ECO499: INDEPENDENT RESEARCH

Malnourishment and Sex Bias in Multidimensional Child Poverty

A Study in Korail Settlement

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Table of Contents

Abstract

Evidence of severe malnourishment and anti-female sex bias has been found in the Korail urban slum settlement of Dhaka. The sex bias is reflected in terms of lower growth dynamics, varying degrees of malnourishment and deprivation in several development indicators. The study deployed a weighted Alkire-Foster methodology for identifying multidimensional poverty and has identified behavioral and public health attributes to play a significantly larger role in reducing malnourishment and sex bias compared to economic variables, such as income and assets. Mother's education for the region of study, although lowered malnourishment, was surprisingly found to not play a significant role in sex bias reduction. An ordered logistic regression model was run to determine the statistical significance of the variables which yielded amongst others that deprivations in type of latrine used and in awareness of local medical costing significantly increased malnourishment.

Chapter 01: Introduction

Nutritional gender inequality has been a persistent problem in many South Asian countries, including in Bangladesh. The gender inequality arises due to various reasons; these could be purely cultural, or due to limited resources in large households. Irrespective of the reason, anti-female sex bias on nutritional grounds has been reported at both regional levels and intra-household level (Chen, Huq, & D'Souza, 1921; Sen and Sengupta, 1983; Morduch and Stern, 1997). In order to identify the causes, which are varied from region to region, over time there has been a shift of focus from "which household is poor" to "who is poor," while the study itself has been extended to analyzing child level poverty (Roche, 2010).

On the issue of being poor, a lot of advances have recently taken place. One of the emerging views of poverty encapsulates a multi-dimensional perspective. Traditionally welfare economics have addressed such natures of problems using either *utility* as basis of measure, often defined as either 'happiness' or 'desire-fulfillment,' or *opulence* reflected as the commodity command of a person or his 'real income'. One of the recent paradigm shifts in this field of analysis comes forth from Amartya Sen where he criticizes both the utility and opulence standpoints and puts forward a new approach based on *capabilities* of the people concerned (Sen, 1985). He opts for a multi-dimensional and composite view of a person's well-being, instead in terms of primary goods or utilities. Although the multi-dimensional approaches do not entirely reflect what Sen envisioned as his alternative[1], this holistic view of poverty is a very handy tool as it lets you identify and isolate the most contributory causes of poverty.

This study is aimed at addressing the issues of malnourishment and anti-female sex bias from a multi-dimensional perspective of *child* poverty in an urban slum area of Bangladesh. This is important because firstly, there are many policy issues surrounding the slum settlement, including those of poverty reduction, public health practices, vaccination and immunization coverage and social equity, all of which this paper addresses. Secondly, the population count of the settlement itself is well over a 100,000 while the slum can be used as a representative for many other slums of the country, re-emphasizing the need for a proper study (Islam, Mahbub, Nazem, Angeles, & Lance, 2005).

[1] which encompasses relative freedom and relative choices amongst other differences.

The research intention can thus be summarized in two objectives:

1) To identify anthropomorphic weight-to-age malnourishment from a multi-dimensional perspective along with its determinants.
2) To recognize the existence of anti-female sex bias and the attributes that contributes to its reduction.

It is important to acknowledge that malnourishment and nutritional sex bias go hand in hand and hence both are addressed simultaneously, although different analytical tools are deployed.

This paper is organized as follows: the next chapter contains the literature review. Chapter 03 presents the study area, a general description of the slum settlement along with the survey design. The following chapter 04 presents the methodology used and chapter 05 presents a socio-economic profile of the surveyed households. Data analysis and relevant discussion begins from chapter 06 with establishing the presence of malnourishment and sex bias. Chapter 07 first establishes the multi-dimensional poverty framework followed by adequate analysis and chapter 08 sets up and presents the results of the econometric model used to identify significant determinants of malnourishment. Finally, chapter 09 ends the study with a succinct conclusion and selective policy recommendations.

Chapter 02: Literature Review

2.1 Nutritional Sex Bias

A landmark study regarding the relationship of undernourishment and sex bias was done by Sen and Sengupta (1983) where the authors established the prevalence of malnourishment and sex bias in India. Ever since, such studies have evolved and emerged in the literature, the bulk of which has been in the 1980s and 1990s.

In the existing literature, the study of undernourishment and sex bias, especially those concerning South Asian countries, has been conducted primarily through two measurement indicators. These are calorie intake (Brown, Black, Becker, Nahar & Sawyer, 1982 & Abdullah and Wheeler, 1985) and anthropometric measures (Morduch and Stern, 1997). In many cases researchers have also combined the two tools (Chen, Huq and D'Souza, 1981; Pitt, Rosenzweig and Hassan, 1990 & Ahmed, 1993). Although each of these studies deal with the general framework of sex differentials, their underlying hypothesis are varied and provide much insight into the existence of sex bias.

Chen, Huq and D'Souza (1981) and Brown, Black, Backer, Nahar, & Sawyer (1982), both draw upon the dataset of Matlab Thana, Bangladesh. Chen, Huq and D'Souza (1981) concluded through purely comparative analysis, that according to anthropomorphic weight-to-age standard, compared to male children over 9 percent more female children were severely malnourished; similarly male calorie intake exceeded female consumption by an average of 16 percent among children under 5 years of age.

Brown, Black, Backer, Nahar, & Sawyer (1982) delved deeper into the food consumption scenario of children between 5 and 30 months of age, by month-wise monitoring of food intake while classifying consumption into subcategories of macronutrients. The authors found that the ingestion of energy decreased with age in girls while remaining similar in boys.

This conclusion is supported by the findings of Pitt, Rosenzweig and Hassan (1990) where they mention that gender differentials in calorie consumption are highly age-dependent. Pitt, Rosenzweig and Hassan (1990) take an interesting, and maybe a more practical, approach to measuring undernourishment and sex bias. Conducted on a dataset covering 15 villages in

Bangladesh, their study reports that gender-based nutrient inequality reflects disparities in labor-market opportunities between men and women. As the men of the household engage in activities in which productivity is sensitive to their health status, the men enjoy greater calorie intake than women.

This makes sense for older age groups but not for younger ones, which their findings also establish. Through regression analysis, they affirm that for children aged 6 and below, boys on average receive more calories than girls. This sex differential is however, leveled between ages 7 through 11 and again increased to a 30 percent difference for ages 12 and above favoring the boys.

Abdullah and Wheeler (1985) took another approach to understanding the sex differential, hypothesizing differential rates of energy and protein intakes due to seasonal variations. Carried out in a single village close to Dhaka in Bangladesh, although their findings do not significantly establish their hypothesis, they do find that women's proportional intakes were not depressed as family total food intake decreases.

This suggests the possibility that the girls are provided with a specific proportion of food and any marginal increase in the food availability from that point is provided to the boys. If such is the case in general, then it can be expected that incrementally wealthier households will exhibit sharper sex differentials, up to a certain point. Although not for this region, this is shown by Sen and Sengupta (1983) where between two villages in India, the village with the better over-all nutritional record displayed greater sex discrimination. Although this certainly cannot be concluded to be a general case, it would be interesting to affirm this hypothesis.

It is worthwhile to note that while conclusions about sex bias has been somewhat conflicting in the studies above, the findings of prevalent sex bias in children under 5 years of age has been consistent. Also to note is that none of the studies aforementioned carried out a sex differential study relating to well-defined poverty stratums. While it can be said that by virtue of defining nutritional levels, some of the studies did perform poverty analysis in the dimension of food intake and thereby relating sex bias, however, it is important to understand the dynamics of sex differentials from a multidimensional poverty perspective.

This study aims to fill in the gap by conducting an undernourishment and sex bias analysis relating to multidimensional poverty measures, following the Alkire-Foster methodology put forth recently in 2007 (discussed below). This paper will only focus on child poverty under the age of 5 and the analysis will be conducted based on anthropomorphic weight-age measures. One of the intentions is to identify whether poor or non-poor households practice more sex bias.

Finally, to note is that the majority of the sex bias studies carried out, especially in Bangladesh, were done in rural village settings, thereby ignoring the large urban slum-dwellers. The survey population for this study is from the largest urban slum settlement in Dhaka, Bangladesh, adding a fresh socio-economic perspective to our understanding of sex bias amongst children.

2.2 The Multi-Dimensional Approach to Child Poverty

Nobel Laureate in Economics, Amartya Sen in his *Capabilities* approach has stressed much on the need for the re-assessment of welfare. He has always advocated a movement to the re-identify the criteria that distinguishes poverty as well as development from a multi-dimensional perspective (Sen, 1999). "Human lives are battered and diminished in all kinds of different ways, and the first task… is to acknowledge that deprivations of very different kinds have to be accommodated within a general overarching framework" (Sen, 2000).

Sen describes the capability approach as a "concentration on freedoms to achieve in general and the capabilities to function in particular" (Sen, 1985, p.266). The core components of the concept lie with functionings and capabilities. Functionings are the achievements of a person; what he may succeed in 'doing or being' (Sen, 1999), while capabilities refers to the freedom a person has to achieve such functionings.

In other words, functionings can be viewed as the various outcomes a person can achieve (such as being healthy) whereas capabilities refer to the real opportunities to achieve these outcomes (such as the ability to be healthy). Extending from this concept, a functioning set is a combination of achievements that a person has achieved and accordingly a capability set is the alternative combinations of functioning sets a person can achieve, from which the person can choose one set. The well-being of a person is thus simply the evaluation of the achieved

functioning set (Sen, 1993). Similarly, sex bias thus represents a lack of functionings and capabilities for the deprived gender.

Although Amartya Sen put forth the concept for the investigation, he did not establish a framework for analysis. One of the approaches to formally operationalize Sen's multidimensional perspective is the Alkire-Foster methodology. The basis for this approach was first suggested by Alkire (2002) for using Sen's approach for the identification of the poor.

This approach was matured in Alkire and Foster (2007) with the methodology using a dual cut-off technique. Dimensions are selected for the identification process, each representing a functioning of the person. The first cut off is the traditional poverty-line which shows whether a person is poor in that specific dimension. The second cut-off is basically a counting methodology where the person has to be deprived in a minimum number of dimensions to be finally counted as poor. The advantage of this approach is that it can identify the dimensions which contribute most to the reduction of well-being of the poor, as well as the ability to carry out a sensitivity analysis to identify the inequality within the poor based on the different cutoffs.

One major difficulty in applying the approach is the choice of dimensions and the indicators. This has also been a major critique against Sen's Capabilities approach. To this, Sen has argued that the choice of relevant functionings and capabilities for any poverty measure is a value judgment rather than a technical exercise. "There is no escape from the problem of evaluation in selecting a class of functionings in the description and appraisal of capabilities, and this selection problem is, in fact, one part of the general task of the choice of weights in making normative evaluation…. The need for selection and discrimination is neither an embarrassment, nor a unique difficulty, for conceptualizing functionings and capabilities" (Sen 1993, p32).

However, Sen has provided suggestions towards the selection of the dimensions. Also noted by Alkire and Santos (2010), this includes a) of *special importance* to the society or people in question, and b) are *socially influenceable* – which means that they are an appropriate focus for public policy (Sen 2004). Thereby, participatory exercises with the population in focus seem to be the ideal exercise for the selection of the dimensions and indicators, which has been carried in this particular study.

Alkire and Santos (2010) have used the approach to develop an Acute Multidimensional Poverty Index for 104 developing countries using household survey where they found 58 percent of Bangladesh's population to be multi-dimensionally poor. Based on the available information in the data-sets they had selected three dimensions, health, education and living standard, with a total of 10 indicators. In Bangladesh, they found living standard to be the highest contributor of poverty, followed by health and education.

Bhuiya, Mahmood, Rana, Wahed, Ahmed & Chowdhury (2007) has conducted a similar multidimensional poverty analysis in selected regions of Bangladesh, although not using the Alkire-Foster method. Their indicators included education, health, social participation, shelter, food & clothing. They found health to be the most deprived dimension.

One of the areas that have been receiving some attention in the last decade is the area of child poverty measurement, which next to sex bias, is one of the foci of this study. While several studies have been done, the Alkire-Foster approach has been linked to child poverty measurement by Roche (2010) who follow eight dimensional domains. In his study each dimension contains one indicator, based on the definition of poverty agreed in the World Summit for Social Development. This approach is attractive because of its flexibility in analysis and straight forward interpretation for application. The eight dimensions are as follows: food, safe drinking water, sanitation facilities, health, shelter, education, information and access to services.

Roche (2010) conducted his study in Bangladesh and had found that the dimension most lacking in children is proper sanitation facilities for both rural and urban children with the risk of eviction of the household the second most important dimension for urban children. Roche's (2010) paper acts as a strong reference for our study. With the identification of multi-dimensional poverty among children, this study looks into the prevalent sex bias within the sample population which is further analyzed to determine the dimensions of poverty that contributes most to prevalent malnourishment.

Chapter 03: Study Area and Survey Design

3.1 Study Area

Urban population in Bangladesh has been increasing over the last decades at 3.5 percent per year, comprising just over 25% of its total population at 35 million (Islam, Mahbub, Nazem, Angeles, & Lance, 2005). This rapid increase has been mainly due to low earning migrant workers moving into the large metropolitan areas and eventually having to settle in slums for shelter. In a study Center for Urban Studies, Mapping and Census, by Islam, Mahbub, Nazem, Angeles, & Lance (2005), it was estimated that the total slum population in six major cities of the country was 5.4 million or roughly 35 percent of the six cities' combined overall population.

Although the population count is high, the figure gains greater significance when the population density is accounted for. The Center for Urban Studies (2005) study mentions that while "Bangladesh has the highest population density in the world (at 2,600 persons per square mile) the population density in the slums is roughly 200 times greater, at 531,000 persons per square mile. This figure becomes even more astonishing when one considers that the slums are dominated by single storied residential structures."

The definition of a slum is considered to be same as set forth by Islam, Mahbub, Nazem, Angeles, & Lance (2005), "A slum (is) thus defined as a neighborhood or residential area with a minimum of 10 households or a mess unit with at least 25 members with four of the following five conditions prevailing within it:

- Predominantly poor housing;
- Very high population density and room crowding;
- Very poor environmental services, particularly water and sanitation facilities;
- Very low socioeconomic status for the majority of residents;
- Lack of security of tenure."

As the slums consist primarily of migrant workers from rural villages where incidences of sex bias have been found (Chen, Huq and D'Souza, 1981; Brown, Black, Becker, Nahar & Sawyer, 1982; Abdullah and Wheeler, 1985 & Ahmed, 1993), there perhaps exists an underlying rationale for similar expectation. However, one should take note that many of the female

members of the slums are also income earners in their family and that the social environment of the slums is different from the rural social environment. Given these and other differences, this study rationalizes in the need to determine the existence of sex bias in such settlements and its degree of incidence.

The Dhaka Metropolitan Area of Dhaka city, the capital of Bangladesh, has been estimated to have a population of 9.1 million of which 3.4 million or a large 37.4 percent are slum dwellers. For this study, the largest informal single slum in the Dhaka (and also in the country), the Korail slum settlement, has been selected primarily due to ease of access. That said, however the slum is representative of the environment of much of the slums in the capital.

3.2 General Description of Korail

The Korail slum settlement began to develop during late 80's on vacant higher grounds around the Gulshan-Banani-Baridhara Lake, eventually expanding by encroaching highly vulnerable water edges. As per last estimation, Korail covers an area of approximately 90 acres with an estimated population of over 100,000 (Islam, Mahbub, Nazem, Angeles, & Lance, 2005).

The eastern and southern edge of the area is defined by the aforementioned lake which acts as the main water reservoir for the adjoining areas. Because of its location near the high-end residential and commercial areas of Dhaka (namely Gulshan, Banani and Mohakhali) it attracts low income people engaged mostly in service jobs such as cleaners, household helpers, rickshaw pullers as well as workers of readymade garments (RMG) industries (Jabeen, Allen and Johnson, 2009).

High population density without proper facilities characterizes the settlement. Most of the houses in Korail are made out of tin while several houses share a single cooking place and latrine. Majority of the area is unhygienic and being close to the lake are prone to water-borne diseases. Water-logging is also common during heavy rainfall.

Lack of security of tenure and consequently threat of eviction is one of the major concerns of the households in the area. This has caused reluctance among the public service authorities to provide regular facilities although within the past year the households have been getting a fixed amount of water supply for a specific period of time during the day for 100 taka

per month. Jabeen, Allen and Johnson (2009) note that "inhabitants living as long as even 20 years are unwilling to invest in improving the living condition," due to the threat of eviction. There is fluctuating electricity supply to the area but no gas supply, so cooking is done on bought firewood costing the households roughly 1,000 taka per month.

3.3 Survey Design

For the purpose of this study primary data was collected both at the household level and at the individual level of children under the age of 5. The survey was carried out in February 2011. We define a household as individuals related by blood or marriage, living on the same premises and sharing the kitchen for a minimum of three consecutive months (Alam, 2009).

Primary data was collected for the study at the household level. The motive for collecting primary data can be summarized in two reasons. The first is because the data collected about the children would have to be systematically related to the multi-dimensional poverty information of each family. Also the national household survey does not provide data of the children's weight for each household.

The second reason is the difficulty of getting accurate age data (Bairagi, Aziz, Chowdhury, & Edmonston, 1982). Special attention was paid to ensure accurate data collection. Measures taken include double checking the age information with the help of other residents familiar with the respective family history, such as was done in Sen and Sengupta (1983).

The Korail Area was divided into 6 regions (See Appendix 01 for a map) out of which 3 were chosen randomly. To note here is that Location 03 of the selected regions is the boat docking area for the settlement, and hence is a major entrance to the slums. With the basic statistical principal that defines a large sample to be one that has 30 observations, a minimum of 30 households were surveyed from each region. In each case, the mother of the household was given preference for data regarding the children health and household expenses, whereas the father was given for income related data. In cases where either of them was absent, data was collected from the present member with the enumerator going back another day for data confirmation. A total of 136 households with 174 children under the age of 5 were surveyed.

A systematic random sampling method was followed similar to the study by Alam (2009). Total number of roads (pathways are a more accurate description) in each of the selected regions was counted. A skipping factor (k) was generated and households on every *k*th pathway were interviewed. However, please note households that did not have at least one child at or below the age of five were not interviewed.

Data were collected on demography, socioeconomic status which included information about households' income, expenditure, land holdings, assets, and households' level of awareness about public health as well as their medical expenses within the last year. In addition to the above information, accurate age and weight data were taken for any children below five years of age along with selective medical history. Please see Appendix II for the questionnaire.

Chapter 04: Methodology

4.1 Undernourishment & Sex Bias

The determination of undernourishment was pretty straight forward, following the anthropomorphic weight-for-age measure. A total of 136 households, with 174 children, were surveyed and the weights of the available children under the age of 5 in the household were taken. The weight of the child was measured against the growth monitoring chart widely used in Bangladesh provided by World Health Organization (WHO). The weight-for-age growth chart is divided into percentiles. Weights falling above the 15^{th} percentile are considered to be normal, between 03^{rd} and 15^{th} percentile to be moderately malnourished and weights falling below 03^{rd} percentile are considered to be severely malnourished. Different growth charts were followed for male and female children, as per procedure. The growth charts are provided under Appendix III.

Since the child was already divided into sub-categories of undernourishment, the difference in percentages of each gender for each sub-category against certain indicators showed us the sex bias, similar to Sen and Sengupta (1983). For the determination of intra-household sex bias however, a different procedure was applied.

Taking the median or the 50^{th} percentile in the growth chart as a standard, the difference, d, between the weight of the child, w, and the standard median weight, s, was taken. Thus, for the i^{th} child, $d_i = w_i - s_i$. Thus with n being the number of females, and m being the number of males, anti-female bias was noted as positive when,

$$\sum_{i=1}^{m} d_i - \sum_{i=1}^{n} d_i > 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

In other words, if the difference from the median for the female child was greater than the difference from the median for the male child, the household was noted to be conducting sex bias against the female child; if vice versa, the household was noted to be conducting sex bias against the male child. For identifying determinants contributory or involved in reducing sex bias, a different approach is used which is explained under section 6.2.

4.2 Poverty Analysis: Choice of Dimensions, Indicators and their respective Weights

As expressed earlier under the literature review (section 2.2), the selection of dimensions and indicators for this study has been the result of value judgment and a participatory exercise with the population. This particular study has 5 dimensions, with equal weight given to each dimension for easier analysis and 14 indicators, with equal weight given to each indicator within a dimension. In order to determine the weight to be put to each dimension a participatory appraisal method was undertaken.

Randomly chosen 15 households from each location were brought together and through discussion and ranking, the *indicators* (not the dimensions) were separated into "most important", "more important" and "less important" categories, emphasizing on the importance of each indicator for the growth of a child. A discussion was first held and then each household was first given the opportunity to do the ranking individually. The average results were then presented to the participating group and a final weight distribution of the indicators attained. Table 01 presents the dimensions, indicators, their assigned weights and their relation to the millennium development goals, used in this study.

Some of the dimensions & indicators require explanation in their selection and execution. The first is the Health dimension. Two indicators were chosen for this dimension, namely (1) Illness in the Household and (2) Child Health Index. A common indicator that was ignored was the mortality rate because the data was not available specifically for the Korail settlement. The first indicator is a binary noting any incidence of major child illness reported by the households within the last year. This excludes mild cases of fever or diarrhea.

The second indicator is a Child Health index made out of the following: (1) Children aged 9-59 months who have not received Vitamin A supplementation in the previous 6 months, (2) Children aged 12-59 months who have not received at least one dose of measles immunization, (3) Children living in households with non-iodized salt, and (4) Children aged 6-59 months living in households in which an adult is not there to support the child more than 5 hours in a day. Any child deprived in two or more of the four above mentioned variables is considered deprived in this specific indicator.

Dimension	Indicator	Deprived if	Related to	Relative Weight
Education	**Household Spouse Education**	Child with mother who has not completed at least five years of primary schooling	MDG 2	20
Health	**Child Illness in Household**	Any household with reported *major* child illness within the past year	MDG 4, 5	10
	Child Health Index	Any child deprived in two or more of the four selected variables	MDG 4	10
Income & Assets	**Household Income**	Any household living under $2/day was considered to be economically poor.	MDG 1	10
	Assets Index	Any household with a rating less than 5/27 in the assets index	MDG 7	10
Living Standard	**Electricity Access**	Any household with no electricity	MDG 7	4
	Cooking Fuel	The household cooks with charcoal or dung; or does not have any gas or firewood for more than 15 days a month.	MDG 7	4
	Latrine Type	Any household with Open or *Kacha* (not cemented) latrine. However, latrines can be shared with not more than five other households.	MDG 7	4
	Drinking Water Supply	The household does not have access to clean drinking water, or it is more than 30 minutes walking distance from home.	MDG 7	4
	Over Crowded Housing	Any child lives in a households with a ratio of more than four persons per sleeping room	MDG 7	4
Awareness & Security	**Averting Behavior Index**	Any household not practicing more than three of the nine public health safety measures	MDG 4, 5	5
	Medical Costing Index	Not aware about two or more of the costs of treatment among the five selected diseases	MDG 4, 5	5
	Savings	Household does not have the habit of saving	MDG 1	5
	Land	Household does not own any amount of land	MDG 1	5

Table 01: Selected dimensions, indicators and their weights.

The second is the dimension of Income & Assets. This dimension also contains two indicators: (1) Household Income, and (2) Assets Index. For the purpose of this study, any household with income under $2/day is considered to be economically poor. This is slightly higher than the $1/day (PPP) cutoff set by the MDG. However, since living in the Korail slums is expensive in itself and extremely difficult for any household earning less than $2/day, setting $1/day becomes an underestimate. Hence, a cutoff value of $2/day was agreed upon. Any income earned from other sources, such as leased land, was also added to the total household income.

The second indicator in the Income & Assets dimension, the Assets Index comprises of 14 potential assets that a household living in Korail slums is most likely to own. Each asset was weighted differently according to their local prices. For example, a TV was given a weight of 4 whereas bedding was given a weight of 1. The assets and their assigned weights for the index are given in Table 02.

#	Asset	Weight
1	Radio	1/27
2	Mobile	2/27
3	Cycle	3/27
4	Boat	3/27
5	Rickshaw	4/27
6	Bedding	1/27
7	Almira	1/27
8	Chair/Table	1/27
9	Fishing Net	2/27
10	Sewing Machine	2/27
11	Cow/Ox	1/27
12	Goat	1/27
13	Hen/Duck	1/27
14	TV	4/27

Table 02: Asset Index Composition

Any child living in a household with a rating less than 5/27 in the assets index is considered to be deprived. Thus, say if a household only owns a mobile, bedding, almira and chair, it would not be considered as deprived; however say if a household only owns a radio, bedding, almira and chair, it would be considered as deprived.

The last of dimensions that require explanation are the first two indicators that are in the dimension of Awareness & Security. The first is an Averting Behavior Index that comprises eight public health practices. It looks into whether the household is negligent or health conscious, in relative terms. The practices are as follows:

(1) Whether drinking water is boiled before consumption,
(2) Source of water used to wash dishes,
(3) Source of water used to take showers,
(4) Whether hands are regularly washed before eating,
(5) Whether hands are regularly washed after use of latrine,
(6) Whether nails are regularly cut and cleaned,
(7) Whether teeth are regularly brushed, and
(8) Whether there is any stagnant water around the household.

Pond water and water taken from any open well was considered to be unclean and to act as catalysts for water-borne diseases. Water from well was still acceptable for taking showers. Any child living is a household not practicing more than two of the eight public health safety measures mentioned above, was considered to be deprived.

The second indicator is an indicator measuring awareness regarding the cost of treatment for five common water-borne diseases that have relatively high frequency in the Korail settlement. If a household is aware of the cost of treatment, then the household would be better prepared to fight against the disease when any member in the household contracts it. Furthermore, they would have better health practices. Both the male and female household members were asked to participate in this question and their combined answers were taken. This indicator's main trait is its social significance. The idea is that a household that is socially inclusive and hence is free from social poverty and health conscious at the same time will not be deprived in this indicator.

The five diseases identified were Diarrhea, Jaundice, Typhoid, Dengue and Cholera. Local estimates for treatment were taken for mild and extreme cases and ± 500 taka were added to the range. If the respondents answer to the cost for treatment fell within the range of a specific

disease, it was noted as being aware and vice versa. Any household not aware about two or more of the costs of treatment was marked as deprived.

4.3 Theoretical Framework of Alkire-Foster Approach

The Alkire-Foster approach has the mathematical structure of one member of a household who is then related to multidimensional poverty measures. For this study, it is the child under the age of 5. The following is the Alkire-Foster methodology developed for poverty measurement (Alkire and Foster, 2007). Please note what is termed as dimensions below is referred to as indicators in this paper.

Consider M_0 to be the poverty measure with a particular selection of dimensions, indicators and weights. M_0 thus measures poverty in d dimensions across a population of n individuals. Let $y = [y_{ij}]$ denote a $n \times d$ matrix of achievements for i persons across j dimensions. Therefore, the typical entry in the achievement matrix $y_{ij} \geq 0$ represents individual $i's$ achievement in dimension j. Each row vector $y_i = (y_{i1}, y_{i2}, \dots, y_{id})$ gives individual i's achievements in the different dimensions, whereas each column vector $y_j = (y_{1j}, y_{2j}, \dots, y_{nj})$ gives the distribution of achievements in dimension j across individuals.

The poverty measure M_0 allows weighting each dimension differently. In order to do so, we define a weighting vector w. The element w_j represents the weight that is applied to dimension j. Note that $\sum_{j=1}^{d} w_j = d$, that is, the dimensional weights sum to the total number of dimensions. In our case of 14 indicators, the weights were designated such that $\sum_{j=1}^{d} w_j = 1$, with each individual $w_j < 1$.

Next we identify the poor as per the dual cut-off rule. The first cut-off is that that we first identify individuals who are deprived in each of the dimensions. Let $z_j > 0$ be the poverty line (or deprivation cut-off) in dimension j, and z be the vector of poverty lines for each of the dimensions of multi-dimensional poverty. Define a matrix of deprivations $g^0 = [g_{ij}^0]$ whose typical element g_{ij}^0 is defined by $g_{ij}^0 = w_j$ when $y_{ij} < z_j$, and $g_{ij}^0 = 0$ when $y_{ij} \geq z_j$. This essentially means that the ij^{th} entry of the matrix equals the dimensional weight w_j when person i is deprived in dimension j, and is zero when the person is not deprived. From the matrix g^0 we

construct a column vector c of *deprivation counts*, whose i^{th} entry $c_i = \sum_{j=1}^{d} g_{ij}^0$ represents the sum of weighted deprivations suffered by person i. In other words, c_i is simply the sum of all the entries in the i^{th} row of the matrix of deprivations g^0.

The second cut-off is that that we identify individuals who are to be considered as multi-dimensionally poor. To do so, consider a cutoff of $k > 0$ and apply it across this column vector c. Let ρ_k be the identification function. Hence, $\rho_k(y_i, z) = 1$, when $c_i \geq k$ and $\rho_k(y_i, z) = 0$, when $c_i < k$. This means that a person is identified as poor if her weighted deprivation count is greater than or equal to k. Alkire and Foster (2007) refer this to as the *dual cutoff* method, because it uses the *within dimension* cutoffs z_j to determine whether a person is deprived or not in each dimension, and the *cross dimensional* cutoff k to determine who is to be considered poor.

Next to aggregate the above information, construct a second of matrices, $g_{ij}^0(k) = g_{ij}^0 \rho_k(y_i, z)$, and $c_i(k) = c_i \rho_k(y_i, z)$. This $g^0(k)$ contains the weighted deprivations of all persons who have been identified as poor and excluded deprivations of the non-poor and $c(k)$, noted as the *censored vector of deprivation counts*, now encompasses zero deprivations for those not identified as multi-dimensionally poor. Thus $c(k)$ is a vector of deprivation counts such that, if $c_i \geq k$, then $c_i(k) = c_i$ and if $c_i < k$ then $c_i(k) = 0$.

Now, let $H = q/n$ be the headcount count ratio where q is the number of people who are poor. Note that this headcount ratio is not sensitive to the breadth of multidimensional poverty because even if a child who is already identified as poor becomes poorer, that is becomes deprived in another indicator or dimension, q remains the same and hence so does the value of H. Also note that $c_i(k)/d$ represents the shared possible deprivations experienced by a poor child i. Hence the average deprivations shared across the poor is given by $A = |c(k)|/(qd)$, where A represents the intensity of multidimensional poverty.

Interestingly, M_0 can be found as either the mean of the matrix $g^0(k)$, that is $M_0 = \mu(g^0(k))$ or M_0 can also be expressed as the product of H and A, that is $M_0 = H \times A$. Thus by being the product of the simple headcount ratio and the average deprivations shared across the poor, M_0, accounts captures the breadth in multi-dimensional poverty. This is shown in more details in Alkire and Foster (2007).

An important trait of M_0 is that it satisfies *dimensional monotonicity.* That is if a poor individual becomes deprived in another dimension, unlike in the case of H, M_0 increases. Alkire and Foster (2007) shows that another important characteristic of M_0 is that it is decomposable by population subgroups. Given two distributions *x* and *y*, corresponding to two population subgroups of size *n*(x) and *n*(y), the population shares or weighted sums of the subgroup poverty levels equals the overall poverty level obtained when the two subgroups are merged [$n(x, y)$]. This is shown as follows:

$$M_0\ (x, y; z) = \frac{n(x)}{n(x, y)} M_0(x, z) + \frac{n(y)}{n(x, y)} M_0(y, z)$$

These properties thus make M_0 an attractive took to use. In our study, since the data we will be incorporating are mostly ordinal, the analysis will be restricted to M_0. Should have cardinal data been used, the analysis could have been extended to include the adjusted poverty gap and adjusted FGT measures.

4.4 Unit of Analysis

Since the objective of this study is to measure sex bias and hence is gender specific, children below the age of 5 will be as the unit of analysis. Such an analysis enables us to compare across gender and age groups, and to document intra-household inequalities. Some household level details is however shown so that the reader can grasp a better understanding of the basic socio-economic status of the survey population, but the bulk of the analysis and representation will assume the child under the age of 5 as the unit, unless otherwise stated.

Chapter 05: Socio-Economic Profile

The summary statistics of the surveyed population is provided in this chapter, first with the household and then with children under the age of 5 as the unit of analysis. At the household level, a total of 136 households were surveyed with 50 from Location 01, 51 from Location 02 and 35 from Location 03. Table 03 gives a very basic household level data relevant to understand the number of children of a household in the region.

#	Variable	Location 01 (n=50)	Location 02 (n=51)	Location 03 (n=35)	Combined (n=136)
01	**Mean Household Size**	4.6 *(1.23)*	4.2 *(1.13)*	4.4 (*1.48)*	**4.4** ***(1.27)***
02	**Mean Child per Household**	2.6 *(1.23)*	2.2 *(1.13)*	2.4 *(1.48)*	**2.4** ***(1.27)***
03	**Mean Child < 5 per Household**	1.3 *(0.51)*	1.2 *(0.47)*	1.3 *(0.63)*	**1.3** ***(0.53)***

Table 03: Household level data showing the number of children of a household

Table 03 shows that the mean number of children per household and the mean number of children <5 per household is pretty consistent across the three locations, with mean of children <5 almost half to the mean of total number of children per household. The mean household size also remains adequately steady at 4.4 members per household.

The child <5 level data of the surveyed population is presented in Table 04 below. The mean household size increases slightly to 4.6 owing to the fact that some of the children (roughly 22 percent) share the same household. We can see that only 13 percent of the children live in households with education above SSC, a relatively large 31 percent with no education and 56 percent with some education below SSC. Interestingly, as you move from Location 01 to Location 03, the percentage of the children living in households with no education decreases, whereas the percentage of the children living in households with education of SSC and over increases.

This suggests the possibility that education level increases as you move from Location 01 to Location 03. A simple ordinary least squares analysis confirms this at 1 percent significance level (*p-value* of 0.007). This is also reflected in the fifth row which shows that the mean education of Location 03 is greater than the others.

#	Variable		Location 01 (n=64)	Location 02 (n=64)	Location 03 (n=46)	Combined (n=174)
01	**Mean Household Size**		4.7 *(1.21)*	4.4 *(1.16)*	4.6 *(1.39)*	**4.6** ***(1.25)***
02	**Highest Household Education**	**No Education**	24 (38%)	19 (30%)	11 (24%)	**54 (31%)**
		Below SSC	36 (56%)	39 (61%)	23 (50%)	**98 (56%)**
		SSC and Above	4 (6%)	6 (9%)	12 (26%)	**22 (13%)**
		Mean Education[2]	0.69 *(0.59)*	0.80 *(0.60)*	1.02 *(0.71)*	**0.82** ***(0.64)***
03	**Occupation (of HH Head)**	**Business**	8 (13%)	12 (19%)	4 (9%)	**24 (14%)**
		Skilled Labor	19 (30%)	16 (25%)	17 (37%)	**52 (30%)**
		Day Laborer	26 (41%)	32 (50%)	14 (30%)	**72 (41%)**
		HH Work	8 (13%)	1 (6%)	4 (9%)	**13 (7%)**
		Others	3 (5%)	3 (5%)	7 (15%)	**13 (7%)**
04	**Occupation (of Spouse)**	**Day Laborer**	13 (20%)	12 (19%)	13 (28%)	**38 (22%)**
		HH Work	44 (69%)	49 (77%)	24 (52%)	**117 (67%)**
		Unable to Work	7 (11%)	3 (5%)	9 (20%)	**19 (11%)**

Table 04: Child <5 level data showing general information of the survey population

Since the males are the main income earners for our dataset, they are considered to be household head. In terms of household head occupation, children with fathers who are day laborers constitute the highest overall percentage, followed by skilled labor and business owners. Note that Location 03 has the lowest percentage of day laborers and the highest percentage of skilled labor, possibly reflective of relatively higher education.

In terms of the occupation of the spouse of the HH head, children with mothers who are engaged only in household work constitute the highest overall percentage, followed by day laborers. Once again it is noteworthy to mention that Location 03 has the lowest percentage of

[2] where 1=no education, 2=educated below SSC & 3=educated till SSC and above.

mothers engaged only in household work and the highest percentage of mothers who are day laborers, meaning in average there are more working mothers in Location 03.

#	Variable		Location 01 (n=64)	Location 02 (n=64)	Location 03 (n=46)	Combined (n=174)
01	**Mean Income (in BDT per month)**		5,302 *(4,948)*	4,755 *(3,529)*	8,861 *(10,365)*	**6,042** ***(6,657)***
02	**Median Income**		5,000	5,000	6,000	**5,000**
03	**Assets (Q3> Q2> Q1)**[3]	**Quartile 01**	32 (50%)	47 (73%)	25 (54%)	**104** **(60%)**
		Quartile 02	26 (41%)	9 (14%)	10 (22%)	**45** **(26%)**
		Quartile 03	6 (9%)	8 (13%)	11 (24%)	**25** **(14%)**
04	**Mean Loan Amount**		16,057 *(18,905)* *(n=35)*	7,326 *(9,290)* *(n=28)*	46,036 *(60,090)* *(n=14)*	**18,333** ***(31,567)*** ***(n=77)***
05	**Median Loan Amount**		10,000	5,000	20,000	**8,000**
06	**Loan Source**	**NGOs**	12	6	2	**20**
		Money-Lender	6	8	4	**18**
		Shop-Keeper	2	3	2	**7**
		Friend/Relative	15	11	6	**32**
		All	**35** **(55%)**	**28** **(44%)**	**14** **(30%)**	**77** **(44%)**
07	**Mean Savings Amount**		5,085 *(4,372)* *(n=13)*	5,781 *(7,710)* *(n=13)*	24,834 *(30,358)* *(n=13)*	**11,906** ***(30,358)*** ***(n=39)***
08	**Median Savings Amount**		4,000	2,000	10,000	**5,000**
09	**Savings Habit**		15 (23%)	18 (28%)	17 (37%)	**50** **(29%)**
10	**Own land**		26 (41%)	18 (28%)	22 (48%)	**66** **(38%)**

Table 05: Child <5 level data showing economic information of the survey population

From Table 04, Location 03 having children < 5 with relatively more educated households begs the possibility for this region to be the highest income earner. This possibility is confirmed in Table 05 above. This makes sense, because Location 03, as mentioned earlier, is the closer to the dock with easier access to commercial areas and hence high earners will tend to

[3] In the Poverty Analysis, those falling under Q1 are termed as poor and the rest is termed as non-poor. This is in lieu to what was proposed in the methodology section 4.2.

settle here. The mean income score is highest for Location 03 at BDT 8,861 (USD 127), followed by Location 01 and then finally lowest for Location 02.

Before progressing further, it is wise to mention that any redundancy in loan or savings data has been removed for the child level analysis. This means that if there are two children from the same household, the loan and savings amount is counted only once. This is done to prevent any misrepresentation of the data.

A similar trend as mean income is followed for mean loan amount with sample mean loan being BDT 18,333 (USD 262[4]) where roughly 44% of the children's households have currently outstanding loans. Note that this is the total amount of any outstanding loan taken by the households; hence the amount is much larger than the mean monthly income. With only 30% of the children's households taking loans in Location 01, it still holds the highest amount, meaning that the loan amount is notably larger. This is reflected in the respective higher median value. Furthermore, NGOs assisted loans are also the lowest in Location 03.

For the mean savings amount, Location 03 again holds the highest value, but this time followed by Location 02 and then Location 01. Similar for mean loan amount, it is worthwhile to note that this is the total amount of current savings of a household.

Each of the mean scores carries large standard deviation values indicative of a wide range of scores meaning a great deal of variance, and the presence of a heavily skewed data due to outliers. Generally speaking, the greater the range of scores, the less representative the mean becomes, hence the median for each is also provided. Even when comparing median values, Location 03 still gets the significantly higher value for each of the means.

In terms of the Asset Quartiles, where $Q3 > Q2 > Q1$, Location 02 holds the greatest percentage of children in poor households (Q1), whereas Location 03 holds the greatest percentage of children in the most well-off households (Q3). Savings habit is again greatest in Location 03 and is lower and roughly similar for Locations 01 and 02.

Thus from this general economic overview of the surveyed population, it can be stated Location 03 is the more affluent of the three regions. While it is inconclusive whether Location

[4] Assuming exchange rate of USD 1 = BDT 70

01 or Location 02 is better-off, it can be extended that Location 01 sustains a greater level of financial activities. Table 03 provides the relevant medical information for the data set.

Variable		Location 01 (n=64)	Location 02 (n=64)	Location 03 (n=46)	All (n=174)
Illness	**Total Cases**	119	102	66	287
	(% of total cases)	(41%)	(36%)	(23%)	
	Total Child Cases	49	38	12	99
	(% compared to total child cases)	(39%)	(37%)	(18%)	(34%)
	Incidence per Child Affected	1.44	1.27	1.33	1.36
	Regional Child Illness	53%	47%	20%	42%
	(% of cases)				
	Regional Child Illness	1.86	1.59	1.43	1.65
	(ratio of total number of children)				
Medical Expenses	**Mean per Child**	3,170	6,724	3,089	4,456
		(6,824)	*(20,428)*	*(9,042)*	*(13,900)*
	Median per Child	650	1,000	100	467
Mean Work Days Lost		17.2	24.0	8.6	17.5
		(30.2)	*(42.3)*	*(29.7)*	*(35.4)*
Most Common Illness Incidence	**Diarrhea**	9%	17%	15%	14%
	High Fever	14%	16%	17%	16%
	Jaundice	13%	6%	2%	7%
	Typhoid	5%	3%	0%	3%

Table 06: Data showing medical information of the survey population

As expected from the previous general information tables, total cases of illness, total child cases of illness and regional child incidence, all fall as you move from Location 01 to Location 03. Location 03 participates in better medical standards comparable to higher well-fare.

The illness incidence per child affected represents the number of illness a child *already* ill could potentially have. We see that this is highest for Location 02. Mean (as well as the median) medical expenses per child is also highest for Location 02. This suggests that although Location 03 enjoys the most overall well-fare, Location 02 spends a higher proportion of their earnings on child treatment, compared to Location 01 or Location 03. The mean work days lost due to illness for the entire household of each child is also highest for Location 02, standing at 24 days per annum. This perhaps somewhat explains Location 02 having the lowest mean income under Table 05.

Finally note that amongst the total cases reported the most common illnesses are Diarrhea and High Fever while Jaundice is also comparatively prevalent in Location 01. We will see that Diarrhea and High Fever are also the prevalent illness amongst children (see Table 12) when we deal with the details of the child sex bias analysis under chapter 6.1.

Chapter 06: Malnourishment and Sex Bias Analysis

6.1 Establishing Presence of Malnourishment and Sex Bias

The level of malnourishment found in the region is distressingly high. The figures are provided in Table 07. Over 51% of the children surveyed were found to be in the severe malnourishment category, and even though over a quarter of the sample follows a normal growth route, another over 21% were moderately malnourished. It is interesting to note here that while the percentage difference between male and female children under the moderately malnourished category is very small (male children are at 21% and the female children are at 20%), under the normal growth category there is about 16% increase in the difference (male children are at 36% and the female children are one again at 20%). This is an initial indicator for existence of sex bias which we will analyze in detail.

Another thing to note here is the difference in the mean weight. The *Std. Δ* calculates the difference between the 03rd percentile (the lower bound of moderately malnourished category) weights of male and female children at mean age (31.34) of the survey population. Given that female children normally weigh less than the male children, this *Std. Δ of 0.55* is the standard weight by which the female should normally fall behind from male at this specific age. As shown below, the *Sample Δ of 1.52* is higher than this almost by one kilogram. This is also indicative of existence of sex bias.

	Normal Growth	Moderately Malnourished	Severely Malnourished	Mean Weight (in kg)	Mean Age (in months)
Male (n=86)	31 (36%)	18 (21%)	37 (43%)	10.84 *(4.07)*	31.67 *(18.11)*
Female (n=88)	18 (20%)	18 (20%)	52 (59%)	9.32 *(3.54)*	31.02 *(18.83)*
				Sample Δ: 1.52	*Std. Δ: 0.55*
Total (n=174)	49 (28%)	36 (21%)	89 (51%)	10.07 *(3.88)*	31.34 *(18.43)*

Table 07: Percentage of Malnourishment of Children below 5 by Sex

Let us now assess the scenario in terms of internal group dynamics. The relationship between weight and age of children is well approximated by a power curve (obviously excluding age zero). The data was thus fitted in the equation $w = ka^g$ with w for weight in kgs and a for

age in months, with k and g being the two coefficients to be estimated (Sen, 1983). The results are provided in table 08 below.

Gender	Sample Size (n)	Estimated k	Estimated g
Male	86	2.54	0.43
Female	88	2.96	0.34

Table 08: Age-Weight Growth Curves; Power Fit: $w = ka^g$

From the g estimates it can be easily seen that the boys grow faster than the girls. However the higher estimate of k for the female children suggests that the girls have higher weight than boys in the early stages of growth. This advantage of girls over boys at very early ages may be in lieu of lower neo-natal mortality of female infants vis-a-vis male infants in Bangladesh (Chen, Huq and D'Souza, 1981). Nonetheless, the difference in the estimated g is another indicator of the prevalent sex bias in the village.

		Normal Growth	Moderately Malnourished	Severely Malnourished	Mean Weight	Mean Age
Location 01	**Male**	11	8	13	11.33	35.39
	(n=32)	(34%)	(25%)	(41%)	*(3.50)*	*(17.21)*
	Female	6	9	17	10.14	34.97
	(n=32)	(19%)	(28%)	(53%)	*(3.25)*	*(17.24)*
				Δ%: 12	*Sample Δ: 1.19*	*Std. Δ: 0.60*
	Total	17	17	30	10.73	35.18
	(n=64)	(27%)	(27%)	(47%)	*(3.40)*	*(17.09)*
Location 02	**Male**	10	9	12	11.18	31.68
	(n=31)	(32%)	(29%)	(39%)	*(4.04)*	*(17.94)*
	Female	6	6	21	8.95	30.12
	(n=33)	(18%)	(18%)	(64%)	*(3.57)*	*(18.58)*
				Δ%: 25	*Sample Δ: 2.23*	*Std. Δ: 0.55*
	Total	16	15	33	10.03	30.88
	(n=64)	(25%)	(23%)	(52%)	*(3.94)*	*(18.14)*
Location 03	**Male**	10	1	12	9.72	26.48
	(n=23)	(43%)	(4%)	(52%)	*(4.75)*	*(19.05)*
	Female	6	3	14	8.72	26.80
	(n=23)	(27%)	(13%)	(61%)	*(3.83)*	*(20.96)*
				Δ%: 9	*Sample Δ: 1.00*	*Std. Δ: 0.50*
	Total	16	4	26	9.22	26.64
	(n=46)	(35%)	(9%)	(57%)	*(4.30)*	*(19.80)*

Table 09: Percentage of Malnourishment of Children below 5 by Sex and Location

The incidence of malnourishment of children under the age of five by sex and location is provided in table 09 above. We can see that under the field of normal growth, male children are always better off than the female children with the *difference* in percentage between the genders being roughly the same (about 15%). As expected, Location 03 enjoys the highest percentage of children with normal growth. Interestingly, in Location 02, male children are more moderately malnourished than female children. However with regard to severe malnourishment for all three locations, female children are more malnourished than the male children, with the highest percentage difference being in Location 02. In regard to the mean weight, Location 02 also has the largest *Sample Δ of 2.23.* This might explain why Location 02 was spending the most for child treatment as shown under table 06 in section 5.

Another interesting characteristic to note is the dual extremities in Location 03 where only 9% of the children are moderately malnourished, 35% experience normal growth and 57% are severely malnourished (35% and 57% are the dual extremities). Given that Location 03 has the highest economic welfare, this is surprising. This suggests the possibility that households that would otherwise have been moderately malnourished, have managed to climb up the socio-economic ladder to be able to provide their children with normal growth. This makes sense as Location 03 has the highest percentage of children with normal growth. This however also suggests that populations of both extremes of the socio-economic ladder live in this region.

6.2 Sex Bias Analysis

Education, especially mother's education is known to play an important role in the reduction of undernourishment and sex bias, so it is impervious that we should look at the relationship between sex bias and mother's education . As per the cutoff setup under the methodology chapter, mothers who have completed at least up to Class 5 are considered literate. The results are given in table 10.

From table 10, we can deduce that just about half of the survey sample consists of malnourished children (moderate and normal combined) whose mothers are illiterate among which about 52% are female. This is in comparison to only 21% of the malnourished children (moderate and normal combined) coming from mothers who are literate among which 65% are female. This is indicative that for educated mothers malnourishment is low. However, whether

mothers' education *statistically* significantly lowers malnourishment is dealt with later in this study under chapter 8.2, but for now we can say that it does lower malnourishment.

In order to establish whether sex bias exists or not we have to look at the table vertically, that is, compare across total or specific levels of malnourishment.

Education of Mother (M=174)		Normal Growth (m=49)	Moderately Malnourished (m=36)	Severely Malnourished (m=89)	Mean Weight	Mean Age
Male Children (N=86)	**Illiterate (n=60) (M: 34%)**	18 (m: 37%)	14 (m: 38%)	28 (m: 31%)	10.73 *(4.19)*	32.85 *(18.33)*
	Literate (n=26) (M: 14%)	13 (m: 27%)	4 (m: 11%)	9 (m: 10%)	11.12 *(3.84)*	28.94 *(17.74)*
Female Children (N=88)	**Illiterate (n=60) (M: 34%)**	14 (m: 29%)	12 (m: 33%)	34 (m: 38%)	9.49 *(3.51)*	32.09 *(18.80)*
	Literate (n=28) (M: 16%)	4 (m: 8%)	6 (m: 17%)	18 (m: 20%)	8.96 *(3.65)*	28.71 *(19.04)*
Education Lower Anti-Female Sex Bias?		**No (0.30<0.73)**	**No (1.55>0.87)**	**No (2.00>1.22)**		

Table 10: Sex Bias in Levels of Malnourishment by Mother's Education

The percentages in the above table are based on the total number of child in each level of malnourishment, which is the number divided by *m*. The basic rationale for determining anti-female sex bias is simple. For the malnourished columns, if the ratios are such that,

$$\frac{Literate_{female}}{Literate_{male}} < \frac{Illiterate_{female}}{Illiterate_{male}}$$

then mother's education *lowers* anti-female sex bias, and vice versa. For the normal growth column the opposite is true, such that if,

$$\frac{Literate_{female}}{Literate_{male}} > \frac{Illiterate_{female}}{Illiterate_{male}}$$

then mother's education lowers anti-female sex bias, and vice versa.

Take the severely malnourished level for example, for both literate and illiterate mothers; the female children are more malnourished than the male. However, note that the ratio of $Literate_{female}/Literate_{male}$ is higher than the ratio of $Illiterate_{female}/Illiterate_{male}$; that is $(2.00 > 1.22)$. This means that for our study sample, when mothers are literate a higher ratio of female children experience severe malnourishment. Thus mother's education does not lower anti-female sex bias. Similar comparative analyses have been done for the rest of the dimensions and the results are provided in the last row.

It is interesting that household spouse education does not lower anti-female sex bias in any of the malnourishment levels. As we will see below, for the same households, having better averting behavior activities or better child health does lower anti-female sex bias. This suggests the possibility that for our study population such behavioral practices are independent of household mother's education but rather are variables of the social environment.

Table 11 provides results of similar analysis of Sex Bias in levels of malnourishment done for Child Health Index (CHI), Averting Behavior Index (ABI) and Asset Index (AI). Note that here for malnourished columns, when

$$\frac{Deprived_{female}}{Deproved_{male}} > \frac{Not\ Deprived_{female}}{Not\ Deprived_{male}} \dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

then the variable does lower anti-female sex bias. The opposite is true for the normal growth column.

We can deduce for CHI, ABI and AI that 33%, 35% and 44% of the respective survey sample consists of malnourished children (moderate and normal combined) whose mothers are deprived, of which 51%, 72% and 53% respectively are female. Similarly keeping CHI, ABI and AI in order, 40%, 37% and 28% of the respective survey sample consists of malnourished children (moderate and normal combined) whose mothers are *not* deprived, of which 51%, 40% and 61% respectively are female.

Comparing the above values we *cannot* say that malnourishment is low for children in households faring better in CHI and ABI, but *can* say that malnourishment is low for children in households faring better in AI (44% of malnourished for deprived vs. 28% of malnourished for

not deprived). [5] This means that malnourishment is low for children in households with more assets.

			Normal Growth (m=49)	Moderately Malnourished (m=36)	Severely Malnourished (m=89)	Mean Weight	Mean Age
Child Health Index (M=174)	**Male** Children (n=86)	**Not Deprived (M: 33%)**	25 (m: 51%)	16 (m: 44%)	17 (m: 19%)	12.28 *(4.21)*	32.03 *(18.22)*
		Deprived (M: 16%)	6 (m: 12%)	2 (m: 05%)	20 (m: 22%)	9.92 *(3.67)*	30.93 *(18.18)*
	Female Children (n=88)	**Not Deprived (M: 29%)**	15 (m: 31%)	13 (m: 36%)	22 (m: 25%)	9.49 *(3.83)*	28.79 *(19.86)*
		Deprived (M: 22%)	3 (m: 06%)	5 (m: 14%)	30 (m: 34%)	9.11 *(3.16)*	33.95 *(17.21)*
Lowers Anti-Female Sex Bias?			**Yes (0.50<0.61)**	**Yes (2.80>0.80)**	**Yes (1.55>1.32)**		
Averting Behavior Index (M=174)	**Male** Children (n=86)	**Not Deprived (M: 30%)**	15 (m: 31%)	13 (m: 36%)	25 (m: 28%)	10.10 *(3.55)*	29.18 *(16.62)*
		Deprived (M: 19%)	16 (m: 33%)	5 (m: 14%)	12 (m: 13%)	12.03 *(4.60)*	35.67 *(19.89)*
	Female Children (n=88)	**Not Deprived (M: 25%)**	17 (m: 35%)	7 (m: 54%)	19 (m: 21%)	10.02 *(3.69)*	30.99 *(19.52)*
		Deprived (M: 26%)	1 (m: 02%)	11 (m: 31%)	33 (M: 37%)	8.66 *(3.30)*	31.04 *(18.37)*
Lowers Anti-Female Sex Bias?			**Yes (0.06<1.13)**	**Yes (2.2>0.54)**	**Yes (2.75>0.76)**		
Asset Index (M=174)	**Male** Children (n=86)	**Not Deprived (M: 40%)**	12 (m: 24%)	4 (m: 11%)	15 (m: 17%)	10.37 *(4.04)*	28.56 *(16.60)*
		Deprived (M: 10%)	19 (m: 39%)	14 (m: 37%)	22 (m: 25%)	11.11 *(4.10)*	33.42 *(18.83)*
	Female Children (n=88)	**Not Deprived (M: 40%)**	9 (m: 18%)	10 (m: 28%)	20 (m: 22%)	9.19 *(3.16)*	29.83 *(19.21)*
		Deprived (M: 10%)	9 (m: 18%)	8 (m: 22%)	32 (m: 36%)	9.43 *(3.85)*	31.96 *(18.68)*
Lowers Anti-Female Sex Bias?			**Yes (0.47<0.75)**	**No (0.57<2.5)**	**Yes (1.45>1.33)**		

Table 11: Sex Bias in Levels of Malnourishment by Child Health Index, Averting Behavior Index and Asset Index

[5] However we will see later that both CHI does reduce malnourishment significantly under chapter 8.2.

Note from table 11 that for our sample population both CHI and ABI lowers anti-female sex bias for all levels. For AI when the overall nutrition is better, that is, normal growth is experienced, anti-female sex bias is reduced. However, note that AI does *not* lower anti-female bias for the overall malnourished children, even though it does so for the severely malnourished category separately. This can be seen by adding the values of moderately malnourished and severely malnourished together and performing the comparative ratio analysis, which yields that, according to equation (2), for an increase in asset, there is a higher ratio of female malnourished children (1.11<1.57). However, one can say that an increase in asset does lower anti-female sex bias at the severe level of malnourishment alone.

6.3 Sex Bias in Medical Expenditure

Having established the presence of sex bias under section 6.1, table 12 below re-affirms the presence in terms of medical expenditure.

		Total Number of Child Illness Reported in the Last Two Years	Mean Medical Expenses	Median Medical Expenses
All Children	**Male**	35 (43%)	3,519 *(8,960)*	500
	Female	46 (57%)	1,722 *(4,487)*	550
	Total	81	2,499 *(6,801)*	500
Only Children <5	**Male**	27 (51%)	2,485 *(4,256)*	500
	Female	26 (49%)	1,672 *(5,812)*	300
	Total	53	2,086 *(5,046)*	500

Table 12: Sex Bias in Medical Expenditure

We can see that both for all children and children under the age of five, mean medical expenses are lower for females. This behavioral trait perhaps explains why overall malnourishment was low for female children (first established in table 07 under section 6.1). The above information however is not enough to establish sex bias. For that we must look into comparable treatment costs for specific illnesses, as the cost of treatment varies with diseases.

However, this also assumes that cost for treatment of the illnesses in focus do not vary too much. Under this assumption, table 13 provides the relevant information for most common illnesses of children under the age of five.

Diarrhea and high fever are the most common reported illness of children under the age of five in our sample population, for both male and female. Table 13 provides expenses made only for these two illnesses for both gender. We can see that for both illnesses, the mean as well as the median medical expenses are higher for boys. In other words, more money is spent for the recovery of a male child compared to that of a female child, representing sex bias in regard to medical expenses made. This can also be an explanation for the higher level of malnourishment in female children.

	Gender	Illness	Incidence	Mean Medical Expenses	Median Medical Expenses
Most Common Illness Incidence for Child <5	**Male**	**Diarrhea**	10 (37%)	1,283 *(1,746)*	425
		High Fever	7 (26%)	609 *(701)*	500
	Female	**Diarrhea**	9 (35%)	531 *(777)*	300
		High Fever	10 (38%)	490 *(547)*	300

Table 13: Sex Bias in Medical Expenditure of Most Common Illnesses

6.4 Effect of Number of Siblings on Malnourishment: A Crude Analysis

Finally for this chapter, we investigate the contribution of number of siblings to sex bias. Table 14 presents the data when the number of siblings is more than one.

	More than One Sibling, *s*	Normal Growth	Moderately Malnourished	Severely malnourished	Total
Male (n=86)	No	17	11	19	**47**
	Yes	14	7	18	**39**
Female (n=88)	No	7	7	24	**42**
	Yes	11	11	28	**46**

Table 14: Levels of Malnourishment by Sex and Number of Siblings

From table 14, for female children, an increased number of siblings of more than one results in slightly higher number of both malnourished (both moderate and severe) and normal growth children. For male children however, an increased number of siblings of more than one results in slightly lower number of malnourished (both moderate and severe) children while the number of children experiencing normal growth increases. Hence, it can be said that having more than one sibling decreases malnourishment for male children, however its statistical significance is questionable.

Chapter 07: Multi-dimensional Child Poverty Analysis

7.1 Establishing the Alkire-Foster Multidimensional Framework

In this chapter we will first establish the framework of multidimensional child poverty and then perform relevant sensitivity analysis to detect malnourishment and sex differentials in our sample population. In chapter 04 under table 01, we had established our 14 indicators in 5 dimensions, their respective weights and their respective first cutoff values, z. Before advancing to present the analysis related to the second cutoff, k, let us look at the incidence of deprivations when the value of $k = 0$, shown in table 15 below. From here from, all representations and analyses will be done with children under the age of 5, as the unit of analysis.

#	Indicator (for k = 0)	Male (%) (n=86)	Female (%) (n=88)	Total (%) (n=174)
01	Household Spouse Education	34	34	68
02	Child Illness in Household	20	22	42
03	Child Health Index	16	22	38
04	Household Income	10	9	19
05	Assets Index	32	28	60
06	Electricity Access	5	3	8
07	Cooking Fuel	3	2	5
08	Latrine Type	13	24	37
09	Drinking Water Supply	1	0	1
10	Over Crowded Housing	24	28	52
11	Averting Behavior Index	14	20	34
12	Medical Costing Index	34	29	63
13	Savings	36	35	71
14	Land	29	33	62
	Total	**19.4**	**20.6**	**40**

Table 15: Incidence of Deprivations by Sex when $k = 0$ for children < 5

The female children are worse off on exactly 7 out of the 14 indicators, when compared to the male children (# 02, 03, 05, 07, 10, 11 & 14). The depth of the incidence is of course another matter that is investigated later. We can see that savings is the major source of deprivation for both male and female, followed by household spouse education, medical costing index, land, and then the assets index.

It is interesting that female children have a higher child health index value even though they have a greater difference in weight from the standard compared to the male children (shown in table 9, chapter 6.1) and have greater child illness. Also note than the female children are almost twice as more deprived in receiving hygienic latrine facility than the male children while the households of the female children are better in terms of the household assets or averting behavior.

Finally note that Electricity Access, Cooking Fuel and Drinking Water Supply, all have very low levels of deprivation for both gender. This is due to our definitions of z, for each of the indicators and also (marginally) increasing better access of the services in the slums.

The multidimensional approach to child poverty takes into accounts not simply one indicator but multiple indicators of poverty giving us a more composite measure; our model encompasses the fourteen indicators mentioned above. The distribution of deprivation counts are presented in table 16; the Alkire-Foster multidimensional adjusted headcount ratio, M_0, for various levels of the second cutoff, k, is presented in table 17, along with the standard headcount and the average deprivation share.

Range of Deprivations, r	Percentage of Children in Poverty
$0 < r \leq 10$	4.6
$10 < r \leq 20$	8.6
$20 < r \leq 30$	12.6
$30 < r \leq 40$	9.8
$40 < r \leq 50$	25.9
$50 < r \leq 60$	17.2
$60 < r \leq 70$	14.4
$70 < r \leq 80$	6.9
$80 < r \leq 90$	0
$90 < r \leq 100$	0

Table 16: Distribution of Deprivation Counts

Table 16 tells us the number of children with households who suffer exactly the range of deprivations specified. 26% of the households (the majority) suffer from deprivations within the range of more than 40 but less than 50. Relating to this, from table 17 we can see that there is a

relatively sharper fall in the value of both $\boldsymbol{H}$ and $\boldsymbol{M_0}$ when moving from a cutoff of 40 to 50; the fall in values ($value\ at\ 50 - value\ at\ 40$) are 0.247 and 0.115 respectively.

Cutoff (k)	Headcount (H)	Adjusted Headcount $[\boldsymbol{M_0 = H \times A, or\ M_0 = \mu(g^0(k))}]$	Average Deprivation Share (A)
10	0.971	**0.450**	0.464
20	0.879	**0.436**	0.496
30	0.776	**0.410**	0.529
40	0.661	**0.372**	0.562
50	0.414	**0.257**	0.623
60	0.224	**0.153**	0.680
70	0.075	**0.055**	0.734
80	0	**0**	0

Table 17: Comparison of different multidimensional child poverty measures for different cutoffs

Keep note that when we refer to a specific cutoff, it corresponds to the proportion of children with poor households that are deprived in at least the specified levels of weighted indicators. Also, the higher the headcount or adjusted headcount value, the higher the poverty. That mentioned, the values of $\boldsymbol{H}, \boldsymbol{A}$ and $\boldsymbol{M_0}$ presented in table 17 are calculated based on the framework provided under chapter 4.3.

We see a decreasing trend for values of both $\boldsymbol{H}$ and $\boldsymbol{M_0}$ with cutoffs as expected. The relatively sharper fall in both $\boldsymbol{H}$ and $\boldsymbol{M_0}$, between 40 and 50 tells us that the poorer households are better represented when our cutoff is below 50. For this specific study, a cutoff value of 40 was selected, both because of the analysis above and representational rationality of the cutoff.

Basically, this means that if a child is deprived in having access to an educated mother (indicator weight = 20), to proper water supply (indicator weight = 04), is exposed to an over-crowded housing (indicator weight = 04), and also deprived in the child health index (indicator weight = 10) while the child's household does not have the habit of saving (indicator weight = 05), the child will be deemed as multi-dimensionally poor (total indicator weights = 43 > 40). While this cutoff level might seem a bit too lax, for our study sample, even fulfilling such basic requirements is a challenge. Hence, a cutoff of 40 is believed to be a good representation for accessing multidimensional poverty.

7.2 Malnourishment and Sex Bias according to Multidimensional Child Poverty

Having set the multidimensional poverty measure framework, let us now look into whether it is a better estimate of, first malnourishment and subsequently presence of sex bias. Figure 01 below graphs the $\boldsymbol{M_0}$ values for the levels of malnourishment according to $k = 40$.

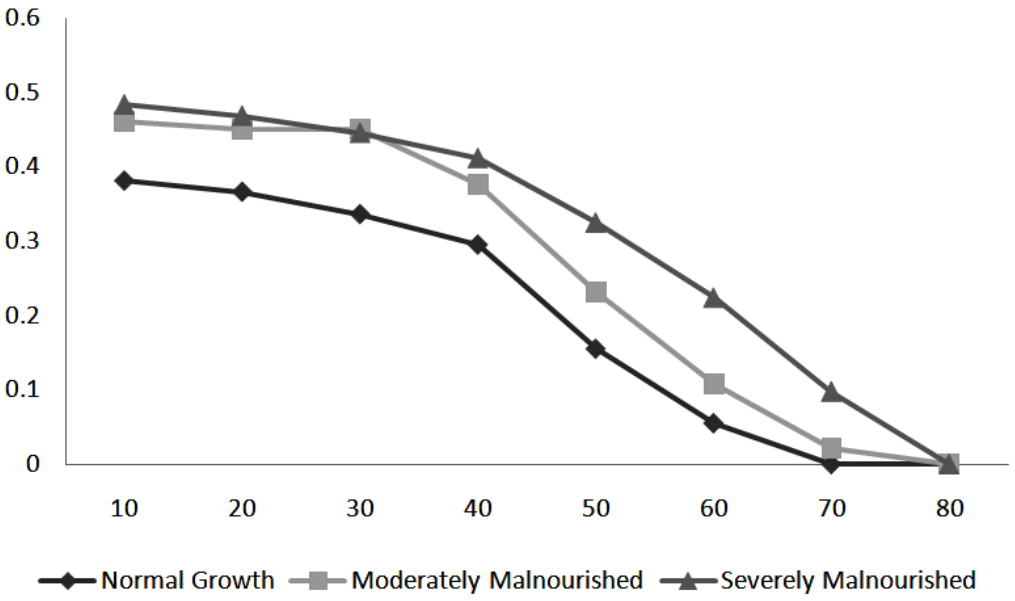

Figure 01: $\boldsymbol{M_0}$ values for the levels of malnourishment according to $k = 40$

For all levels of cutoffs except for 30, we can see that values of $\boldsymbol{M_0}$ is lowest for normal growth, second for moderate malnourishment and highest for severe malnourishment. Notice how after $k = 40$, the gap between moderate and severe malnourishment starts increasing. This tells us that both moderate and severe malnourishment is more 'distinct' for $k < 40$ and as multidimensional poverty decreases for $k > 40$, the moderate malnourished group slowly tend towards being normal. This also gives rationale for $k = 40$ to be a suitable cutoff for analysis.

As noted earlier under section 4.3, $\boldsymbol{M_0}$ has the very useful trait of being able to be broken down into any number of subgroups. Table 18 shows us the decomposition of child poverty when we set $k = 40$ and along with different measures of poverty, similar to Roche (2010). The decomposition is made first on the basis of location and then on the basis of the different levels of malnourishment. For each subgroup, the decomposition is made further based on gender. Table 19 shows the same data ranked with 1 = poorest, 2 = mediocre and 3 = most well-off (ranking is done with 1 and 2 only for between gender) for each of the measures. While men and female are ranked for each subgroup, totals of location and levels of malnourishment are also ranked. Sample size for $k = 40$ is $n = 115$.

	Total Sample	% Contribution	Mean Weight	Mean Income	% Contribution	Asset Index	% Contribution	M_0	% Contribution	H	% Contribution	A
Location 01												
Male	22	19	11.75	5,136	21	0.125	20	0.372	19	0.688	20	0.540
Female	23	20	9.65	4,034	17	0.145	24	0.413	22	0.688	21	0.601
Total	45	39	10.68	4,573	38	0.135	44	0.392	41	0.703	42	0.558
Location 02												
Male	24	21	11.48	4,077	18	0.097	17	0.445	25	0.774	25	0.575
Female	23	20	9.46	4,804	21	0.118	20	0.41	22	0.697	21	0.588
Total	47	41	10.49	4,433	38	0.107	36	0.427	47	0.734	45	0.581
Location 03												
Male	10	9	8.70	3,100	6	0.096	7	0.24	5	0.435	6	0.552
Female	13	11	8.65	8,238	20	0.148	14	0.293	9	0.565	10	0.518
Total	23	20	8.67	6,004	26	0.126	21	0.266	14	0.500	15	0.533
Normal Growth												
Male	17	15	14.21	5,782	18	0.118	15	0.293	12	0.548	12	0.535
Female	11	10	12.55	5,273	11	0.131	11	0.299	8	0.611	9	0.489
Total	28	24	13.55	5,582	29	0.123	25	0.295	19	0.571	21	0.517
Moderately Malnourished												
Male	14	12	12.71	3,379	9	0.087	9	0.421	14	0.778	14	0.541
Female	11	10	9.82	4,318	9	0.165	13	0.332	8	0.611	9	0.544
Total	25	22	11.44	3,792	18	0.122	22	0.377	22	0.694	23	0.542
Severely Malnourished												
Male	25	22	8.06	3,850	18	0.113	21	0.393	23	0.676	22	0.582
Female	37	32	8.27	5,538	38	0.127	34	0.425	37	0.712	35	0.598
Total	62	54	8.19	4,857	55	0.121	54	0.412	60	0.697	57	0.591
Sex (Total)												
Male	56	49	11.09	4,318	44	0.107	43	0.363	48	0.651	48	0.557
Female	59	51	9.36	5,261	57	0.134	57	0.380	52	0.670	52	0.567
Total	**115**	**100**	**10.2**	**4,802**	**100**	**0.122**	**100**	**0.372**	**100**	**0.661**	**100**	**0.562**

Table 18: Decomposition of Child Poverty along Different Measures of Poverty

	Mean Weight	Ranking Mean Weight	Mean Income (MI)	Ranking MI	Asset Index (AI)	Ranking AI	M_0	Ranking M_0	H	Ranking H	A	Dif. in rank $MI - M_0$	Dif. in rank $AI - M_0$	Dif. in rank $H - M_0$
Location 01														
Male	11.75	2	5,136	2	0.125	1	0.372	2	0.688	-	0.540	0	-1	-
Female	9.65	1	4,034	1	0.145	2	0.413	1	0.688	-	0.601	0	1	-
Total	***10.68***	***3***	***4,573***	***2***	***0.135***	***3***	***0.392***	***2***	***0.703***	***2***	***0.558***	***0***	***1***	***0***
Location 02														
Male	11.48	2	4,077	1	0.097	1	0.445	1	0.774	1	0.575	0	0	0
Female	9.46	1	4,804	2	0.118	2	0.410	2	0.697	2	0.588	0	0	0
Total	***10.49***	***2***	***4,433***	***1***	***0.107***	***1***	***0.427***	***1***	***0.734***	***1***	***0.581***	***0***	***0***	***0***
Location 03														
Male	8.70	2	3,100	1	0.096	1	0.240	2	0.435	2	0.552	-1	-1	0
Female	8.65	1	8,238	2	0.148	2	0.293	1	0.565	1	0.518	1	1	0
Total	***8.67***	***1***	***6,004***	***3***	***0.126***	***2***	***0.266***	***3***	***0.500***	***3***	***0.533***	***0***	***-1***	***0***
Normal Growth														
Male	14.21	2	5,782	2	0.118	1	0.293	2	0.548	2	0.535	0	-1	0
Female	12.55	1	5,273	1	0.131	2	0.299	1	0.611	1	0.489	0	1	0
Total	***13.55***	***3***	***5,582***	***3***	***0.123***	***3***	***0.295***	***3***	***0.571***	***3***	***0.517***	***0***	***-1***	***0***
Moderately Malnourished														
Male	12.71	2	3,379	1	0.087	1	0.421	1	0.778	1	0.541	0	0	0
Female	9.82	1	4,318	2	0.165	2	0.332	2	0.611	2	0.544	0	0	0
Total	***11.44***	***2***	***3,792***	***1***	***0.122***	***2***	***0.377***	***2***	***0.694***	***2***	***0.542***	***-1***	***0***	***0***
Severely Malnourished														
Male	8.06	1	3,850	1	0.113	1	0.393	2	0.676	2	0.582	-1	-1	0
Female	8.27	2	5,538	2	0.127	2	0.425	1	0.712	1	0.598	1	1	0
Total	***8.19***	***1***	***4,857***	***2***	***0.121***	***1***	***0.412***	***1***	***0.697***	***1***	***0.591***	***1***	***0***	***0***
Sex (Total)														
Male	11.09	2	4,318	1	0.107	1	0.363	2	0.651	2	0.557	-1	-1	0
Female	9.36	1	5,261	2	0.134	2	0.380	1	0.670	1	0.567	1	1	0
Total	**10.2**		**4,802**		**0.22**		**0.372**		**0.661**		**0.562**			

Table 19: Decomposition of Child Poverty with Ranked Different Measures of Poverty

Table 18 and table 19, both show four measures of poverty: income, asset, headcount ratio (H) and the adjusted headcount ratio (M_0). Please note that the % contributions in table 18 are represented as a ratio of the whole sample, hence a category with a higher M_0 can still have lower % contribution. We see this happening for the female children under the normal growth category of table 18 with $M_0 = 0.299$ (as opposed to $M_0 = 0.293$ for the male children) but with a % contribution of 8 percent (as opposed to 12 percent for the male children). This means that in the normal growth category a lower number of female children contribute to more multi-dimensional poverty. In other words, the female children are experiencing more severe multi-dimensional poverty when compared to the male.

From table 18, one can see that after applying the cutoff, children under the severely malnourished category constitute a large portion (54%) amongst the levels of malnourishment while location 03 contributes the least (20%) amongst the three locations. This indicates that the multidimensional poverty was a good fit as it now comprises more of those who are malnourished and less of those who are better off (as it is the for location 03; established under chapter 5). For females of location 03, note that while 20% contribute to the high mean income, only 14% contribute to the asset index and a lower 9% contribute to the adjusted headcount, representative of the higher welfare of the region.

Now, turning to table 19 for comparative analysis, when you look at the second last two rows comparing the total male and female children, we see that in terms of weight, the female are more deprived than the male. This deprivation in nourishment is not reflected by the income or the asset index. Both income and asset index indicate that the male are more deprived; however, the multidimensional poverty measures do represent the ranking according to mean child weight, signifying that the female are overall more in poverty.

We see the opposite when we look at only the severe malnourishment case. This is interesting because at our selected cutoff at the severe malnourishment level, the male have a lower average weight with lower mean income and assets. However, both $\boldsymbol{H}$ and $\boldsymbol{M_0}$ indicate that the female children are more still multi-dimensionally poor than the male children. This can have important policy implications as to which area to target for development – whether the focus will be economic or behavioral.

For the moderately malnourished case and location 02, we can see that none of the measures rank the same as the weight, where the mean weight of male children is lower than that of the female children; however all the measures point towards the male being more deprived. In case of normal growth and location 01, the female are more deprived in mean weight, which coincides with the income and multidimensional poverty measure, but not in terms of assets.

Now comparing across locations, even though location 03 is termed the poorest according to mean weight for our selected cutoff, the location is still confirmed to be most better off when mean income or $\boldsymbol{H}$ or $\boldsymbol{M_0}$ are used for the measurement. For the malnourished levels, the severe malnourishment category is identified as the poorest by the asset and multi-dimensional measures. Thus overall, we can say that compared to income or asset index, $\boldsymbol{H}$ and $\boldsymbol{M_0}$ more often better represent malnourishment, while adding more information in cases it does not.

The last three columns of table 19 summarize the above information, where a -1 means that the category is better off multi-dimensionally and a +1 simply state the opposite. To recap, with $k = 40$ and according to $\boldsymbol{H}$ and $\boldsymbol{M_0}$, the female children are more deprived in subgroups of location 01, location 03, normal growth & severe malnourished and also when the sample as a whole is represented.

To understand the sex differential better, table 20 shows the $\boldsymbol{M_0}$ values for both male and female children for various cutoffs.

Cutoff (k)	Male	Female	Difference $(\boldsymbol{Female - Male})$
10	**0.445**	**0.450**	**0.005**
20	**0.429**	**0.443**	**0.014**
30	**0.409**	**0.411**	**0.002**
40	**0.363**	**0.380**	**0.017**
50	**0.267**	**0.249**	**-0.018**
60	**0.124**	**0.180**	**0.056**
70	**0.018**	**0.091**	**0.073**
80	**0**	**0**	**0**

Table20: Sensitivity Analysis of Gender specific M_0 values for different cutoffs.

Table 20 tells us that except for $k = 50$ all other cutoffs indicate that female children are more multi-dimensionally poor compared to the male children. Note also that after $k = 50$ the difference in the values starts increasing, meaning amongst children who are deprived in 60% or more of the weighted indicators, female children are increasingly more deprived. This once again reiterates the presence of anti-female sex bias also in multi-dimensional poverty. As we have seen earlier in table 16, there are no children with 80% or more deprivations.

So far sex bias has been analyzed taking the entire sample as a whole. Now let us take a quick look at intra-household sex bias. In our sample population we only have 15 household with both male and female children under the age of 5, yielding a sample size of 31 children. Therefore our approach to this analysis will be limited. As noted under equation (1) in section 4.1, taking the median or the 50th percentile in the growth chart as a standard, the difference, d, between the weight of the child, w, and the standard weight, s, was taken. Thus, for the i^{th} child, $d_i = w_i - s_i$. A Table 21 provides the mean and median d by sex.

	Mean of $\boldsymbol{d}$ *(standard deviation)*	Median of $\boldsymbol{d}$
Male (n=15)	-2.92 *(1.49)*	-2.8
Female (n-16)	-3.08 *(1.89)*	-3.35
Total (n=31)	-3.00 *(1.68)*	-3.2

Table 21: Intra-household Sex Bias Analysis.

It is easy to see from table 21 that the mean d for female children is lower than that of the male children, although very marginally. It however does restate the lingering anti-female sex differential in our society.

7.3 Indicator Attribution Analysis

Having established the presence of sex bias in poverty, let us now turn towards the case of indicator deprivations for our selected cutoff. Table 22 below, gives us the share of population deprived by indicator for poor and non-poor households a $k = 40$.

	Education	Health		Income & Assets		Living Standard				Awareness and Security					
	HH Spouse Education	Child Illness in HH	Child Health Index	HH Income	Assets Index	Electricity Access	Cooking Fuel	Latrine Type	Drinking Water Supply	Over Crowded Housing	Averting Behavior Index	Medical Costing Index	Savings	Land	Weighted Total Incidence
Relative Weights	**20**	**10**	**10**	**10**	**10**	**04**	**04**	**04**	**04**	**04**	**05**	**05**	**05**	**05**	
Poor (*k* = 40)															
Male (n=56)	53	30	19	15	45	8	1	14	2	34	20	42	45	40	31.2
% Contribution	**94.7**	**53.6**	**34**	**26.8**	**80.4**	**14.3**	**1.8**	**25**	**3.6**	**60.8**	**35.8**	**75**	**80.4**	**71.5**	**48.3**
Female (n=59)	55	29	32	15	41	6	3	35	0	39	22	34	47	46	33.47
% Contribution	**93.3**	**49.2**	**54.3**	**25.5**	**69.5**	**10.2**	**5.1**	**59.4**	**0**	**66.2**	**37.3**	**57.7**	**79.7**	**78**	**51.7**
Total (n=115)	*109*	*59*	*51*	*30*	*86*	*14*	*4*	*49*	*2*	*73*	*42*	*76*	*92*	*86*	*64.68*
% Contribution	***94.8***	***51.4***	***44.4***	***26.1***	***74.8***	***12.2***	***3.5***	***42.7***	***1.8***	***63.5***	***36.6***	***66.1***	***80***	***74.8***	***100***
Non-Poor (*k* = 40)															
Male (n=30)	7	5	9	2	10	0	4	8	0	7	4	18	18	10	7.3
% Contribution	**23.4**	**16.7**	**30**	**6.7**	**33.4**	**0**	**13.4**	**26.7**	**0**	**23.4**	**13.4**	**60**	**60**	**33.4**	**51.8**
Female (n=29)	5	9	6	1	8	0	0	6	0	9	12	17	14	12	6.8
% Contribution	**17.3**	**31.1**	**20.7**	**3.5**	**27.6**	**0**	**0**	**20.7**	**0**	**31.1**	**41.4**	**58.7**	**48.3**	**41.4**	**48.2**
Total (n=59)	*12*	*14*	*15*	*3*	*18*	*0*	*4*	*14*	*0*	*16*	*16*	*35*	*32*	*22*	*14.01*
% Contribution	***20.4***	***23.8***	***25.5***	***5.1***	***30.6***	***0***	***6.8***	***23.8***	***0***	***27.2***	***27.2***	***59.4***	***54.3***	***37.3***	***100***

Table 22: Share of population deprived by indicator for poor and non-poor households at $k = 40$.

In table 22, indicators where the female children have a higher share for both poor and non-poor households are marked in grey. Note that the percentage contribution in this table is done for poor and non-poor separately to allow comparison. We can see that in the weighted total incidence, the female children are slightly more deprived than the male children for the subgroup identified as poor at $k = 40$ with percentage contribution of male and female at 48.3 and 51.7 respectively. The opposite is true for non-poor households. This caters for anti-female sex bias in children that are multi-dimensionally poor.

For poor households, the indicators for which female children have greater share of deprivation are as follows: (1) Child Health Index, (2) Cooking Fuel, (3) Latrine Type, (4) Over-crowded Housing, (5) Averting Behavior Index, and (6) Land. Among the six mentioned, note that the deprivation share difference from the male children is greatest (>20) for the child health index and type of latrine used.

It is interesting that for non-poor households in the indicator of household child illness female children constitute a greater share than male children. This shows that among non-poor households female children experience illness almost twice to that of male children. Households with female children also experience a greater share of deprivation in averting behavior, land ownership and more overcrowded housing noting the highest (>25) deprivation share in case of averting behavior.

While female children deprivation is accounted, it is also important to pay attention to deprivation of male children. Male children are especially deprived (>15) in the medical costing index than the female children for the poor households group. Table 22 thus allows us to understand how the indicators play a role in establishing the prevailing sex differential.

Chapter 08: Econometric Model and Estimation of Malnourishment

8.1 Setting up the Econometric Model

In this chapter we carry out econometric estimation to determine which of these variables statistically significantly contribute to reducing child weight and subsequently malnourishment. Two models are first tested. The first using OLS regression with the dependent variable being the cardinal values of child weight in kilograms. The second using ordered logit regression with ordinal levels of malnourishment that we have used for our analysis, as the dependent variable, where a value of 1 was assigned to those undergoing normal growth, 2 for moderately malnourished and 3 for severely malnourished. Intuitively, the second model is a better estimate of malnourishment because of the choice of the dependent variable but in order to check the robustness of the model (where the signs should associate in the same direction) both models are tested.

#	Independent Variable	Variable Explanation	Model 01 Expected Sign	Model 02 Expected Sign
01	**Child Sex**	1 = male; 2 = female	−	+
02	**Child Age**	Increasing Cardinal Values in Kilogram	+	−
03	**Mother's Education**	0 = No Education/Education < class 5; 1 = Education ≥ class 5	+	−
04	**Total Child Illness**	0 = Household with no reported child illness; 1 = Household with reported child illness	−	+
05	**Child Health Index**	0 = Child not deprived in ≥ 2 CHI variables 1 = Child deprived in ≥ 2 CHI variables	−	+
06	**Total Income**	0 = Income > USD 2 or BDT 140 per day; 1 = Income ≤ USD 2 or BDT 140 per day	−	+
07	**Latrine Type**	0 = Sanitary; 1 = Not Sanitary	−	+
08	**Averting Behavior Index**	0 = HH practicing > 3 health safety measures 1 = HH practicing ≤ 3 health safety measures	−	+
09	**Medical Costing Index**	0 = Aware about treatment cost of ≥ 1 illness 1 = Aware about treatment cost of < 1 illness	−	+
10	**Savings**	Cardinal Value when HH has savings; 0 when HH does not have savings	+	−
11	**Mother's Occupation**	0 = Unable to Work; 1 = Day Laborer; 2 = HH Work	+	−
12	**More than One Sibling**	0 = Number of Siblings < 2; 1 = Number of Siblings ≥ 2	***unsure***	***unsure***

Table 23: Independent variable for Econometric estimation

Table 23 presents a list of independent variables selected on the basis of the multidimensional poverty framework and other variables deemed plausible for the estimation. For a more detailed explanation of variables 03 to 10, please see chapter 04. Model 01 has child weight as the dependant variable and model 02 has malnourishment. By virtue of construction, Model 02 is expected to have the opposite signs to those of Model 01.

As suggested by previous studies conducted in this region mentioned in chapter 02, we expect a negative association between sex and child weight; in other words, we expect the female child to have lower weight. Naturally weight is expected to increase with age and hence the positive expected sign.

The next eight variables come from the fourteen indicators selected for multi-dimensional poverty analysis. The variables that were not selected include assets index, land, electricity, cooking fuel, water supply and overcrowded housing. The variables from the Living Standard dimension were rejected on ground of lack of variability. Very few of the households were deprived in access to electricity, cooking fuel and water supply whereas very few were not deprived in terms of overcrowded housing.

The assets index was rejected due to suspected collinearity with income. The reason why the binary of income was chosen over the assets index is because from table 19 we saw that it was a better reflective of child weight. Finally, land was rejected because for the households that owned land, the revenue earned from the land was added to their regular income for total household income which was then turned into the income binary. Therefore, further adding the land variable contains the risk of collinearity and hence was rejected.

Expected signs for variable 03 to 06, and 08, are almost self explanatory and hence I will not go into their elaboration. The type of latrine used was included because an unhygienic latrine could be the contagion for illness and hence a negative association was expected. The rationale for expecting a positive sign with savings is that households who save are assumed to have better family planning abilities and hence provide better care for their child, resulting in higher weight and lower malnourishment. A similar rationale exists for the negative relationship with medical cost index (where, 1 = deprived).

Mother's occupation is also perceived to play an important in the upbringing of a child as it is the mothers who usually manages the family in this region. Mother's occupation was therefore added.

The expected positive association comes from an understanding that mothers who do more household work are able to give more time to the children and this lowers the child malnourishment.

The last interaction variable, more than one sibling, was added based on previous literature finding for other regions which was thought to be also relevant for this study. Chamarbagwala (2011) finds that the number of siblings plays an important role in child health. The expected association for this variable was unsure. A negative association can happen due to limited nutritional resources divided between greater numbers of children. However a rationale for otherwise also exists such that if the sibling is elder, s/he might take better care of the child resulting in a positive relationship.

8.2 Results of Econometric Estimation: Entire Sample

OLS regression for the first model is acceptable because child weight measured in months can be considered as continuous and using ordered logit for the second model is acceptable as it treats the three ordinal values as though they were crudely ranked. The results are presented in table 24.

#	Variable	Model 01 (n=174)		Model 02 (n=174)		
		Coefficient	P-value	Coefficient	Odds Ratio	P-Value
01	**Child Sex**	−1.284	0.000*	0.748	2.113	0.037**
02	**Child Age**	0.170	0.000*	−0.019	0.981	0.036**
03	**Mother's Education**	0.229	0.229	−0.391	0.677	0.084***
04	**Total Child Illness**	−0.128	0.685	0.374	1.453	0.289
05	**Child Health Index**	−1.164	0.000*	1.985	7.280	0.000*
06	**Total Income**	−0.951	0.017**	0.733	2.081	0.106
07	**Latrine Type**	−0.723	0.025**	0.922	2.513	0.017**
08	**Averting Behavior Index**	−0.099	0.755	0.219	1.245	0.540
09	**Medical Costing Index**	−0.723	0.029**	1.396	4.038	0.000*
10	**Savings**	0.00003	0.041**	−0.00005	0.99995	0.091***
11	**Mother's Occupation**	0.287	0.210	−4.505	0.637	0.097***
12	**More than One Sibling**	0.569	0.089***	−1.038	0.354	0.007*
	Constant	7.200	0.000*	-	-	-
		$Prob > F = 0.0000$			$Prob > chi^2 = 0.0000$	
		$Adj. R^2 = 0.754$			$Pseudo. R^2 = 0.2025$	
					* = significant at 1%	
					** = significant at 5%	
					*** = significant at 10%	

Table 24: Determinants of Child Weight and Malnourishment

For both the models, we can see that the coefficient signs match with the expected, noting that the 10th variable, savings, barely makes it. The 12th variable, more than one sibling, whose expectation was unsettled, comes out to have positive association with child weight and negative association with malnourishment. This suggests the possibility that a larger proportion of the 'extra' sibling takes better care of the child resulting in a positive relationship. However this is a bit stretched explanation and a proper breakdown of the siblings is required for confirmation.

In model 01, 8 out of 12 variables are significant at the 10% (or better) significance level whereas in model 02, 9 out of 12 variables are significant, while total income is not significant by a small margin. This suggests that model 02 is a better estimate of malnourishment.

It is interesting that in model 02, mother's education and occupation, both are significant in reducing malnourishment, suggesting that educated people are more aware of the risks of poor health and hence are keener to look for ways to adapt to it, but the variables are not significant for reducing child weight in model 01. A possible explanation could be that the educated mothers' reduce malnourishment at the margin; that is they work towards reducing more of severe malnourishment and less of moderate malnourishment. Another aspect could simply be that the education that the mothers' *had* received was not adequate enough for playing a role in reducing anti-female sex bias. This is controversial, but if such is the case for our study population, the social environment induced household behavior possibly plays a bigger role in reducing malnourishment than simply mothers' past education alone[6].

Two variables that are consistently insignificant are total child illness and averting behavior index, although their signs are consistent with the expectation. The fact that a regression analysis holds all other variables constant, except the variable in focus, can be used to explain this. The results essentially says that simply practicing averting behavior does not necessarily reduce malnourishment; similarly, simply being ill does not reduce malnourishment. Other factors such as vaccination and availability of disposable income for treatment are also involved.

While we cannot interpret the coefficients of the ordered logistic regression directly, we can however do so for the OLS regression. Thus when child health index increases by one, which means when it moves from being not deprived to being deprived, child weight falls by 1.164 kilograms.

[6] This does not in any way lower the importance of present-day education provision nor deems it as ineffective.

Similar interpretation extends to the rest of the variables. Thus the top five significant independent variables with largest effect on child weight are as follows: (1) Sex of the Child, (2) Child Health Index, (3) Income Standing, (4) Medical Costing Index, and (5) Type of Latrine Used.

It is somewhat surprising that for our study sample, the medical costing index and type of latrine play a more important role in child weight reduction than averting behavior index or even total child illness. A unit increase towards deprivation for both the variables lowers child weight by 0.723 kilogram. The significance of medical costing index playing such an important role emphasizes the importance of proper family planning in Korail for better up keeping of the children.

Interpreting model 02 directly through the odds ratio is a bit more complicated. Taking the sex of the child as an example, for one unit increase in child sex (that is, from male to female), the odds (or chances) of severe malnourishment versus the odds of combined moderate malnourishment and normal growth categories is 2.113 times greater. Likewise, the odds of the combined categories of severe and moderate malnourishment versus the odds of normal growth are 2.113 times greater (Ordered Logistic Regression, 2011). In other words if the child is a girl, the probability of malnourishment significantly increases.

Interpreting the role of mothers' education in a similar fashion, for one unit increase in mothers' education, the odds (or chances) of severe malnourishment versus the odds of combined moderate malnourishment and normal growth categories is 0.677 times *lower*. Likewise, the odds of the combined categories of severe and moderate malnourishment versus the odds of normal growth are 0.677 times lower. Thus mother's education significantly reduces malnourishment.

The top five independent variables with largest effect on child malnourishment are as follows: (1) Child Health Index, (2) Medical Costing Index, (3) Sex of the Child, (4) Type of Latrine Used, and (5) Income Standing (this variable is not significant by the margin). Note that even though the order is not the same, the same five variables are also in the 'top five' list for model 01.

Another advantage of ordered logit is that it lets you compute predicted probabilities of the dependent variable for each of the independent variables. Table 25 below provides this information. The deprived status for each of the independent variable is highlighted in grey. Interpretation of the table is as follows: if the child is a male then the probability of the child experiencing severe malnourishment is 42.8%, moderate malnourishment is 22.6%, and normal growth is 34.5%.

For all of the deprived cases the probability of being malnourished is greater compared to that of the not deprived status, except for total income. In case of total income, the two probabilities are almost equal (51% and 50.8%) while those with income ≤ USD 2 or BDT 140 per day do have a lower probability of being moderately malnourished.

#	Independent Variable	Variable Status	Dependent Variable Predicted Probability		
			Normal Growth	Moderately Malnourished	Severely Malnourished
01	Child Sex	Male	34.5	22.6	42.9
		Female	22.7	18.5	56.2
02	Child Age	Age > 30 moths	33.8	20.6	45.6
		Age ≤ 30 months	23.3	20.5	56.2
03	Mother's Education	Education ≥ class 5	32.2	21.1	46.7
		No Education/Education < class 5	24.6	20.3	55.1
04	Total Child Illness	Household with no reported child illness	28.7	21.1	50.1
		Household with reported child illness	28.3	19.7	52.0
05	Child Health Index	Child not deprived in ≥ 2 CHI variables	39.2	24.1	36.6
		Child deprived in ≥ 2 CHI variables	11.0	14.6	74.4
06	Total Income	Income > USD 2 or BDT 140 per day	28.4	20.7	51.0
		Income ≤ USD 2 or BDT 140 per day	29.3	19.9	50.8
07	Latrine Type	Sanitary	36.6	22.8	40.6
		Not Sanitary	14.3	16.6	69.1
08	Averting Behavior Index	HH practicing > 3 health safety measures	32.5	22.2	45.3
		HH practicing ≤ 3 health safety measures	23.6	18.5	57.8
09	Medical Costing Index	Aware about treatment cost of ≥ 1 illness	41.1	21.6	37.3
		Aware about treatment cost of < 1 illness	21.4	19.9	58.6
10	Savings	HH has savings;	32.3	20.4	47.3
		HH does not have savings	27.5	20.6	52.0
11	Mother's Occupation	Unable to Work;	27.7	19.4	52.9
		Day Laborer	14.2	15.7	65.1
		HH Work	31.0	21.6	47.4
12	More than One Sibling	Number of Siblings < 2	28.1	19.7	52.2
		Number of Siblings ≥ 2	29.0	21.4	49.6

Table 25: Predicted Probabilities of Levels of Malnourishment from Ordered Logistic Regression

Note that for the child health index, latrine type and medical costing index, the probability reduction in malnourishment (>20%) and increase in normal growth (>19%) is largest when moving from a deprived state to a non-deprived state, indicating the importance of these variables.

8.3 Results of Gender Specific Econometric Estimation

The final exercise of this study involves running econometric estimations for male and female children separately. As the ordered logit model contained more significant variables, the following analysis is done using model 02 only. Since we are only looking at the association of the independent variables with the dependent, only the signs of coefficients along with their levels of significance are presented in table 26 below.

#	Variable	Entire Sample (n=174)	Male Children (n=86)	Female Children (n=88)
		Coefficient	Coefficient	Coefficient
01	**Child Sex**	+**	**(dropped)**	
02	**Child Age**	−**	−*	+
03	**Mother's Education**	−***	−***	−
04	**Total Child Illness**	+	+	+
05	**Child Health Index**	+*	+*	+*
06	**Total Income**	+	+	+
07	**Latrine Type**	+**	+**	+
08	**Averting Behavior Index**	+	−	+**
09	**Medical Costing Index**	+*	+*	+***
10	**Savings**	−***	−***	−
11	**Mother's Occupation**	−***	−	−
12	**More than One Sibling**	−*	−	−**
		$Prob > chi^2 = 0.0000$ $Pseudo\ R^2 = 0.2025$	$Prob > chi^2 = 0.0000$ $Pseudo\ R^2 = 0.2533$	$Prob > chi^2 = 0.0001$ $Pseudo\ R^2 = 0.2308$
				* = significant at 1% ** = significant at 5% *** = significant at 10%

Table 26: Gender Specific Ordered Logistic Regression Outcome

The male children regression has 7 out of 11 variables significant while the female children regression has only 4 out of 11 variables significant. Even though 10 of the variables for both genders maintain the same sign as the total regression, one of the variables change their sign, although

insignificantly, in each case. Thus variables can affect separate genders differently. The altered signs are displayed in grey in table 26.

It is interesting that we see a positive association between child age and undernourishment for the female regression group. This does have economic significance that female children have a higher probability of suffering malnourishment whereas male children do not. This hints towards the existence of anti-female sex bias but the result is not conclusive due to its statistical insignificance.

Although the negative association with deprivation in mother's education is significant for the male children, it is not significant for the female children. This finding correlates to the findings in table 10 that mothers' education does not play a role in reducing sex bias for our study population. Possible explanations for this are the same as discussed for mothers' education under section 8.2.

What is surprising is that averting behavior index has a negative association with the male children. Despite being statistically insignificant, malnourishment decreasing with more deprivation in averting behavior is difficult to explain. One possibility could be that instead of better health practices, these households invest more time in reducing malnourishment through some other means not caught by this model. The other possibility could simply be that the first cutoff, z, that households practicing $\leq$ 3 health safety measures are considered deprived, used for creating the averting behavior index was not appropriate for the male children. This, of course requires further investigation.

Also note that averting behavior is statistically significant against malnourishment for the female children even though this is not the case when the sample is taken as a whole or for the male children. This implies that deprivation in averting behavior plays a key role in increasing malnourishment for the female children. Finally observe that although the income standing of the family matters such that a positive association has been found for all three cases, neither of them is statistically significant. This implies that even though household income is important, it is not the sole neither the prime attribute in reducing malnourishment.

Chapter 09: Conclusion and Policy Recommendations

This study has taken a holistic approach in identifying the determinants of malnourishment and anti-female sex bias in the Korail slum settlement in Dhaka. With increasing incidence of diarrhea along with low immunization and vaccination coverage, it is important to understand the malnourishment scenario in the area (Alam, 2009; Tawfik, Hoque & Siddiqi, 2001). Sex bias is a huge impediment to development and empowerment in many developing countries and its determinants vary with region. This study has found the presence of anti-female sex bias along with attributes involved in reducing its incidence in Korail. The findings thus have important policy implications in terms of relevant development activities and allocation of resources.

Incidence of poverty and lower welfare is seen to have increased as we moved further away from the embankment towards the inside of Korail. Remarkably high incidence of undernourishment, even of the severe type has been found to exist in the region. Significant systemic sex bias is reflected through higher deprivation of female children vis-à-vis male children within each of the study locations. Similar results were also found when compared through multi-dimensional poverty measures. The study also established that the Alkire-Foster adjusted headcount measure is a better estimate for malnourishment. In other words, a multi-dimensional holistic approach should be taken when evaluating the poverty scenario of this region.

Anti-female sex differential is also confirmed in terms of expenditure for treatment both for all children and for children under the age of 5, translating to higher cases of malnourishment. Furthermore, in the multidimensional poverty analysis, incidence of female child illness was higher than that of the male. Thus a policy where treatment of female children is subsidized in the region can help reduce the sex differential and subsequently malnourishment.

Although mother's education played a role in significantly reducing malnourishment for the population as a whole, it did not reduce anti-female sex bias. Rather, behavioral attributes such as those in the averting behavior index, and public health responses such as those included in the child health index reduced anti-female sex bias. Therefore, if reduction in anti-female sex bias is a prime

focus of a policy, development initiatives should focus in improving the public health measures in the region.[7]

In addition to child health index and averting behavior, deprivation in apt knowledge regarding medical costing was also seen to play a role in having a higher probability of malnourishment, suggesting that such information is crucial for better family planning. A similar effect was seen for the households deprived in the habit of saving, implying that households that have developed the habit of saving are better family planners. Although household income was deemed important, it was seen that it did not have the most significant effect compared to other behavior related indicators. On the other hand, both the multi-dimensional poverty analysis and econometric analysis found that type of latrine used has a significant impact on malnourishment, as also identified by Roche (2010). Thus improvements in these sectors are crucial for reduction in malnourishment.

One of the key points of the findings is that it is impervious that we start taking holistic and multi-dimensional approaches to understand poverty, malnourishment and sex bias. While such an aggregate measure is important, the ability to decompose and understand individual contribution is also important, as the findings of this paper reflect. This has been the main approach to malnourishment and sex bias analysis in this study.

[7] Note once again that this does not provide any statement regarding present-day education provision. Although this does emphasize the need for translation of "formal" education to real life scenario, such that present day education can significantly contribute to reducing sex bias.

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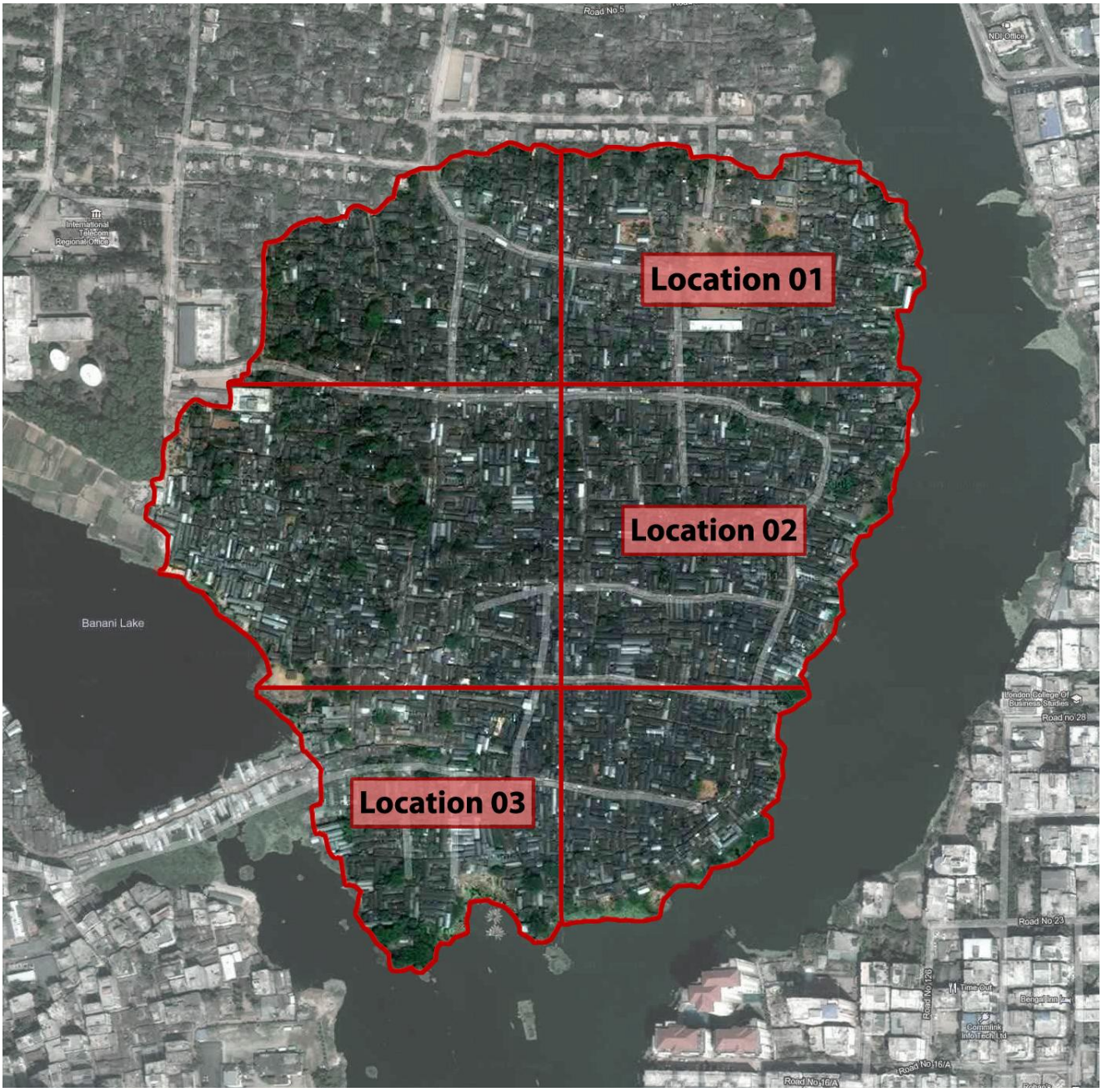
Appendix I: Map of the Study Area



Appendix II: Questionnaire

Please find the Questionnaire attached in the following pages

Questionnaire Number:

Malnourishment and Sex Bias in Multidimensional Child Poverty

ESS, BRAC University

Greetings! We are conducting a survey on behalf of Department of Economics and Social Sciences, BRAC University on malnourishment and sex bias in multidimensional child poverty. This research is solely for academic purposes and all your responses will remain confidential. We will be extremely grateful if you agree to collaborate with us and give some of your time to answer a set of questions we have. The questions are designed to help us understand the wellbeing of your family. We thank you and eagerly hope for your co-operation.

Instructions for enumerators:

- Survey **5 households** from the settlement
- Interview **only** households with children less than 5 years of age
- Interview **both** the household male and female
- The interview can go on for **35-45 minutes max.**
- Write all codes in **English**
- Where appropriate, **0 = no; 1 = yes**.

Identification:

Name of Respondent: ……..

Location: 01 / 02 / 03

By the Lake: Yes No

Mobile Number: ……..

Enumerator's Information:

Name: ……

Date: 11th February, 2011

Starting Time: ……..

Ending Time: ……

Signature: ……

Cross Checked by:

Name: ……

Date: ……..

Signature: ……..

Part 01: General Household Information

1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Member ID	**Name**	**Position in House-hold (HH)** (See Code)	**Sex** (1=Male; 2=Female)	**Age** (in months for children)	**Weight** (of children only; in kgs)	**Did your child receive Measles (Haam) Immunization?**	**Did your child take Vitamin A tablet within the last 6 months?**	**Highest Education Level** (See Code)	**Main Occupation**
M1									
M2									
M3 (child)									
M4 (child)									
M5 (child)									
M6 (child)									

Relationship with HH Head (1.3):	Highest Education Level (1.9):	Occupation (1.10):
1 = HH Head 2 = Spouse 3 = Son/Daughter	0 = No Education 1 = Below Class 5 5 = Below SSC but more than Class 5 10 = SSC 11 = HSC 12 = BA or equivalent	1 = Student 2 = Household Work 3 = Agriculture/Farming/Fishing 4 = Day Laborer 5 = Business 6 = Skilled Worker (carpenter/blacksmith/mechanic/RMG etc.) 7 = Unable to Work/Unemployed (Others = please specify)

1.11 Do you use iodized salt in your cooking?	
1.12 How many of you live in the same room in your household?	
1.13 How many hours per day are you and your partner away from your child?	

Part 02: Household Income, Expenditure and Assets

2.1 What is the monthly average, highest and lowest income of the household in the last year?					
Average Monthly Income (in taka)		**Highest Monthly Income (in taka)**		**Lowest Monthly Income (in taka)**	

2.2 What is the monthly average, highest and lowest expenditure of the household in the last year?					
Average Monthly Expenditure (in taka)		**Highest Monthly Expenditure (in taka)**		**Lowest Monthly Expenditure (in taka)**	

2.3 Does the household have the following assets? If yes, how much are they worth? (0 = does not own, else = value in BDT)

#	Asset	BDT	#	Asset	BDT
1	Electricity		8	Almira/ Alna	
2	Radio		9	Chair/ Table	
3	Mobile		10	Fishing Net	
4	Cycle		11	Sewing Machine	
5	Boat		12	Cow/ Ox	
6	Rickshaw/Van		13	Goat	
7	Bedding		14	Hen/ Duck	
15	Any Other (Please Specify with BDT):				

2.4 Do you own any land in your village (or anywhere) outside of the slums? (0 = does not own, else = amount of land)

Type of Land	Arable Land	Non Arable Land	Lease/ Mortgage to Others
Amount of Land (in decimal/*shothangsho*)			

2.5 Do you have any sort of income per month/per year from the land you own?	
If yes, how much (in taka)**?**	

Part 03: Health Averting Behavior

	3.1	3.2	3.3	3.4	3.5	3.6
	From where do you fetch your drinking water? (see code)	**Do you boil the water before drinking?** (see code)	**What is the source of water that you use to wash dishes and clothes?** (see code)	**Do you wash your hands with soap before eating?** (see code)	**What type of latrine does your household use?** (see code)	**Do you wash your hands with soap after using the latrine?** (see code)
3.7	**3.8**	**3.9**	**3.10**	**3.11**	**3.12**	
From where do you fetch the water you use to take your showers? (see code)	**(if 1 to Q4.8) Do you or any of your neighbors wash cattle in the same pond?** (see code)	**Do you regularly clean and cut your nails?** (see code)	**Do you regularly brush your teeth?** (see code)	**Do you have gas connection in your house?** (see code)	**Is there any stagnant water around your household?** (see code)	

Code:							
	3.1: 1 = tube well 2 = pond 3 = well 4 = WASA Other = (please specify)	3.2: 0 = no 1 = yes	3.3: 1 = tube oil 2 = pond 3 = well 4 = WASA Other = (please specify)	3.4: 1 = yes 2 = yes, but do not use soap 3 = sometimes 0 = no	3.5: 1 = Open field 2 = *Kacha* 3 = Sanitary	3.6: 1 = yes 2 = yes, but do not use soap 3 = sometimes 0 = no	3.7: 1 = pond 2 = use water from tube well 3 = WASA Other = (please specify)
3.8: 1 = yes 2 = maybe 0 = no	3.9: 1 = yes 2 = not regularly 0 = no	3.10: 1 = yes using toothpaste 2 = yes using toothpowder 3 = not regularly 0 = no	3.11: 1 = yes 2 = not regularly 0 = no	3.12: 1 = yes 2 = sometimes 0 = no	3.13: 1 = yes 2 = I do not know 0 = no		

Part 04: Medical Information

	4.1		4.2	4.3
Member	**Did you or your household members suffer from any major illness in the past year?** (0 = no; 1 = yes)	**Which household member** (please match with member ID in 1.1)	**If yes to 4.1, what was it?** **(see code)**	**How much money was spent for the treatment?** **(in taka)**
I1				
I2				
I3				
I4				

	4.4	4.5
Member	**What was your main source of money to pay for the treatment?** **(see code)**	**How many work days were lost due to the illness?** **(in days)**
I1		
I2		
I3		
I4		

4.2 (do not count mild cases of fever and diarrhea):	4.4:
1 = Diarrhea 2 = Malaria 3 = High Fever 4 = Dengue 5 = Tuberculosis 6 = Jaundice 7 = Eye Disease 8 = Heart Disease 9 = Typhoid 10 = Cancer 11 = Asthma 12 = Gastric ulcer 14 = Cholera 15 = Measles Other = (Please Specify)	1 = Family Income 2 = Savings 3 = Loan from relative 4 = Loan from Moneylender 5 = Loan from NGO 6 = Sale of Property 7 = Insurance 8 = Govt. expense Other = (Please Specify)

Part 05: Loan and Savings Status

#	5.1 **Do you have any outstanding loans?** (1=Yes, 0=No)	5.2 **If yes to 6.6, with whom?** (see code)	5.3 **If yes to 6.6, what was the original amount of the loan taken?** (in taka)	5.4 **When was your last loan taken?** (see code)	5.5 **Did you ever take loans for covering health/medical expenses?** (see code)	5.6 **If yes to 6.10, from whom?** (see code)
L1						
L2						
L3						

Code:

5.2 & 5.6:	5.4:	5.5:
1 = BRAC 2 = Grameen 3 = Asha 4 = Proshika 5 = Sajida Foundation 6 = CARE 7 = Other NGO 8 = Public Bank 9 = Money-lender 10 = Shop-keeper 11 = Friend/Neighbor 12 = Relative Other = Please Specify	0 = Never took a loan 1 = Within last 1 year 2 = Within last 2 years 3 = Within last 3 years 4 = Within last 4 years 5 = Within last 5 years 6 = More than 5 years ago	1 = Yes, only once 2 = Yes, more than once 0 = No

#	5.7 **Do you have any savings?** (1=Yes, 0=No)	5.8 **If yes to 6.12, what is the cumulative amount of your savings?** (in taka)	5.9 **For how long do you have the habit of saving?** (number of months)	5.10 **Did you ever take out your savings for covering health/medical expenses?** (1=Yes, 0=No)	5.11 **If 1 in 6.16, by what amount?** (in taka)
S1					
S2					
S3					

Part 06: Awareness of Households

6.1 Do you have an idea of how much it costs for the treatment of the following diseases? (if No=0, if Yes write amount in taka, if free=99)				
Diarrhea	**Typhoid**	**Dengue**	**Jaundice**	**Cholera**

That is the end of the questionnaire. Thank you for taking part in the survey.

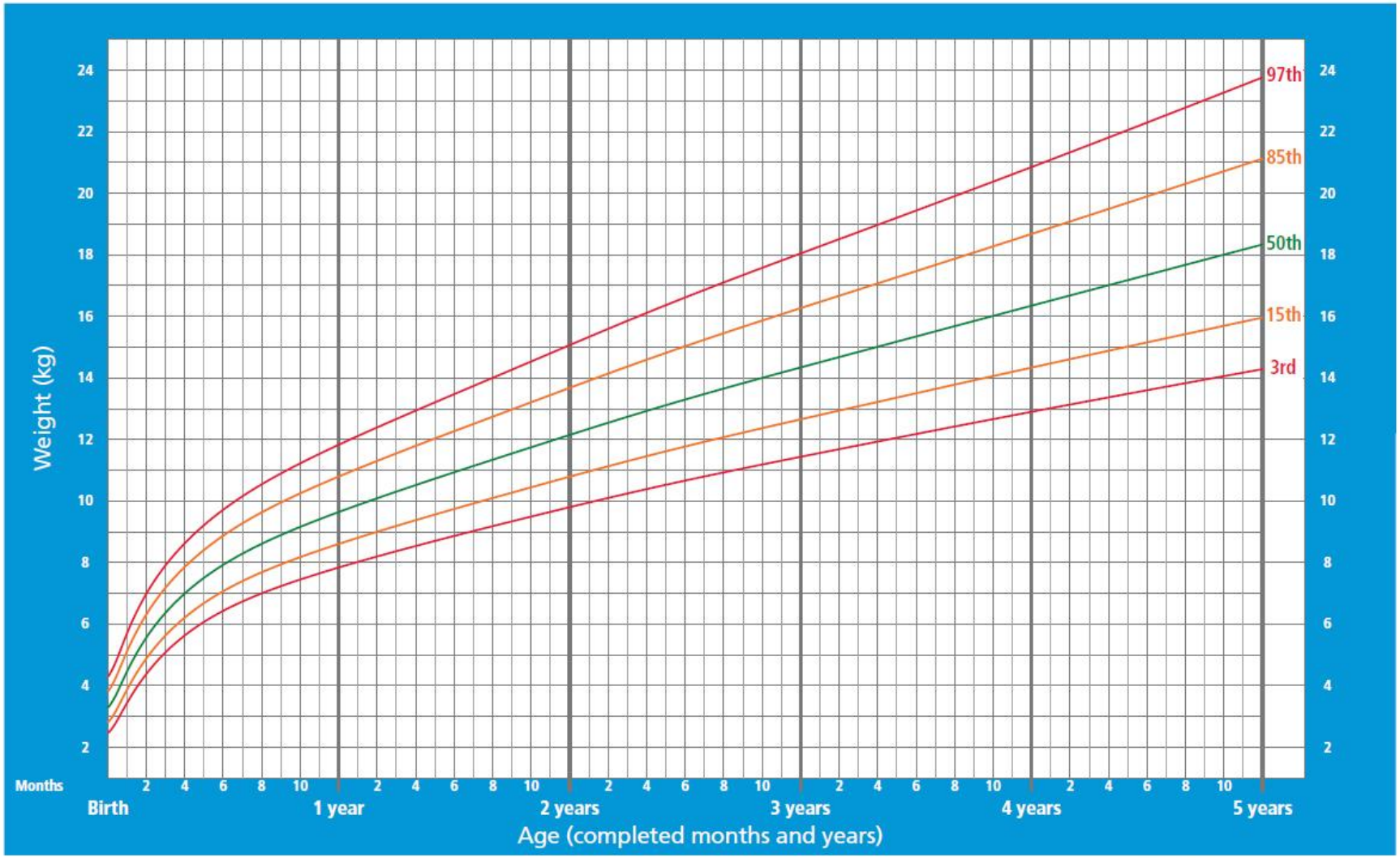
Appendix II: Growth Charts

Please find the Growth Charts attached in the following pages

Weight-for-age BOYS

Birth to 5 years (percentiles)

World Health Organization

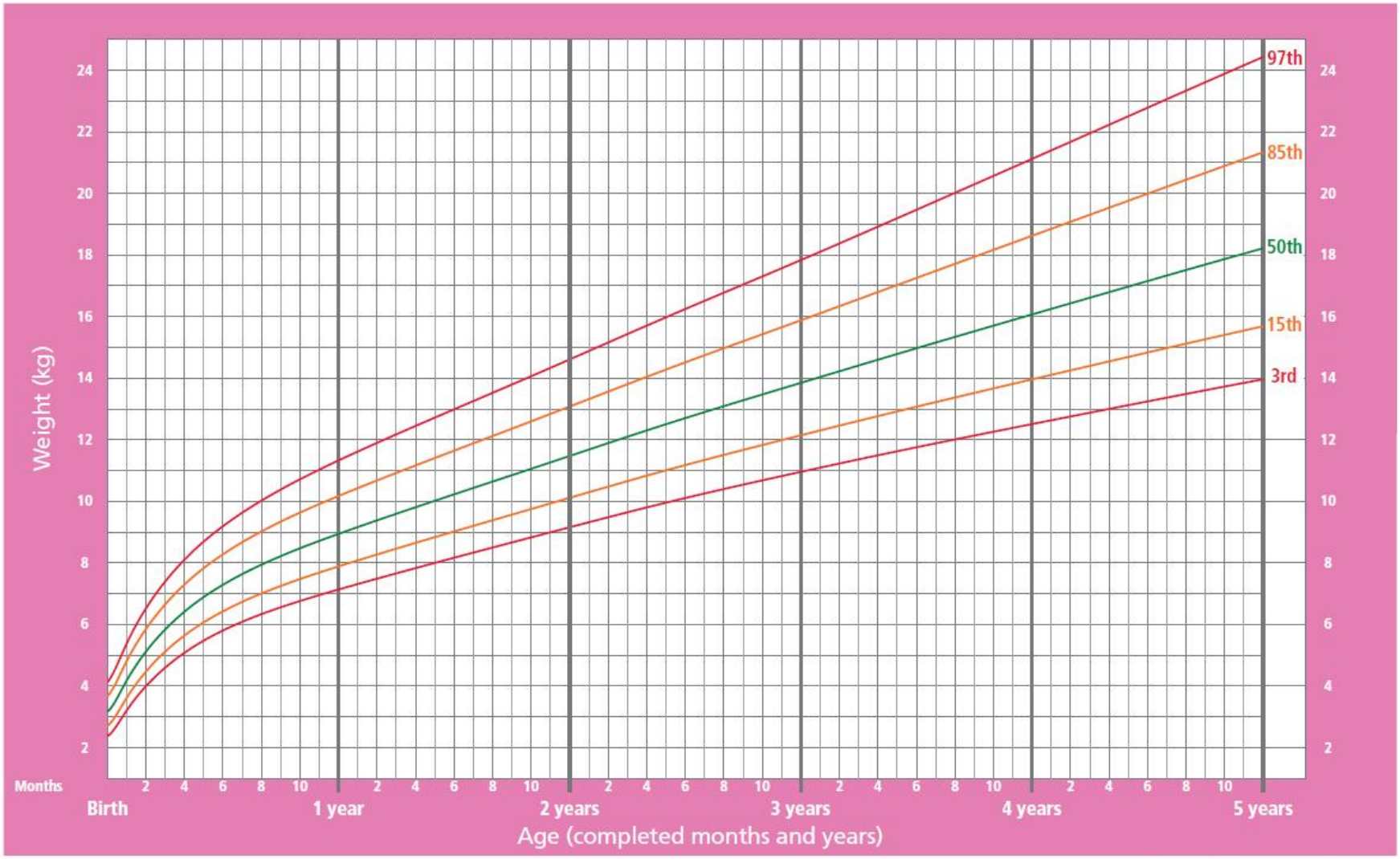


WHO Child Growth Standards

Weight-for-age GIRLS

Birth to 5 years (percentiles)

World Health Organization



WHO Child Growth Standards