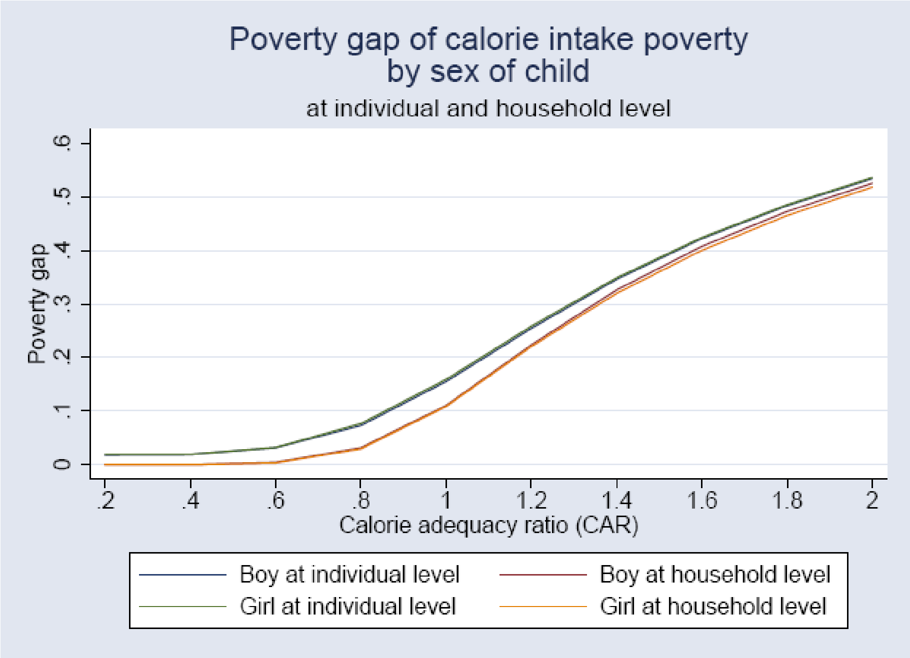
Figure 2: Poverty gap curves for calorie intake (entire population of children)



For a poverty line equal to one, the household poverty gap is 0.125 while the individual poverty gap is 0.15. The household poverty gap thus underestimates the individual poverty gap by 17 percent. This is a little bit less than the figure obtained by Haddad and Kanbur of 23%. The distance between the two curves increases when we move to the lower poverty line 0.8 and the measurement error reaches more than 50 percent. In contrast, it gradually decreases as we move toward higher poverty lines. This is consistent with our earlier observation that the poorest a household is, the higher are the chance that its children suffer from inequality.

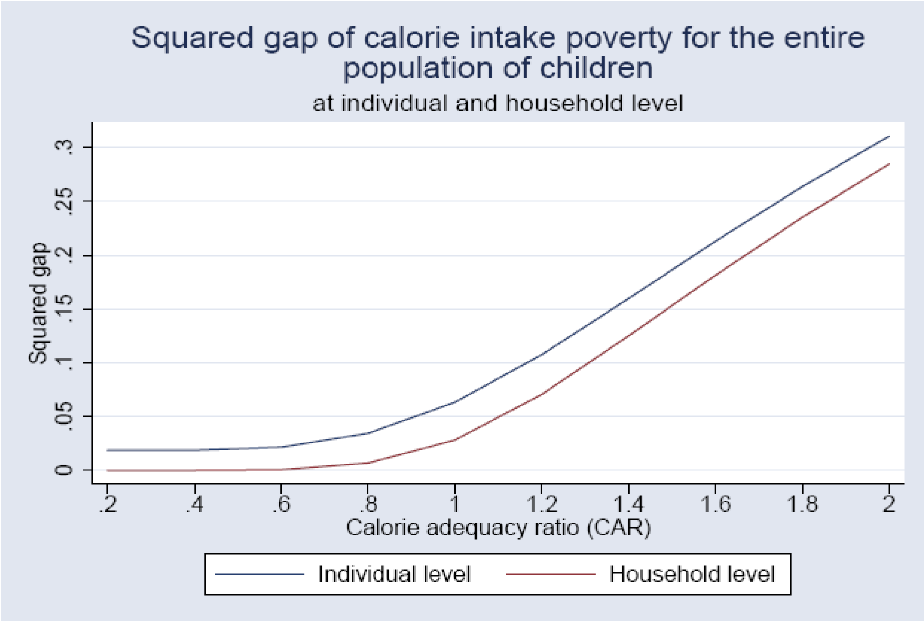
As shown in Figure 3, there is no discernible difference between the girl poverty gap and the boy poverty gap. So if there is discrimination between girls and boys, it is not with respect to the intrahousehold allocation of calories.

Figure 3: Poverty gap curves for calorie intake by sex of child (entire population of children)



We know that the squared individual poverty gap is higher than the squared household gap since we have second-order dominance. We are also interested by the extent of the measurement error between the two. The next figure illustrates this. For a poverty line equal to one, the squared poverty gap is 0.635 based on individual data and 0.3 based on household data. This is underestimation error of 53 percent, which is slightly higher than the 44% obtained by Haddad and Kanbur. The distance between the two curves is roughly constant for the range of poverty lines between 0.8 and 1.2, but if we express it in %, the measurement error decreases on this range from ---- to ----. Clearly, there is a dramatic understatement of the squared poverty gap index when intrahousehold inequalities are neglected. Again, this is consistent with children suffering more from inequality the poorest is their household.

Figure 4: Squared poverty gap for calorie intake (entire population of children)

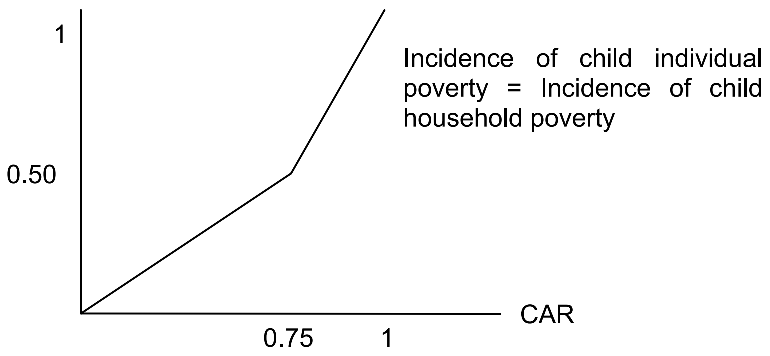


4.2 Identifying the Poor Children

Even when the incidence of poverty is the same using individual and household level data, a result we get for a CAR around one, the children identified as poor may not necessarily be the same. Recall that $P_0^H = P_0^I$ when $P_0^A = P_0^C$. So, even if P_0^A is very large, as long as it is close to P_0^C, the household-level poverty incidence will not be far from the individual-level poverty incidence. In other words, the distance between the two incidence curves indicates the errors that we make when in aggregate, but it is not a good indication of the errors that we make in the identification of the poor.

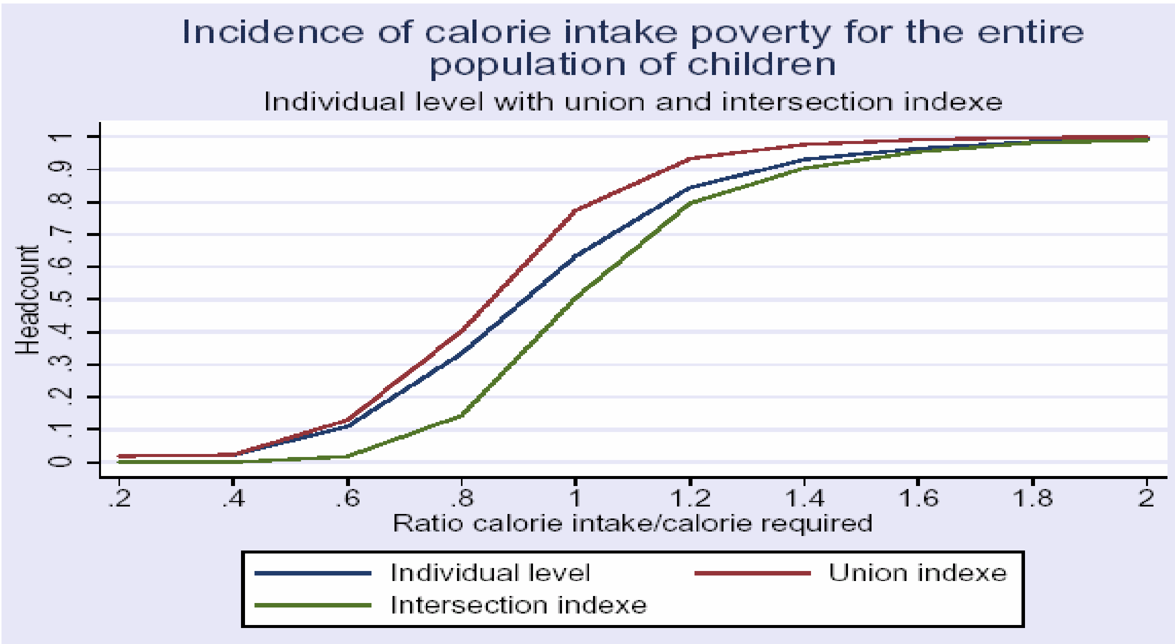
Let us take an example to illustrate. Consider two households each having one child. The child from the first household has a y_{11}/y_{11}*=1 and a Y_1/Y_1*=0.75. The child from the second household has exactly the opposite, a y_{12}/y_{12}*=0.75 and a Y_2/Y_2*=1. The following figure shows the incidence of poverty for the two children distribution. With a poverty line of 0.75, the child from the first household would be identified as poor with a household level measurement, while it is really the child from the second household who is poor. This happens because only the ranking of children change, the distribution of y_{ih}/y_{ih}^* stays the same.

Figure 5: Example: incidence curves for two-child household



Our third question is thus the following: How different is the identification of poor children with a household-level approach compared to an individual-level approach? In other words, are the poor children identified with an individual-level approach the same than the children identified with a household-level approach? The following figure provides information on this.

Figure 6: Incidence of calorie intake poverty for the entire population of children



The child intersection poverty curve represents the percent of children that are identified as poor with both levels of measurement, that is those belonging to the set B. The child union poverty curve represents the percent that are poor either when poverty is measured at the household level or when it is measured at the individual level, that is those belonging to the set {A ∪ B ∪ C}. The distance between the union curve and the individual curve corresponds to P_0^A. The distance between the individual curve and the intersection curve represents P_0^C. The distance between the intersection curve and the x-axis gives P_0^B. The link between the graphs 1 and 4 is the following:

If $P_0^A = P_0^C$ in graph 4, then $P_0^H = P_0^I$ in graph 1
If $P_0^A > P_0^C$ in graph 4, then $P_0^H > P_0^I$ in graph 1
If $P_0^A < P_0^C$ in graph 4, then $P_0^H < P_0^I$ in graph 1

Since P_0^A is smaller than P_0^C for all the poverty lines roughly below one, we find that $P_0^I > P_0^H$, i.e. poverty incidence is greater when measured at the individual level. Since it is the opposite for the poverty lines roughly above one, we get $P_0^I < P_0^H$. For poverty lines around one, the two distances are similar, which explains why we get similar results for the incidence.

Figure 6 shows that poor children living in non poor households and non poor children living in poor households are two important phenomena. For poverty lines around CAR equal to one, close to 14 percent of poor children are living in a non poor household. A similar percentage of non poor children are living in a poor household. Therefore, when poverty is measured at the household level, 14 percent of all children are wrongly excluded from the set of the poor, and the same percentage is wrongly included in the set of the poor.[14] Said differently, 30 percent of all children are classified on the wrong side of the poverty line when intrahousehold resource allocation is not taken into account. This is a very important number. What is even more striking is that none of this shows up in the simple comparison of poverty incidence measured at the individual and household level in graph no.1. The reason for which the headcount ratios are close is not because resources are equitably allocated within households with a CAR equal to one, but because the percent of children suffering from negative discrimination is equivalent to the percent of children benefiting from positive discrimination. This shows that simply comparing individual-level incidence with household-level incidence can be very misleading when it comes to assessing the role of intrahousehold resource allocation on the poverty status of the different household's members.

This brings us to an important question. If household CAR and household expenses are highly correlated and if the intrahousehold allocation of CAR is representative of the allocation of non food expenses[15], then this means that we are currently doing a very bad job in identifying poor children. This also raises questions about the best indicator for targeting. One must wonder if a poverty indicator other than household expenses which could be measured at the individual level would perform better, or else, a complementary indicator.

5. Negative and positive discrimination toward children

We now examine the extent of positive and negative discrimination toward children in various aspects of intrahousehold allocation. First, we examine the intrahousehold allocation of nutrients (calories) as measured by the calorie adequacy ratio. We then look more largely at the intrahousehold allocation of food consumption, before finally turning our attention to the intrahousehold allocation of non-food consumption. In a second stage, we examine what factors, including distribution factors, make households more or less equitable toward children in these various dimensions?

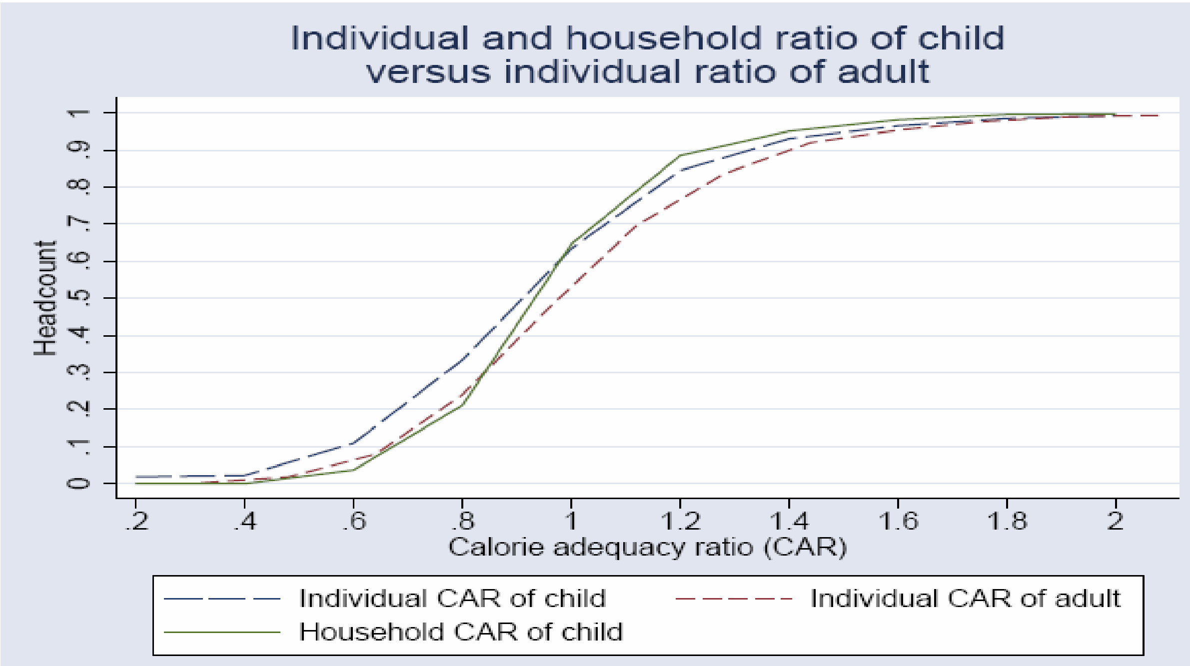
[14] This is what is typically referred to as errors of type I and II.
[15] It seems however reasonable to think that inequality would in fact be amplified in non essential goods. See Bouis and Pena 1997 for a discussion on that.

5.1 The intrahousehold allocation of nutrients

If a household allocated its nutrients among its members in proportion to their individual needs, all household members would have a caloric adequacy ratio (CAR) equal to the household CAR, where the latter is simply the ratio of the sum of calorie intakes and requirements over all household members. If an individual has a CAR that is greater (less) than the household CAR, we conclude that s/he is the object of positive (negative) discrimination on the part of the household's decision-making unit. Note that if one household member has a CAR above the household CAR, necessarily at least one other household member has a CAR below the household CAR.

To begin our analysis, we return to a modified version of Figure 1 in which we have added the adult CAR incidence curve (Figure 7), let us first compare the incidence curves of children and their households. We first note that, based on the observation of individual calorie intakes, nearly two-thirds (headcount=0.63) of Bangladeshi children do not have sufficient caloric intake to meet their minimal requirements (CAR<1), taking into account their age, size and level of activity ("Individual CAR of child"). A full third of children do not even attain 80 percent of their requirements (CAR<0.8) and ten percent of all children intake less than 60 percent of their caloric needs.

Figure 7: Child, Adult and Household Calorie Adequacy Ratio Incidence Curves (CARs)



Incidence rates for children are consistently above ("dominate") those of adults ("Individual CAR of adult"), among whom only half do not fulfill their calorie intake needs and only a quarter consume less than 80 percent of their minimum requirement. Note that this does not necessarily imply that, on average, children face more negative discrimination than adults, as it is possible that there is simply a higher share of children living in calorie-poor households.

When we now consider the average CAR of the households in which these children live ("Household CAR of child"), we observe that roughly two-thirds of children live in households that have insufficient caloric intake to satisfy the basic requirements of their members **if calories were distributed equitably among all members**. As this is also roughly the proportion of children who do not satisfy their own requirements based on individual observations, this suggests that there is no positive or negative discrimination towards children on average. However, it is still possible that some of the children with CARs below one are from households with CARs above one and vice versa. If this is the case, we can conclude that the incidence of positive discrimination approximately balances out that of negative discrimination. More compelling evidence of discrimination against children is that only 20 percent of children live in households that have insufficient resources to provide their members with at least 80 percent of their caloric requirements, while we observe that 33 percent of children are below this level. This is an extremely important first result indicating that the use of household-level nutritional data to assess child nutritional poverty is likely to lead to substantial underestimation of severe malnutrition.

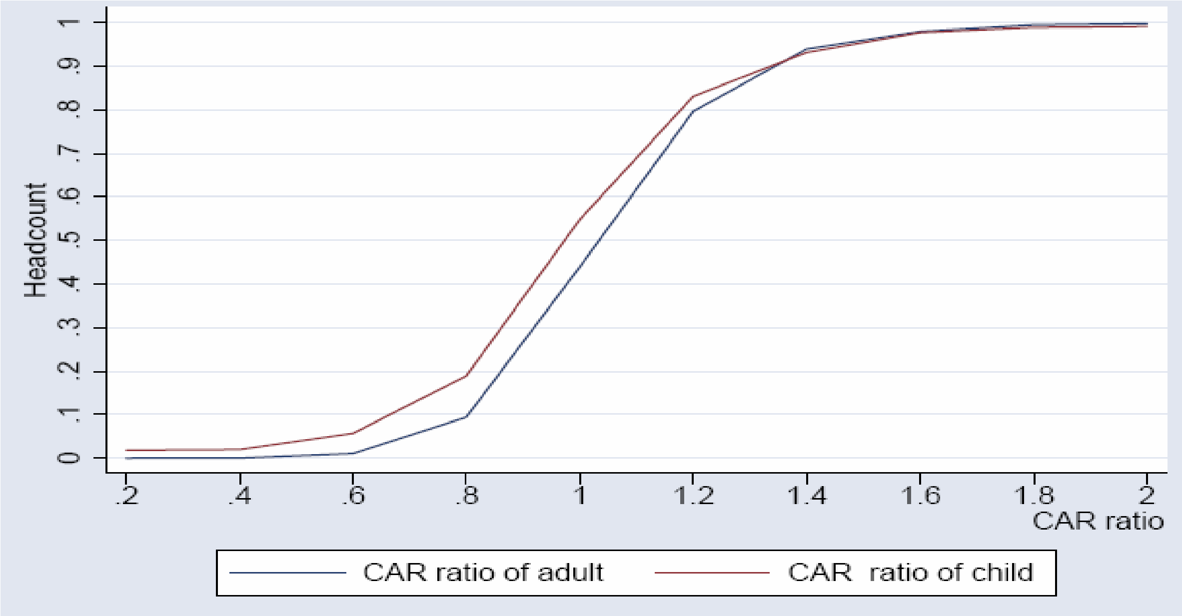
This result may give us the impression that 13 percent (33 – 20) of households with CARs above 0.8 discriminate negatively against children by giving them less than their fair share of household calories. However, if some of the households with CARs below 0.8 discriminate positively in favor of their children to raise their CARs above 0.8, then the percentage of the households with CARs above 0.8 that discriminate against children would have to be even bigger to explain this gap. In order to see more clearly, we now turn our attention to the ratio of individual to household CARs, measured separately for each person.

A synthetic measure of discrimination for any individual is the ratio of her/his CAR to that of her/his household; the CAR ratio. Note that the CAR ratio does not tell us anything about the level of an individual's CAR, as it is possible to have a low CAR ratio with a high individual CAR if the individual's household has an even higher CAR. In this section, we graph CAR ratio curves, which show, for each possible value of the CAR ratio, the percentage of individuals (headcount index) with a CAR ratio less than or equal to this. As the distribution becomes more equitable, the curve will have a longer and more vertical central section. The flatter the middle section of a CAR ratio curve is, the more there is discrimination. The higher the curve is, the more negative is this discrimination.

In Figure 8, we first note that the child CAR ratio curve clearly shows first-order dominance over the adult CAR ratio curve for CAR ratios up to nearly 1.4, indicating that children suffer much more negative discrimination than adults. More than half of all children suffer from negative discrimination (i.e. CAR ratio < 1) and, conversely, less than half benefit from positive discrimination. In contrast, roughly 40 percent of adults face negative discrimination, whereas 60 percent benefit from positive discrimination. Furthermore, nearly twice as many children (20 percent versus 10 percent) suffer from severe negative discrimination with individual CARs that are less than equal to 80 percent of their respective household's CAR. These children receive 80 percent or less of the calories they would have received if their household's caloric resources were distributed equitably.

Thus, our second major conclusion, which is coherent with our earlier observation that child CAR curves are consistently above adult CAR curves, is that children suffer more from negative discrimination in the intrahousehold allocation of nutrients.

Figure 8: Child and Adult CAR Ratio Incidence Curves

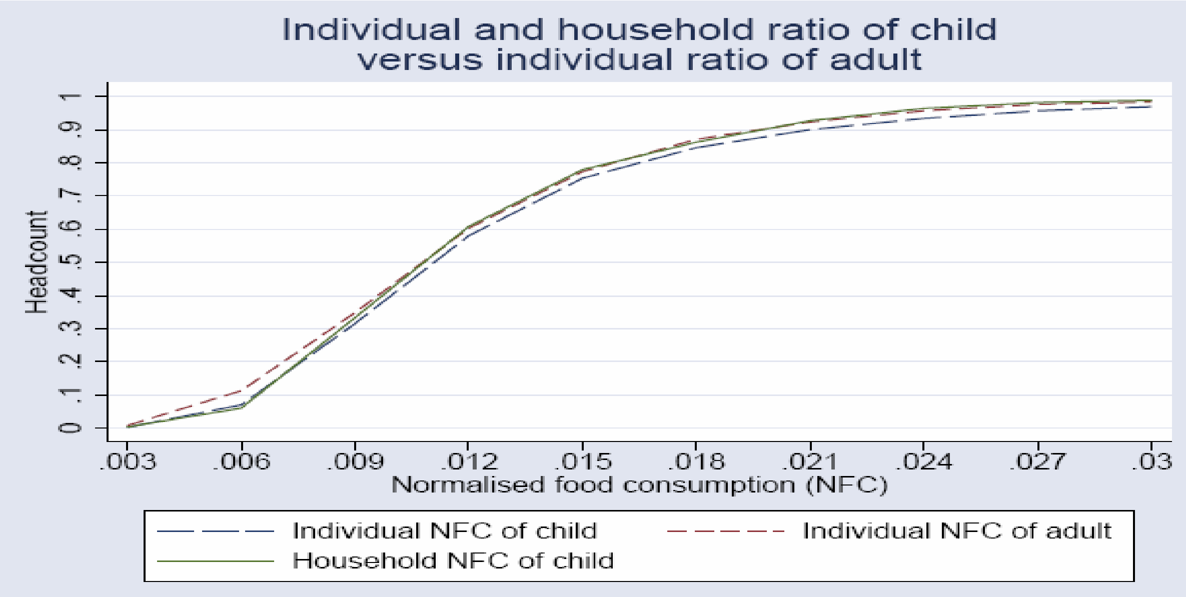


5.2 The intrahousehold allocation of food consumption

The caloric contents of food items differ and thus, within a given budget, it is possible that the calories provided will vary substantially. As the food budget is a better measure of household capabilities, whereas calorie intake is relatively more akin to an outcome measure, it is interesting to compare the intrahousehold allocation of food consumption. In the process, we also measure the cost per calorie, which may vary from one individual (household) to another. A priori, we might assume that foods with higher cost per calorie are more "luxurious" and generate welfare that is distinct from their nutritional contribution. We will explore this further on.

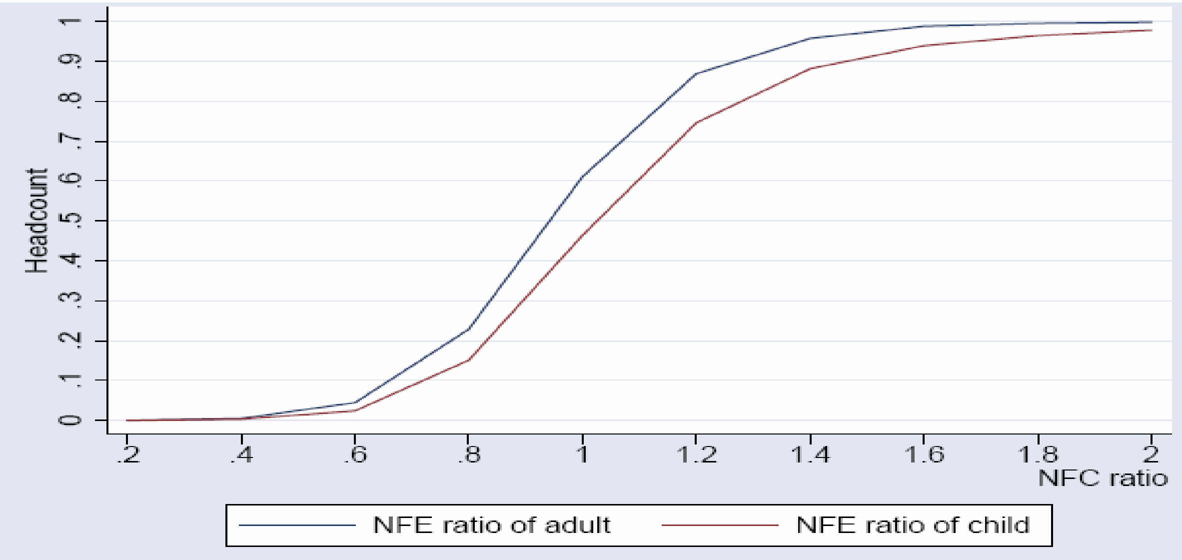
We first note that the adult normalized food consumption (NFC) incidence curve stochastically dominates that of children, which is exactly the opposite of what we observed in the case of caloric intake. Furthermore, when we compare the incidence curve of children with that of their households, there is a clear indication of **positive** discrimination towards children, with the exception of the very poorest households ($NFC_h \leq .006$), whereas we found evidence of negative discrimination in the case of the intrahousehold allocation of nutrients. The only possible explanation for this contradictory result is that the cost per calorie (CPC) is, on average, higher for children than for the other members of their households.

Figure 9: Child, Adult and Household Normalized Food Consumption (NFC)



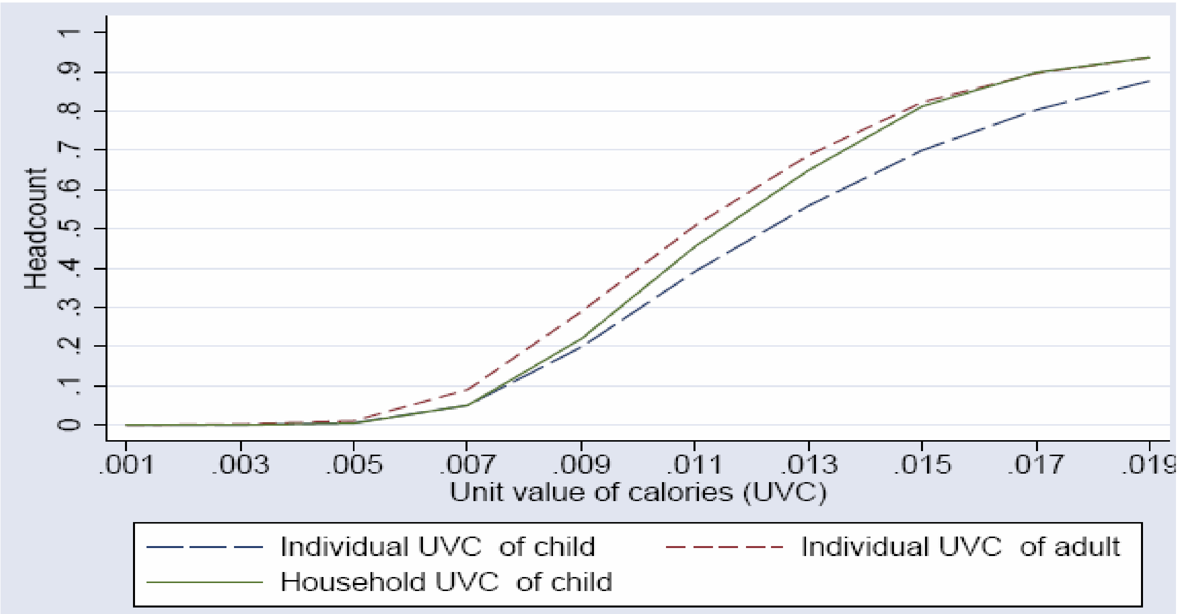
When we now consider the NFC ratios of children and adults (Figure 10), we discover further evidence of positive discrimination towards children. The adult NFC ratio curve clearly dominates that of children for NFC ratios above 0.4. Whereas more than 60 percent of adults have a NFC ratio below one, indicating that they receive less than their fair share of household food consumption, this is true for less than half of all children. Note that a full quarter of all children receive at least 20 percent more than their fair share (NFC ratio > 1.2). In contrast, roughly 15 percent of children receive no more than 80 percent of their fair share. This, again, contrasts with our results for the CAR and suggests that the cost per calorie for children is, on average, higher than for adults.

Figure 10: Child and Adult NFC Ratio Incidence Curves



Indeed, our data indicates that the average CPC for children is .0529 takas, as compared to only .0514 takas for adults. A closer look at the data reveals that this difference is due primarily to an apparent nutritional preoccupation. In particular, children consume a higher share of high CPC items such as fruit and certain milk products, whereas adults consume a higher share of low CPC items such as rice. Presumably, these items are allocated towards children for their non-caloric contributions: vitamins, protein, etc. Children also consume a larger proportion of high CPC "treats" such as biscuits and chocolate. in Figure 11, we see that the adult CPC incidence curve dominates that of children for CPCs greater than .005 takas per calorie, indicating that there are a larger share of adults within this range of CPCs. Also, children are shown to have a smaller incidence of these low CPCs than their households for CPCs greater than .007.

Figure 11: Child, Adult and Household Average Costs per Calorie (CPC) Incidence Curves



5.3 The determinants of intrahousehold allocation

The discussions presented in the sections above have given important indications about the nature of intra-household resource allocation to children in terms of distribution of calories, food and non-food consumption. In this section, we undertake multivariate regression analyses to examine the determinants of the intra-household resource allocation to children.

Following the analyses of the preceding sections, we concentrate on the incidence of child poverty as reflected in their CARs, as well as their food and non-food consumption. Rather than employing different frameworks, a general approach is used here to explain the three indicators of our interest. It is assumed that an outcome (such as CAR, food and non-food consumption) associated with children is likely to be determined by the corresponding outcome at the household level as well as other individual (i.e. child-specific) and household characteristics. Given this specification, the coefficient on the comparable household outcome will determine the direction of discrimination towards the children. If household resources are distributed equitably (i.e. according to the individual needs of each household members), the estimated coefficient would be such to generate a unitary elasticity of household resources to individual allocation. If the generated elasticity coefficient is greater (less) than unity for children, we can conclude that children get more (less) than their "fair" share and benefit (suffer) from positive (negative) discrimination. The gender of the individual will pick up any discrimination between boys and girls.

First, let us consider the regression of children CARs. The average CAR ratio of the child's household (CAR_h) is included among the explanatory variables. Along with the children's age and sex, two dummies indicating the youngest and eldest amongst the children, and another dummy indicating children who are ill at the time of the survey are also included. Household characteristics are represented by a set of variables commonly used in the literature including education, age and sex of the household head, education of the children's mother and father, household size, location and religion of the household, and the ratio of adults to household size. The only atypical variable used in this equation is an awareness index (awareness), which is constructed on the basis of the mother's knowledge about food ingredients that are considered to have direct relevance to children's health outcomes.[16] In a country like Bangladesh, educational attainment does not necessarily imply improved knowledge on nutrition. In most cases, mothers come to know about nutrition either from the mass media or from the health workers of the non-government organisations (NGOs).[17] If our hunch is correct we would expect to see a statistically significant and positive influence of awareness on children's CARs, other things remaining constant.

It needs to be mentioned here that the inclusion of the household CAR is likely to trigger an endogeneity problem, requiring the use of instrumental variable regression methods for consistent and efficient parameter estimates. Therefore, it is necessary to identify a set of determinants that can be used as instruments of CAR_h. Appendix Table 1 shows the results of an instrumenting equation that uses all the exogenous variables from the main regression, as well as per capita household expenditure (lnpcexp), its square, the proportions of several age groups in each household and the village-level prices of important food items. Overall, the explanatory power of the equation is quite satisfactory (R^2=0.23), allowing us to use its fitted value (CAR_{hf}) in the CAR_i equation to replace CAR_h.

The results of the 2SLS estimates of children's CARs show that CAR_{hf} is highly significant with a coefficient of 0.77 (Table 1). It so happens that the estimated elasticity at the means of the data also turns out to be almost identical. The imposition of a restriction of unit coefficient on CAR_{hf} is strongly rejected at the one percent level. That the estimated elasticity is significantly less than one is an indication that households do discriminate negatively against children by allocating to them less than their "fair" share of household calorie resources. As children grow older, their calorie adequacy ratio falls further, as reflected in the negative and statistically significant coefficient of age. Households probably recognize the nutritional vulnerability of younger children and hence discrimination against them is less important. Another important finding is that girls' CARs that are, on average, three percent less than for boys.

Amongst other significant variables, the awareness index, registering statistical significance at the 10 percent level, emerges in line with our *a prior* expectation, exerting a positive influence on CAR_i. Quite strikingly, mother's education has a statistically significant negative

[16] During the survey, the mothers in the households were asked six specific nutrition and health-related questions. Someone who could answer all questions correctly was awarded a full mark of 1. Correct answer to only one question resulted in a score of 1/6.

[17] In fact, the correlation coefficient between awareness and mother's education in our sample is very low.

effect. It could be that educated mothers in Bangladeshi households tend to have more influence in the allocation of non-food expenses, rather than the allocation of household nutrients. Some evidence to this effect is provided later. Other things held constant, the youngest child in the household tends to have a lower CAR, where the estimated parameter is significant at the one percent level. This suggests some birth order effect, although there is no significant difference in the CARs of the eldest children.

Table 1: Determinants of the Calorie Adequacy ratio of Children: 2SLS Estimates

Dependent variable is individual calorie adequacy ratio (CAR_i)				
	Coefficient	**t-ratio**	**Coefficient**	**t-ratio**
Constant	.3862***	3.56	.3749***	3.40
CAR_{hf}	.7786***	9.10	.7750***	9.00
Age	-.0083**	-2.46	-.0069*	-1.70
Sex (1= girl)	-.0297*	-1.93	-	-
Religion (1= Muslim, 0 otherwise)	-.0305	-0.63	-.0297	-0.61
Location (1=rural, 0 otherwise)	.0101	0.58	.0105	0.61
Sex of the household head (1=male)	-.0369	-1.27	-.0364	-1.25
Education of the Household head	-.0006	-0.24	-.0006	-0.22
Education of mother (years spent in school)	-.0080**	-2.54	-.0079**	-2.50
Awareness	.0608*	1.71	.0606*	1.70
Age of father	.00006	0.03	.00007	0.04
Age of mother	-.00003	-0.01	.00003	0.01
Household size	.0020	0.24	.0021	0.25
Ratio of adult to household size	-.0085	-0.11	-.0114	-0.15
Whether the child was ill (1=yes)	.0036	0.23	.0036	0.23
Whether youngest among kids (1=yes, 0 otherwise)	-.0639***	-3.01	-.0645***	-3.03
Whether eldest among kids (1=yes, 0 otherwise)	-.0222	-1.04	-.0221	-1.03
Whether girl aged up to five years (1=yes)		-	-.0097	-0.29
Whether girl aged between six to nine years (1=yes)		-	-.0346	-1.55
Whether girl aged between 10 and 14 years (1=yes)		-	-.0392**	-2.09
Number of observations		1393		1393
F-statistics		7.34***		6.86***

Note: Statistical significance at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

Finally, a number of interesting results are tied to non-significant variables. Religion, location, size and the share of adults in the household, as well as the gender and education of the head and the age of parents, all have no significant impact on child CARs. It also does not appear to matter whether the child is ill or first-born (eldest).

To examine the nature of boy-girl discrimination more closely, in the second regression in Table 1, the sex dummy variable is replaced by three separate dummies, viz. girls aged up to five years, girls between six and nine years, and girls aged between 10 and 14 years. The coefficients on all these dummies are negative. However, it is only the coefficient on the 10-14 years age group that achieves statistical significance at the conventional level. Therefore, it seems that the gender discrimination is mainly focused among older children.[18]

[18] Just to confirm this, another regression changing the base category to 10-14 years was run in which case the coefficient on the pre-schooler girl dummy variable was not found to be significant. If the regression is run with the interaction variable age $\times$ gender after removing all the age category dummy variables, the obtained coefficient on the interaction term is negative and highly significant.

We now apply the same analysis to the intrahousehold allocation of food and non-food consumption within the household. As in the previous case, allocation of consumption is expected to be determined by household expenditure in that category, along with other individual and household characteristics. However, since children have calorie requirements lower than adults, an equitable (fair) distribution of food consumption would suggest that children have less than an equal share without this implying discrimination. To take this possibility into account, we normalize individual consumption by individual calorie requirements and household consumption by the sum of calorie requirements over all household members. Although it is difficult to ascertain whether a fair share for children in the case of non-food goods can imply less than the per capita household non-food expenditure, we also choose to normalize non-food consumption by individual and household calorie requirements.

Because of the same type of endogeneity problem as in the CAR analysis, a 2SLS procedure is once again applied. The instruments used for household food expenditures (normalized by household calorie requirements) are non-food expenditures, household size and various age composition, education and sex of the household head, landholding, and the prices of several important food items. For the non-food consumption equation, household size, location, and age composition, education of household head, and logarithm of landholding are used. The food and non-food consumption regressions, as presented in Appendix Tables B and C, show that the chosen instruments can explain the variations in these equations very well (R^2 around 0.4).

Regression results reported in Table 2 show that the estimated elasticity of child food consumption to household food consumption is 0.89 (column 1), although the null hypothesis that this elasticity is equal to one could not be rejected. Recall that in our earlier stochastic dominance analysis, which does not include any controls for individual and household characteristics, suggested that children suffer negative discrimination in terms of the intrahousehold allocation of calories but that they benefit from positive discrimination when we consider food consumption. While the contrast is less dramatic in these regressions (which include a full set of controls), it still appears that discrimination is more negative towards children in terms of calorie intake than overall food consumption.

The coefficient on age in this case is positive and highly significant. This contrasts with the CAR analysis and suggests that, while households show concern for the caloric intake of younger children, they show less concern for their overall food consumption. The sex dummy once again picks up a highly significant negative relationship, suggesting discrimination against girls in terms of food consumption. As in the case of CARs, the youngest child tends to suffer more from negative discrimination. No other determinant is found to be having any significant influence on food consumption allocated to children, including mother's education, which had a negative impact on calorie allocation. When the age group dummy variables for girls, similar to those in Table 1, are introduced, it is found that the negative gender discrimination is focused among the youngest and oldest groups of girls.

Table 2: Determinants of Food Consumption on Children: 2SLS Estimates

Dependent variable: log (food expenses allocated to children)				
	Coefficient	**t-ratio**	**Coefficient**	**t-ratio**
Constant	6.8028***	42.06	6.8132***	41.42
log (normalized household food expenditure)	.8898***	12.00	.8933***	12.07
Age	.0516***	12.13	.0511***	9.99
Sex (1= girl)	-.0836***	-3.65	-	-
Religion	.0258	0.44	.0240	0.40
Location (1=rural, 0 otherwise)	-.0250	-0.91	-.0261	-0.95
Sex of the household head (1=male)	-.0152	-0.36	-.0177	-0.42
Education of father	.0039	0.95	.0038	0.92
Education of mother	-.0053	-1.16	-.0054	-1.20
Age of father	.0004	0.14	.0002	0.05
Age of mother	.0029	0.77	.0031	0.81
Household size	-.0170	-1.48	-.0162	-1.42
Ratio of adult to household size	-.1044	-0.92	-.0973	-0.86
Whether the child was ill (1=yes)	-.0173	-0.75	-.0175	-0.76
Whether youngest among kids (1=yes, 0 otherwise)	-.0806**	-2.60	-.0756**	-2.40
Whether eldest among kids (1=yes, 0 otherwise)	-.0121	-0.39	-.0120	-0.39
Whether girl aged up to five years (1=yes)	-	-	-.1222**	-2.68
Whether girl aged between six to nine years (1=yes)	-	-	-.0353	-0.98
Whether girl aged between 10 and 14 years (1=yes)	-	-	-.0951***	-3.19
Number of observations		1393		1393
F statistics		42.35***		37.36***

Note: Statistical significance at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

In the case of non-food consumption by children (Table 3), the elasticity with respect to household non-food expenditure is about 0.82, which is again found to be not statistically significantly different from one. Just like the food consumption equation, the coefficient on age is positive and highly significant. However, the estimated coefficients associated with the gender dummy and mother's education are particularly interesting as, unlike the previous cases, we find that both of them are positive and statistically significant at less than the one percent level. These results would imply that, in the case of non-food consumption, there is gender discrimination in **favor** of girls and that mother's education positively influences children's non-food consumption. One possible explanation may be that some non-food items specifically for girls are more expensive. This may be particularly true for girls' versus boys' clothing and items such as cosmetics. Concerning mother's education, this should not be taken as a surprise. Although there is no study on this, from our knowledge of Bangladeshi society we find it quite convincing that with the rise in mothers' education, sometimes they have a tendency to sacrifice food for non-food expenses. Non-food expenses are important for showing households' prosperity and improved living standards, whereas food consumption is personal and not observed by the community.

In contrast, mother's age and father's education both have negative and significant impacts. Households in rural areas also tend to discriminate more negatively toward children in terms of non-food consumption. The illness dummy is also taking up a significant positive coefficient, which might be capturing some of the health and medical treatment related expenses at the time of children's illness. Finally, discrimination is significantly more positive with respect to children's non-food consumption in larger families.

Table 3: Determinants of Non-food Consumption on Children: 2SLS Estimates

	Dependent variable: log (non-food expenses allocated to children)			
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	5.60***	-10.43	5.59***	10.38
log (normalized household non-food expenditure)	.8168***	6.21	.8141***	6.18
Age	.1310***	14.94	.1302***	12.50
Sex (1= girl)	.1862***	3.81	-	-
Religion	-.1272	-0.87	-.1281	-0.88
Location (1=rural, 0 otherwise)	-.2000***	-3.15	-.2024***	-3.19
Sex of the household head	-.0302	-1.05	-.0325	-0.27
Education of father	-.0338**	-2.24	-.0336**	-2.23
Education of mother	.0628***	6.52	.0627***	6.40
Age of father	.0091	1.60	.0089	1.56
Age of mother	-.0150**	-2.00	-.0152**	-1.99
Household size	.1271***	3.75	-.1275***	3.76
Ratio of adult to household size	.0751	0.27	.0850	0.30
Whether the child was ill (1=yes)	.2509***	4.94	.2509***	4.95
Whether youngest among kids (1=yes, 0 otherwise)	.0083	0.31	.0133	0.2
Whether eldest among kids (1=yes, 0 otherwise)	.0259	0.87	.0265	0.39
Whether girl aged up to five years (1=yes)			.1487*	1.7
Whether girl aged between six to nine years (1=yes)	-	-	.2297**	3.30
Whether girl aged between 10 and 14 years (1=yes)	-	-	.1786***	2.60
Number of observations		1419		1419
F statistics		63.22***		56.17***

Note: Statistical significant at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

When the age category dummy variables for girls are entered in the place of the sex dummy, results do not change qualitatively (Column 4 in Table 3). However, there is now the evidence that girls of all age groups are favored compared to boys.

6. References

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7. Appendix A – Regression results

Appendix Table 1: Determinants of Household Calorie Adequacy Ratio (CAR_h)

	Dependent variable: Household calorie adequacy ratio	
	Coefficient	**t-ratio**
constant	-2.4220***	-4.80
Log(Per capita monthly expenditure)	.8156***	6.09
Square of log(Per capita monthly expenditure)	-.0422***	-4.56
Religion(1=Muslim)	.0518**	2.38
Location (1=rural, 0 otherwise)	.0259**	2.02
Household size	.0086*	1.64
Education of father	.0025	1.51
Education of mother	-.0100***	-4.70
Age of father	-.0018	-1.59
Age of mother	.0021	1.40
Sex of the household head (1=male)	-.0200	-0.96
Awareness	.0746**	3.21
Ratio of pre-schooler members to household size	.0953	1.27
Ratio of 6 to 9 aged members to household size	-.0433	-0.60
Ratio of 10 to 14 aged members to household size	-.1463**	-2.15
Ratio of 15 to 17 aged members to household size	-.1127	-1.38
Ratio of adult to household size	-.1625447	-2.13
log (Rice price)	-.0276	-1.09
log(Wheat price)	.0048	0.10
log (Fish price)	.0931**	3.27
log (Egg price)	-.0615**	-2.11
log(Meat price)	-.0526**	-2.72
Log(Sugar price)	-.0351*	-1.68
Log(Pulse price	-.0066	-0.19
Number of Observations		1395
F-Statistics		17.51***
R^2		0.23

Note: Statistical significant at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

Appendix Table 2: Determinants of Food Consumption (normalized by calorie requirements)

Dependent variable: Log(total household monthly food expenditure/total household calorie requirements)		
	Coefficient	t-ratio
Constant	-4.3538***	-9.36
Log(Per capita non-food expenditure)	.2137***	17.12
Household size	.0123*	1.65
Location (1=rural, 0=otherwise)	-.1304***	-5.82
Sex of the household head (1=male)	-.0646*	-1.92
Ratio of 6 to 9 aged members to household size	-.2420**	-2.92
Ratio of 10 to 14 aged members to household size	-.4012***	-6.35
Ratio of 15 to 17 aged members to household size	-.3319**	-3.22
Ratio of adult to household size	-.2174**	-2.44
Log(Landholding+1)	.0067	1.30
log (Rice price)	.0879*	1.69
log(Wheat price)	.1480**	2.24
log (Fish price)	.1122*	1.89
log (Egg price)	.1771***	3.46
log(Meat price)	.1046**	2.92
Log(Sugar price)	.1479**	2.33
Log(Pulse price	-.1896**	-2.92
Education of father	.01272***	5.65
Number of Observations		1433
F-Statistics		49.86***
R^2		0.39

Note: Statistical significant at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

Appendix Table 3: Determinants of Household non-food expenditure

Dependent variable :Log(household non-food expenditure)		
	Coefficient	t-ratio
Constant	-3.163***	-16.65
Household size	-.2127**	-10.98
Location (1=rural, 0=otherwise)	-.3876***	-7.86
Sex of the household head (1=male)	.04928	0.61
Ratio of 6 to 9 aged members to household size	.1055	0.55
Ratio of 10 to 14 aged members to household size	-.1666	-1.15
Ratio of 15 to 17 aged members to household size	.20735**	0.94
Ratio of adult to household size	.7839***	3.66
Log(Landholding+1)	.1177***	9.54
Education of household head	.07474***	14.71
Number of Observations		1433
F-Statistics		89.63
R^2		0.41

Note: Statistical significant at the one, five and 10 percent levels are denoted by *, **, and ***. Inferences drawn based on the robust standard errors.

8. Appendix B – Calculating Individual Calorie Requirements

It is desirable that an individual should get the expended energy per unit of time (per day, for convenience) to maintain existing health. Broadly, total energy expenditure of an individual includes expenditure at rest and during physical activity. The values of these two components depend on individual-specific factors like age, sex, body weight and composition, physiologic state (e.g. growth, pregnancy, lactation) and on some natural factors. Resting energy expenditure (REE) is the starting point in measuring calorie requirements and is defined as the energy expended by an individual at rest under thermally neutral conditions. Basal metabolic rate (BMR) is defined to be the REE soon after awakening in the morning measured at least 12 hours from the last meal. In practice the variation in measured REE and BMR is very low and in literatures these two terms are used interchangeably.

Generally, REE is the largest component of calorie requirements if physical activity is not too great. It depends largely on physical characteristics such as weight, height, sex, and age. In the literature, REE is measured using several empirically derived equations. In this paper we have used the equations from WHO (1985), which are given in Table 4.1.

Appendix Table 4: Equations for Predicting Resting Energy Expenditure from Body Weight[a]

Sex and Age Range (Years)	Equation to Derive REE in Kcal/day	R[b]	SD[b]
Males			
0-3	(60.9 × wt[c]) – 54	0.97	53
3-10	(22.7 × wt) + 495	0.86	62
10-18	(17.5 × wt) + 651	0.90	100
18-30	(15.3 × wt) + 679	0.65	151
30-60	(11.6 × wt) + 879	0.60	164
> 60	(13.5 × wt) + 487	0.79	148
Females			
0-3	(61.9 × wt) - 51	0.97	61
3-10	(22.5 × wt) + 499	0.85	63
10-18	(12.2 × wt) + 746	0.75	117
18-30	(14.7 × wt) + 496	0.72	121
30-60	(8.7 × wt) + 829	0.70	108
> 60	(10.5 × wt) + 596	0.74	109

[a] From WHO (1985). These equations were derived from BMR data.
[b] Correlation coefficient (R) of reported BMRs and predicted values, and standard deviation (SD) of the differences between actual and computed values.
[c] wt is weight of person in kilograms.
Source: Adapted from WHO (1985).

The equations in the above table provide approximated values of REE that are widely accepted. This set of equations does not include height as this variable was found not to be statistically significant in determining REE.

Energy expenditure is largely influenced by the characteristics of physical activity, which can be of many sorts and of different intensities. Defining physical activity and its inclusion into the measurement of calorie requirement is of immense importance as it argued to be the second largest component of energy requirement. The traditional approach of defining physical activity by occupation categories is inadequate and does not provide the closest approximation. This is because individuals perform different types of activities every day to fulfil the economic and social responsibilities and allocate time to maximize utility out of those activities. Different types of activity require different levels of energy expenditure and energy expenditure of a particular activity is an increasing function of time allocated to the activity. Thus, in measuring energy requirement one should incorporate not only activities but also the time allocation. As a result we have used a weighted average of energy factor where the categorization of activities and also the values of the energy factor associated with each category are taken from NRC (1989) and the weights are the allocated time in each activity per day, which comes from the survey data. A total of 31 types of activities are considered in our study and they are then categorizes into five categories namely resting, very light, light, moderate, and heavy according to the intensity of energy expenditures, as the names suggest. Table 2 is reproduced from a NRC (1989) report with the activity types considered in each category in our study.

Appendix Table 5: Energy Requirement Factors

Activity category	Activity	Representative value for factor per unit of activity
Resting	Sleeping, eating, drinking	REE × 1.0
Very light	Office work, work in own business, looking after crops, looking after poultry and livestock, social and political activity, others.	REE × 1.5
Light	Collecting firewood, fishing, mason, carpentry, weaving, handicrafts, walking, transportation, work at school, shopping, cooking, domestic work, washing clothes and dishes, looking after the children and elderly, playing games, religious activity.	REE × 2.5
Moderate	Ploughing, weeding, fetching water, riding bicycle, boating, harvesting crops, leveling crop lands, throwing fertilizers in the fields, non-mechanical irrigation	REE × 5.0
Heavy	Digging, brick-breaking, carrying loads, rickshaw-van pulling.	REE × 7.0

Source: WHO (1985).

To make time allocation representative, an average of three days is taken for each individual. The weighted average of the activity factor is then used as multiple of REE to get to the approximate value of energy requirement. Physiologic state of pregnancy and lactation of mothers are taken into account in calculating energy requirements. During pregnancy, extra energy is required due to added maternal tissues and the growth of the fetus and placenta. Ignoring any changes in metabolic requirements and physical activity during pregnancy, if any, it is suggested by WHO (1985) that a pregnancy allowance of 300 Kcal/day should be added. Similarly, lactating mothers require extra energy to produce milk. Though the required energy due to lactation depends on the quantity of milk produced and may be on some other physiologic factors, for simplicity on average 500 Kcal/day is added to the requirement of the lactating mothers as suggested by WHO (1985).

The methodology for calculating calorie requirement presented above is assumed to be applicable to all individuals of all different age groups, including children. However, in WHO (1985), it is recommended that for children below 10 years of age calorie requirements be estimated from intake associated with normal growth. From the data of some developed countries, WHO (1985) provides average energy allowance per kilogram of body weight for the children of below 10 years of age to calculate the daily energy requirement. For children of 10 years or more, calorie requirements are calculated as an activity factor multiple of REE. The problem with calculating the calorie requirements of children less than 10 years old is in the difficulty in the identification of physical activity (WHO 1985). However, in our study we are using the weighted average activity factor to calculate calorie requirements for children less than 10 years of age as we have gathered comprehensive data of the activities performed by children and also the time allocation. This, is of course, an attempt to approximate the measurement. Along with this we can also calculate calorie requirements of children less than 10 years or age with the information published by the WHO (1985). However, it needs to be mentioned here that, because of difficulties associated with measuring food intake of children less than 1 year of age, we are excluding them from our analysis.