DISAPPEARING SEX-BIAS IN CHILD HEALTH IN BANGLADESH*

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ABSTRACT

We examine the nutritional status of children in Matlab, Bangladesh using data from the 1996 Matlab Health and Socioeconomic Survey and find sharp declines in severe wasting, and a near disappearance of previously reported sex disparities. Remaining disparities appear to be based primarily on available household resources and competition for those resources. Declines in moderately and severely wasted children are observed with increases in household income and for children whose mother has some education. Further, maternal contribution to income is found to decrease severe wasting. Birth order effects demonstrate that the presence of older siblings increases the chance of wasting, but for severe wasting the effect declines sharply by age of the child. Other family composition variables that in the past have predicted greater wasting are no longer significant; the only remaining significant effect is protective—girls aged 5-9 are less wasted if they have at least one older sister.

DISAPPEARING SEX-BIAS IN CHILD HEALTH IN BANGLADESH

The health and survival of children often is viewed as a mirror on the health of their society and on that society's ability to protect and promote the wellbeing of its vulnerable members. In most countries, females are advantaged over males in survival. In those populations in which male life expectancy exceeds that of females; the differential usually is attributed to discrimination against girls and women and to the low social standing of mothers and their lack of power within the household (DeRose, Das, and Millman 2000; Kahn 2002; Winikoff 1988). The female disadvantage in Bangladesh starts in childhood and was documented in the late 1970's and early 1980's in the higher proportion malnourished of girls aged 1-4 compared to boys (Chen et al. 1981; Bairagi 1986) and in the higher mortality risks of girls (Shaikh et al. 1985). Das Gupta (1987) suggested that not all girls in South Asia are at higher risks. She established, for the Punjab, that only girls with older sisters experienced higher mortality. Muhuri and Preston (1991) and Muhuri and Menken (1997) found a similar, but more complex pattern associated with family composition and the arrival of the next child. Yet, improvements in child survival have occurred in Bangladesh, dramatically so for children aged 1-4 (Table 1). Mortality for boys in this age group dropped from 22/1000 to 7/1000 children. The rate declined even more for girls, from 37/1000 to 7/1000. Children aged 5-9 followed a similar pattern, but from a much lower base, while there was little change for children 10-14. The gap in life expectancy at birth also has diminished, with males retaining only a small advantage (Mostafa et al. 1998).

It therefore is appropriate to examine whether the differentials found earlier for children persist or have shifted over time. In this paper, we study nutritional status rather than mortality for several reasons. Mortality has declined so much that extremely large samples of children would be needed to detect differentials. Second, understanding differentials in nutritional status and therefore health short of mortality may lead to intervention programs to promote child health. Third, appropriate data are available from the 1996 Matlab Health and Socioeconomic Survey (MHSS), which collected information on nutritional status of nearly 5000 children aged 1-14, along with data on family composition and socioeconomic status of the household. Concern for child health was one of the motivations for this survey.

Background

Additional research in South Asia has found that girls with older sisters had significantly higher mortality than those with only surviving older brothers or no older siblings (Amin 1990) and higher age-specific death rates than others at every age interval from 0-34 (Arnold et al. 1998). Other factors such as low income, lack of maternal education, inadequate health care use, and large family size were also associated with higher mortality risks (Muhuri and Preston 1991; Das Gupta 1987; D'Souza and Chen 1980). But girls' excess mortality risks transcended socioeconomic status (Muhuri and Preston 1991; Das Gupta 1987). More recent studies continue to find selective neglect of girls based on certain sex and birth-order combinations. Pande (2003) recently found that both boys and girls in India with two or more surviving siblings of the same sex were worse off in terms of severe stunting and incomplete immunization. By contrast, Madise, Matthews and Margetts (1999) found evidence that girls were better nourished than boys in six African countries. A United Nations (1998) report offered evidence from 52 countries to support the conclusion that while "systematic neglect of girls in terms of diet and domestic care is uncommon," girls are most severely disadvantaged in South-central Asia. This report also points out that female disadvantage based on behavioral factors often is masked by biological factors that favor girls.

Some family structure characteristics that have been found to correlate positively with the health of children include currently married status of the mother in Africa (Desai 1992) and education and economic empowerment of mothers (Kahn 2002). Hill and Upchurch (1995), using Demographic and Health Survey data in 35 countries, found “a pervasive pattern of girl disadvantage” that is associated with the low social status of women.

In order to address the relationship of sex, socioeconomic status of parents and household, and family composition on the nutritional status of children, we consider the following questions:

Does sex bias in nutrition persist despite improvements in child mortality?

We analyze the nutritional status of all children aged 1-14, subdivided into the usual age categories 1-4, 5-9, and 10-14. Nutritional status is defined using weight-for-age (wasting). We consider both severe and moderate wasting since moderate malnutrition is found to compromise the immune system and increase the rate of infection (Moore et. al. 1999; Martorell and Ho 1984) and lead to higher mortality (Pelletier, Frongillo &Habicht 1993).

Does maternal empowerment mitigate sex-bias in the nutritional status of children?

In this study we consider maternal education as a measure not only of knowledge, but of empowerment. The powerful positive effects of maternal education on child health in developing countries are well documented (Muhuri 1995; Bicego and Boerma 1993; Mosley & Chen 1984; Ware 1984). LeVine et al. (1991) explored the mechanisms in education that improve child health, and found that “women’s attendance at school initiates a cumulative process over the generations that contributes to the demographic transition.” Ware (1984) suggested exploring intervening variables between maternal education and child health such as use of medical facilities, infant feeding practices, mothers' economic activities and cultural sex preference. Sandiford, Cassel, Montenegro and Sanchez (1995) found that education plays a positive role in child health and survival, independent of other social and economic advantages, including physical access to medical care.

We also examine father's education as a measure of socioeconomic status and for contrast with the relationship of maternal education to child health.

Does access to health care mitigate sex differences in nutritional status of children?

As will be described below, ICDDR,B: The International Centre for Health and Population Research, has for many years provided a Maternal and Child Health and Family Planning Program (MCH-FP) in approximately half of the area in which the MHSS was fielded. Fertility dropped more quickly in the MCH-FP area than in the remaining, or comparison, area, so family sizes are smaller (van Ginneken et al 1998). Furthermore, mortality declines among children are more pronounced in the MCH-FP program area than in other parts of Matlab, declines that can be attributed in part to the effects of prolonged birth spacing and health care access (Muhuri and Menken 1997), disease treatment (van Ginneken et al. 1998), and reduced fertility (Legrand et al. 1996).

Pelletier (1998) reviewed studies in Bangladesh and reported that most find a weaker association between nutritional status and mortality of males compared to females, strongly suggesting males receive better health care. The presence of the MCH-FP program means more equal access to health care for boys and girls that does not rely on parents to bring their children for treatment, instead providing home visits. Thus if sex differences depend on access to care, they should be lower in the MCH-FP area.

Are levels and sex differentials in malnutrition related to economic status of the household?

Many studies have documented the role of economic status in the provision of adequate food and health care of children. In this study we include, in addition to household income, a measure of the economic contribution of the mother. This latter measure may be considered an empowerment measure as well, since women who contribution more to the economic welfare of the household may have more decision-making power and may allocate resources to children differently than they would--or could--otherwise.

Does family structure contribute to sex-bias in nutrition?

Data from Indonesia, another Muslim country in South Asia, suggest that older males in a household may be protected from famine at the expense of younger siblings in the household (Thomas, Frankenberg, Beegle and Teruel 1999), making the presence of older male siblings in the household an important consideration. However, Foster (1995) finds no sex effect for malnutrition in the famine following severe flooding in Bangladesh in 1988. Yet sex biases in food and other resource allocation may remain. We consider the same measures of composition of the sibling set used by Muhuri and Preston (1991) and Muhuri and Menken (1997) as well as birth order and the number of younger siblings who may be competing for resources.

Setting, Data, and Methods

Setting

The population under study comes from rural Bangladesh, a society where environmental hazards are high and community health and educational infrastructure is poorly developed. The overwhelming majority of older individuals live with adult children (mostly sons) and alternative sources of support--financial and otherwise--outside the family are scarce. Per capita income is $370/year. The predominant occupation for rural males is agriculture, with labor force participation rates remaining very high even for older males. Women largely are restricted by convention to activities within the home with relatively little opportunity to venture outside the homestead. Given the high level of poverty and the scarcity of health providers (4071 persons/physician, 17446 persons/registered nurse), contact with the formal health care system is thought to be relatively infrequent.

The Matlab Health and Socioeconomic Survey (MHSS) is a large-scale survey of adult health that was conducted in a rural area of Bangladesh in 1996. It is a multistage, multisample household survey. The bari sample that we use collected information from over 11,000 individuals aged 15 and over and nearly 5000 children aged 1-14 in 4,538 households. .

While designed for comparability to similar nationally representative family life surveys such as the Indonesian and Malaysian Family Life Surveys (IFLS, MFLS), the MHSS eschewed a nationally representative sample in favor of a sample based entirely in Matlab, where the ICDDR,B has operated the Demographic Surveillance System (DSS) since 1966 (Rahman, Menken, Foster, Peterson et al, 1999). Matlab DSS data have been used extensively in the demographic literature and the DSS is considered to be one of the few high quality (i.e., complete, accurate and up-to-date) demographic data sources in the developing world (Fauveau 1994). In particular, age reporting is considered to be highly accurate, a feature not found in other South Asian data sources (Menken and Phillips, 1990).

Sampling

The multi-stage MHSS sampling was conducted as follows (Rahman, Menken, Foster, Peterson et al, 1999). The Matlab surveillance area consists of 8640 baris or residential compounds, of which roughly one third (31.1%) or 2687 baris were randomly sampled. The bari is the basic unit of social organization in rural Bangladesh and in Matlab in particular (Aziz, 1979; Makhlisur Rahman, 1986). Baris usually consist of a cluster of households linked in many instances in a kin network; note, however, that about 16% of baris consist only of a single household and even in multi-household baris, kin networks may exist only for sub-clusters of households. Sampling baris rather than households provides a better representation of family networks, a major focus of the MHSS survey. Within each bari, up to two households were selected for detailed interviews. Within each selected household, two children were selected at random for further data collection.

For baris with two or fewer households, all households were chosen. For baris with more than two households, the first household was chosen at random; the second household was selected from the bari in order of preference as follows: (i) the household of the father and/or mother of the head of the first sampled household; (ii) a household containing a son of the head of the first sampled household (chosen at random if there are multiple sons in separate households in the bari); (iii) a household containing a brother of the head of the first sampled household (chosen at random if there are multiple brothers in separate households in the bari) and (iv) a second randomly selected household.

Probability weights are available for each individual included in the bari sample.

Variables

Weight and height (or length of the very young) were measured for a subsample of all children in the MHSS. Malnutrition is used to measure a child's nutritional status and as a proxy for poor health, short of death. Numerous studies have established the relationship between malnutrition and death in Matlab (Bhuiya 1989). Although poor nutrition is a leading cause of increased overall mortality (Fauveau and Briend in Fauveau 1994), studies suggest that the most significant cause of *differentials* in mortality rates is access to health care (Chen, Huq, & D'Souza 1981), which is controlled by parents.

Therefore, the nutrition of children in Matlab will be examined to determine which children (if any) are selectively discriminated against. The World Health Organization (WHO 1997) has endorsed a nutritional standard for developing countries that classifies a child as wasted if weight-for-age is more than two standard deviations below the mean in the comparison standards. We use an earlier standard, which is derived from the same data on US children used in the WHO standard. A child with weight-for age less than 60% of the median in the standard is classified as severely wasted, while one with weight-for-age less than 80% of the median is considered moderately wasted (see Table 2). We use the earlier standard for several reasons. First, we wish to compare the nutritional status of Bangladeshi children today with those studied by Chen et al. (1981) and Bairagi (1986), who used the older standard. Second, the weight-for age data for Bangladeshi children is severely negatively skewed. In this situation, a standard based on the mean fails to provide adequate nutritional distinction; over one-third of the children under study would be considered severely wasted under this standard. Finally, the standardized weights are based on children in the United States, where over-nutrition might be expected to positively skew weight and height data. This situation creates fall-off from the standard that likely is the result not of poor nutrition in Bangladesh, but rather of an improper standard of comparison. Fall-off is particularly acute in adolescence, and children over the age of 10 in developing countries may be misclassified as wasted based on this standard. Many scholars have called for an international standard appropriate for comparison in developing countries, and this paper provides additional support for the need for an appropriate nutritional standard for children in developing countries.

Table 3 provides information on the distribution of some predictor variables. Maternal and paternal education are included as categorical variables in which the higher category was some, as opposed, to no schooling. Maternal age is used to test whether nutritional status of children varied according to whether the mother was older or younger--such variation could result from the differential status of the mother with age, cohort changes in childrearing practices, or biological effects of maternal age at the birth of the child. Residence in the area in which the MCH-FP program operated also is indicated by a dummy variable. Differences in treatment that might persist despite the availability of services are considered using interaction effects for girls in the MCH-FP area. A measure of household income for the year prior to the MHSS was prepared by Randall Kuhn and Nizam Khan (2004) to account for income from a variety of sources considered in the MHSS; it is reported in 1000 taka units (1000 taka ~$16). Maternal income contribution is considered high if the mother contributed more than 1000 taka in that period, medium, if she contributed over 300 but less than 1000 taka, low if she made a contribution but it was less than 300 taka, or no contribution. Household size simply is the total number of persons resident in the household. Family composition variables considered include the total number of children and the number of male children in the household, birth order, the presence of older siblings in various combinations, and the number of younger siblings. Following Muhuri and Menken (1997), we considered combinations of 0, 1, and 2+ older brothers and 0, 1, and 2+ older sisters. While we modeled the effects of all of possible combinations with sex of the index child, only those identified by Muhuri and Menken (1997) as factors contributing to high mortality risk--boys with two older brothers, girls with an older sister, or second children with an older brother--remain in the final models in order to be able to fairly compare results to the previous work. The distributions of these variables for children aged 1-4 is shown in Table 4 along with the comparable distributions given by Muhuri and Menken (1997). None of the variables that were considered but not included in the final model significantly affected the outcome.

It is important to note that, at each stage, interactions with sex of the child were added to the models to detect whether effects of any of these factors depended on child sex. In addition, age interactions or age/sex interactions were included to test whether the impact of each factor differed according to the age or age/sex of the child.

Logistic regression is used to determine the importance of these factors for severe child wasting. Further, multinomial regression is used to determine whether the relationships of these factors differ for moderate as compared to severe wasting. Although ordered logististic regression was considered, we found that the effects of many key variables on different categories of the dependent variable differed, so that ordered logit models are not appropriate. (Long 1997). In all analyses, probability weights were specified and children of the same mother were treated as a cluster.

Findings

Weight-for-age is available for 4,280 children aged 0-14 years of age. Obviously erroneous measures (e.g., a 70 kg 3-year old) led to exclusion of a few children. Table 2 provides descriptive statistics of wasting of children in the MHSS and, for comparison, of children in Matlab in 1978 (Chen et al. 1981). Children aged 0-9 in 1996 are far less likely to be considered severely wasted than are those aged 10-14. Moderate wasting is more prevalent among children aged 5-9 than among the youngest children, making children aged 0-4 overall the least likely to experience wasting. The large proportion of wasted children over age 10 is thought not to be a cohort effect; if this were the case high levels would likely reflect high levels of chronic deprivation (Waterlow 1972) in this cohort. Instead, this phenomenon is thought to result from “fall-out” from the U.S. median used in the comparison, since U.S. adolescents over the age of 10 are most likely to be obese (Cole, Bellizzi, Flegal, and Dietz 2000).

We limit our logit analysis to severe wasting. This is the population in poorest health and is the group considered by Bairagi (1986), who referred to this level of malnutrition as “third-degree wasting.” Further, we limit our analysis to wasting because low weight-for-age reflects both malnutrition that results in shortness and low weight-for-height. Future work will scrutinize stunting to determine if shorter children experience increased ill health, or if they are merely being compared to an inappropriate U.S. standard, similar to children aged 10-14.

Model 1 of Table 5 shows that severe wasting increases with age, which is consistent with past research (children aged 0-4 are the reference group). Model 2 adds age/sex interaction to ask if girls are at higher risk of severe wasting in each age category and whether that risk differs by age. Only girls aged 10-14 appear to have an added risk of severe wasting. Model 3 adds maternal and paternal education; only mother’s education matters in any of our models. Children of mothers with some education are less likely to be severely wasted. Paternal education is therefore not included in the later models shown. In this and all subsequent models, after a new factor was added, additional models tested whether age, sex, or age/sex interactions with that factor were significant. In model 4, maternal age is added, but has no significant relationship to severe wasting. Model 5 examines the effects of residence in the MCH-FP treatment area, which are not significant. Model 6 adds overall household income, and model 7 includes mother’s economic contribution to the household. Although none of the individual mother’s contribution categories are significant, the three cannot be dropped from the specification. However, the fit of the model that includes only the highest maternal contribution is not significantly different from that of Model 7. The likelihood of wasting decreases as household income increases and decreases sharply if the mother contributes more than 1000 taka to the household.

Birth order was added first alone and then as age and age/sex interactions. In this case, as in no previous one, the interaction with age is significant and is included in Model 8. For children under ten, the higher the birth order, the more likely they are to be severely wasted, but the effect declines with age. By age 10-14, there is no significant effect of birth order. Further models added the household or family composition factors, first as total household size, then all categories of sibling composition, and then only those representing children found to be at high risk in earlier work: those with of two or more older brothers (boys), an older sister (girls), or occupying second place in the birth order with an older brother (both sexes), and, lastly, number of younger siblings. None, alone or in combination, were significant.

Results of this logistic regression analysis confirm that severe wasting increases with age. However, our suspicions that the U.S. standards are inappropriate for 10-14 year olds are heightened by the odds ratio of wasting compared to 1-4 year olds; while exponentiating the logistic regression coefficients in Model 1 yields over 2 times greater odds of wasting among 5-9 year olds, similar odds of wasting for 10-14 year olds are more than 15 times greater when compared to 1-4 year olds. We believe this unreasonably large jump in wasting for those aged 10-14 suggests the standard is inappropriate for South Asian children rather than a true cohort or age effect that significantly raises severe wasting.

Overall, the protective factors related to a significant reduction in a child’s chances of severe wasting may be considered as measures of resources available to the child: higher overall household income, maternal education, and maternal contribution to household income all serve to increase these resources. Birth order is a risk factor, although its effect declines with age of the child. The only sex difference is for girls age 10-14 and, as described above, we question whether this is real or an artifact of an inappropriate standard. However, it is possible that lingering sex bias can be found by examining moderate wasting among girls. We turn to multinomial regression to ask whether sex-based nutritional disadvantages exist, but with less severity, in which case we would expect to find more moderate wasting among girls than boys

Multinomial Analysis: Moderate and severe wasting

The results are displayed in Table 6. Moderately and severely wasted children each are compared with those mildly wasted/normal to search for nuance in the existence of sex-bias in Matlab.

Model building proceeded in the same order as before, when only severe wasting was considered. Interestingly, residence in the MCH-FP area was a significant predictor of severe wasting until birth order was added. When the family composition variables were added (Model 9), only one--indicating the child was a girl with at least one older sister--was significant. We again asked whether the effects differed by age of the child. In fact, only for girls aged 5-9 was the effect of having an older sister significant. Unlike in earlier work, in this case the presence of an older sister appears to be protective--both moderate and severe wasting are less likely. Finally, we found that the risks of both moderate and severe wasting increase with the number of younger siblings.

We limit our description of the results again to the final model, Model 11 in Table 6. In the multinomial models, for the most part, the factors that predicted severe wasted also predicted moderate wasting, and, in general, the coefficients were larger for severe wasting. For example, for age 5-9, the coefficient for moderate wasting is 1.0 and for severe it is 2.2. Similarly, the coefficient of household income is -.004 for moderate and -.007 for severe wasting. High maternal economic contribution was significant only as protection against severe wasting.

This more discriminating analysis uncovers two sex differences. Girls aged 5-9 with at least one older sister are protected--they are *less* likely than others to suffer either moderate or severe wasting. And girls age 1-4 have higher risk of moderate wasting than boys their age.

Interestingly, the increased risk for girls 10-14 found in Table 5 disappears when moderate wasting is no longer lumped with none or mild wasting. This change appears to result from the fact that girls 10-14 have more younger siblings than do boys their age--a perhaps subtle piece of evidence that some sex preference remains, so that parents are likely to have more children after the birth of a girl than of a boy. The effect appears to come from the competition due to more young children rather than from differential treatment of children.

Discussion

The results presented here document that severe wasting has declined over the two decades prior to the MHSS for children aged 1-4 and the strong gender disparity has nearly disappeared. This change is consistent with the declines in mortality by gender observed in Matlab over the same period.

Yet disparities do remain. They appear, however, to be based primarily on the resources available in the household and competition for those resources. On the resource side, the probability of being wasted, whether severely or moderately, declines with household income and for children whose mother has some education. Severe wasting is less likely among approximately one-third of children whose mothers contribute more than 1000 taka to the household income. These findings suggest that children are better off the greater the household resources and the more their mothers contribute to those resources. Both the maternal education and maternal income effects may be interpreted as working through increased status and decision-making by mothers, who perhaps may direct more of household resources in ways that benefit their children.

On the competition side, the birth order effects indicate that the more older siblings a child has, the greater that child's risk of being wasted, but, for severe wasting, the effect declines sharply by age of the child. For moderate wasting, the effect of birth order increases with age, but both the size of the effect and the change with age are much smaller. The large increase in probabilities of moderate and severe wasting seen as the number of younger siblings increases is likely due to the effects of competition for resources within the household.

Even the single remaining sex differential in the effects of family composition--the positive effect of having at least one older sister for a girl aged 5-9--may be interpreted as an older sister protecting the younger sister in resource allocation.

Two other findings are worthy of repetition here. In the final model, girls aged 1-4 are more likely than boys of the same age and other characteristics to be moderately wasted. The effect is of nearly the same magnitude for severe wasting but is not significant. A question therefore remains of gender discrimination among the smallest children we are considering.

The Maternal and Child Health and Family Planning Program is associated with significantly reduced risks of severe wasting. However, the effect becomes non-significant as soon as birth order of the child is introduced into the model. This finding indicates that the Program exerted its effect by enabling parents to reduce the number of children they had.

Consequently, children in the MCH-FP area are more likely to be of low birth order than those in the comparison area. Since the effect of the Program seems to work completely through birth order, it is unlikely that it significantly affected child health by increasing access to health care.

Finally, we note the dramatic increase in the two decades prior to the MHSS in the proportion of children who were in lower risk categories. Referring back to Table 4, the proportion of girls aged 1-4 in the low risk category under the Muhuri and Menken (1997) scheme rose from 32.5 in 1982-83 to 58 percent in 1996. Even more dramatic is the fact that the proportion of children whose mothers had some education rose from 31.5 to 55 percent over the same period. We considered the effect simply of this change in maternal education, taking second born boys aged 5-9 whose mothers made no economic contribution and whose household income was at the mean (39.7). For this group, the predicted percent with severe wasting from Table 5, Model 8 is 11.6% for a child whose mother has no education and 6.3% for those with some education--a reduction of 46% in severe wasting. If, further, the educated mother's economic contribution was high, the predicted percent drops to 4.5%--a 63% reduction over the son of the mother with no education and little or no economic contribution.

These results also lead to other questions that we will address in further research. The relationship of maternal education and income to child health suggests that maternal empowerment and participation in decision-making may affect child health. The MHSS collected information that currently is being used to develop better indicators of women's empowerment that will be then tested for relationship to child health.

The fall-off with age of children from the standard will be investigated further through consideration of other health measures in the MHSS. We will be asking whether the relationship of wasting to other aspects of poor health changes with age. For example, if children aged 10-14 who are classified as severely wasted are much less likely to have severe chronic disease than severely wasted 1-4 year olds, we would take this as further evidence that the standard for wasting is problematic.

Seasonal differences in the availability of food, found to significantly affect rates of malnutrition (Engberg, Sabry, and Beckerson 1987), should be examined in order to perhaps target aid during the periods of greatest need. As the UN points out (1998), sex-based differences in health are not universal in the developing world. To date, evidence suggests that the problem is most acute in South Asia and the Middle East crescent. Macro-level work to identify problem areas and micro-level work to identify mitigating household variables can help to pinpoint areas in which children are most at risk of poor health.

Finally, we have found here that health of children is related to resources and competition. A next step will be to ask whether the same factors are similarly related to other aspects of human capital formation such as schooling.

In conclusion, this paper offers strong support for good news. Malnutrition has declined in rural Bangladesh and, with it, strong disparities by gender have been reduced. Female education has increased dramatically and, with it, children have greater chances of good health. The family planning program has been effective in reducing high order births, thereby contributing to increasing children's chances of being in a low risk group for poor health. This study complements the growing body of literature documenting the long-term effects of the MCH-FP in Bangladesh, and confirms the importance of the intervention on the health of children, largely due to family planning. Sex-bias in nutrition documented in the past is greatly reduced, and differences largely are the product of educated mothers, higher household resources, and mothers who contribute to household finances. While it is not possible to entirely answer each of the questions we pose at the outset, many new facts are known. We demonstrate that sex-bias, while not eliminated in Matlab, is decreasing along with child mortality in the region. The health of children in Matlab reflects an accelerating demographic transition in Bangladesh, characterized by declining fertility and higher rates of child survival. Education of girls and women is on the rise, and women demonstrate increasing autonomy in the home. Despite these positive developments, however, many children remain at serious risk of malnutrition, and targeted efforts to improve treatment and education are sorely needed.

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Table 1: Death Rates of Children in Matlab, by age and sex: 1983 and 1996 (per 1000 population)

Age	Boys		Girls		Both sexes	
	1983	1996	1983	1996	1983	1996
1-4 years	21.9	6.7	37.0	7.4	29.1	7.1
5-9 years	3.2	1.1	4.8	1.5	3.9	1.3
10-14 years	1.3	1.1	1.4	1.5	1.3	1.3

Source: Mostafa et al. 1998 and Shaikh et al. 1985

Table 2: Proportion of Wasted Children, by age in 1996 and for age 1-4 in 1978

	1978 Ages 1-4		1996 Ages 1-4			1996 Ages 5-9			1996 Ages 10-14		
Level of Wasting	Boys	Girls	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Mild/normal	40.1	26.0	54.5	43.1	49.1	24.3	26.5	25.5	9.9	8.5	9.1
Moderate	54.8	59.6	42.3	53.6	47.6	64.9	64.1	64.5	60.8	50.6	55.6
Severe	5.1	14.4	3.2	3.3	3.2	10.8	9.4	10.0	29.2	40.9	35.2

N=4280

Sources: 1996 MHSS and Chen et al. 1981

Table 3: Definitions and distributions of predictor variables

	Proportion		
Age categories	Total	Boys	Girls
Ages 1-4: Child between age 1 and 4 at start of child-year observation	26.5	27.0	25.9
Ages 5-9: Child between age 5 and 9 at start of child-year observation	35.5	34.8	36.2
Ages 10-14: Child between age 10 and 14 at start of child-year observation	38.0	38.2	37.8
Parental education			
Mother has some education	49.0	47.7	50.2
Father has some education	60.6	61.4	59.7
Maternal age			
Mother less than 28 years old	22.9	22.7	23.2
Mother between 29 and 34 years old	32.0	32.4	31.5
Mother between 35 and 39 years old	21.1	21.5	20.7
Mother older than 40 years	24.0	23.5	24.6
Treatment area residence			
Child resides in treatment area	48.4	47.9	48.8
Maternal contribution to household income			
No maternal contribution (0 taka contributed to household income)	16.1	16.7	15.4
Low maternal contribution (1-300 taka contributed to household income)	22.9	21.9	24.0
Medium maternal contribution (300-1000 taka contributed to household income)	30.9	32.2	29.5
High maternal contribution (More than 1000 taka contributed to household income)	30.1	29.2	31.0
Household income			
Mean	39.7	40.6	38.9
Standard deviation	50.1	55.0	44.4
Younger Siblings			
Mean	1.0	0.9	1.0
Standard deviation	1.1	1.1	1.1
Percent with no younger siblings	44.4	46.2	42.4

N=4788

Table 4: Percentage of children aged 1-4 in high risk subgroups defined by family composition and mother's eductation: 1982 vs. 1996

Percentage of aged 1-4 children in subgroups defined by family composition and mother's education: 1982 vs. 1996

Boys

	MCH-FP area		Comparison area		Both	
	1982	1996	1982	1996	1982	1996
Family composition						
Boys with 2+ brothers	26.0	23.1	34.4	26.8	30.5	25.0
Girl with older sister(s)	-	-	-	-	-	-
Second-born children with 1 brother	11.8	16.8	10.6	12.5	11.2	14.6
Other (low risk)	**62.2**	**60.1**	**55.0**	**60.6**	**58.3**	**60.4**
Children of mothers with some schooling	**32.7**	**57.0**	**30.9**	**58.3**	**31.7**	**57.7**
N	*2943*	*316*	*3434*	*343*	*6377*	*659*

Girls

	MCH-FP area		Comparison area		Both	
	1982	1996	1982	1996	1982	1996
Family composition						
Boys with 2+ brothers	-	-	-	-	-	-
Girl with older sister(s)	54.1	26.52	59.9	27.3	57.2	26.9
Second-born children with 1 brother	11.2	17.92	9.4	12.7	10.2	15.1
Other (low risk)	**34.7**	**55.6**	**30.7**	**60.0**	**32.5**	**58.0**
Children of mothers with some schooling	**33.0**	**54.8**	**29.2**	**51.8**	**31.1**	**53.2**
N	*2176*	*279*	*3173*	*330*	*5889*	*609*

Sources: 1996 MHSS and Muhuri and Menken (1997)

Table 5: Binomial Logit Coefficients Describing the Effects of Various Characteristics on the Log Odds of a Child Being Severely Wasted
(Standard errors in italics under coefficients)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Ages 5-9	1.207 **	1.297 **	1.259 **	1.235 **	1.243 **	1.260 **	1.277 **	1.784 *
	0.275	*0.396*	*0.400*	*0.401*	*0.402*	*0.400*	*0.400*	*0.696*
Ages 10-14	2.791 **	2.528 **	2.537 **	2.493 **	2.518 **	2.555 **	2.592 **	3.729 **
	0.242	*0.341*	*0.343*	*0.355*	*0.343*	*0.344*	*0.344*	*0.620*
Girls aged 1-4		0.027	0.017	0.022	-0.001	0.021	0.032	0.152
		0.461	*0.461*	*0.461*	*0.460*	*0.461*	*0.460*	*0.474*
Girls aged 5-9		-0.154	-0.160	-0.158	-0.157	-0.157	-0.145	-0.172
		0.276	*0.280*	*0.281*	*0.282*	*0.281*	*0.278*	*0.281*
Girls aged 10-14		0.517 **	0.501 **	0.498 **	0.515 **	0.505 **	0.523 **	0.516 **
		0.144	*0.146*	*0.145*	*0.144*	*0.145*	*0.145*	*0.146*
Mother has some education			-0.680 **	-0.724 **	-0.728 **	-0.686 **	-0.677 **	-0.673 **
			0.156	*0.145*	*0.145*	*0.142*	*0.141*	*0.144*
Father has some education			-0.115					
			0.147					
Mother's age				0.032				
				0.068				
MCH-FP area residence					-0.203			
					0.137			
Household income (1000 taka units)						-0.004 *	-0.004 *	-0.004 *
						0.002	*0.002*	*0.002*
Low maternal income contribution							-0.231	
							0.262	
Medium maternal income contribution							-0.113	
							0.264	
High maternal income contribution							-0.465	-0.351 *
							0.258	*0.137*
Birth order * ages 1-4								0.222 *
								0.113
Birth order * ages 5-9								0.111 *
								0.056
Birth order * ages 10-14								-0.057
								0.030
Constant	-3.399 **	-3.412 **	-3.049 **	-3.149 **	-2.980 **	-2.957 **	-2.782 **	-3.829 **
Log likelihood	-1766.96	-1753.84	-1717.88	-1718.37	-1715.81	-1708.75	-1701.25	-1689.70
DF	2	5	7	7	7	7	10	11
Pseudo R squared	0.1357	0.1421	0.1597	0.1594	0.1607	0.1633	0.1670	0.1727

*Significant at.05
**Significant at .01

n=4249

Table 6: Multinomial Logit Coefficients Describing the Effects of Various Characteristics on the Log Odds of <u>Moderate</u> Child Wasting (Compared to Mildly wasted/Normal)

(Standard errors in italics under coefficients)

Moderately wasted

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Ages 5-9	0.960 **	1.237 **	1.246 **	1.199 **	1.243 **	1.232 **	1.250 **	1.185 **	1.160 **	1.169 **	1.003 **
	0.110	*0.164*	*0.165*	*0.168*	*0.166*	*0.165*	*0.164*	*0.226*	*0.226*	*0.255*	*0.244*
Ages 10-14	1.834 **	2.066 **	2.118 **	2.011 **	2.113 **	2.135 **	2.152 **	2.067 **	2.061 **	2.096 **	1.726 **
	0.149	*0.201*	*0.201*	*0.208*	*0.201*	*0.202*	*0.201*	*0.299*	*0.299*	*0.324*	*0.339*
Girls aged 1-4		0.472 *	0.475 **	0.491 **	0.462 *	0.448 *	0.441 *	0.474 *	0.723 **	0.599 **	0.470 *
		0.185	*0.184*	*0.185*	*0.185*	*0.187*	*0.187*	*0.185*	*0.198*	*0.220*	*0.185*
Girls aged 5-9		-0.101	-0.110	-0.107	-0.112	-0.099	-0.100	-0.093	0.159	0.241	0.101
		0.151	*0.151*	*0.150*	*0.151*	*0.151*	*0.151*	*0.150*	*0.165*	*0.186*	*0.167*
Girls aged 10-14		-0.019	-0.028	-0.029	-0.013	0.000	-0.004	-0.010	0.262	0.341	-0.034
		0.243	*0.244*	*0.245*	*0.245*	*0.246*	*0.247*	*0.246*	*0.261*	*0.302*	*0.247*
Mother has some education			-0.422 **	-0.401 **	-0.427 **	-0.482 **	-0.460 **	-0.445 **	-0.447 **	-0.448 **	-0.412 **
			0.130	*0.131*	*0.129*	*0.113*	*0.113*	*0.115*	*0.116*	*0.117*	*0.114*
Father has some education			-0.262 *	-0.275 *	-0.254						
			0.133	*0.134*	*0.133*						
Mother's age				0.099							
				0.057							
MCH-FP area residence					-0.178	-0.186	-0.180				
					0.110	*0.111*	*0.110*				
Household income (1000 taka units)						-0.004 **	-0.004 **	-0.004 **	-0.004 **	-0.004 **	-0.004 **
						0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
Low maternal income contribution							0.333				
							0.180				
Medium maternal income contribution							0.151				
							0.168				
High maternal income contribution							0.016	-0.176	-0.171	-0.171	-0.174
							0.168	*0.122*	*0.124*	*0.123*	*0.122*
Birth order * ages 1-4								0.030	0.010	0.039	0.037
								0.043	*0.044*	*0.050*	*0.043*
Birth order * ages 5-9								0.047	0.030	0.028	0.077 *
								0.034	*0.036*	*0.039*	*0.037*
Birth order * ages 10-14								0.053	0.030	-0.016	0.092
								0.047	*0.052*	*0.057*	*0.052*
Girl with older sisters(s)									-0.544 **		
									0.169		
Boy with two older brothers									0.246		
									0.174		
Second child with an older brother									-0.124		
									0.165		
Girls aged 1-4 with older sister(s)										-0.432	
										0.313	
Girls aged 5-9 with older sister(s)										-0.744 **	-0.729 **
										0.229	*0.230*
Girls aged 10-17 with older sister(s)										-0.306	
										0.413	
Boy aged 1-4 with 2+ older brothers										-0.078	
										0.325	
Boy aged 5-9 with 2+ older brothers										0.276	
										0.260	
Boy aged 10-14 with 2+ older brothers										0.815 *	
										0.412	
Second child aged 1-4 with an older brother										-0.061	
										0.268	
Second child aged 5-9 with an older brother										-0.155	
										0.254	
Second child aged 10-14 with an older brother										-0.263	
										0.387	
Number of younger siblings in the household											0.169 *
											0.078
Constant	-0.031	-0.254 *	0.117	-0.073	0.213	0.238	0.083	0.056	0.071	0.059	-0.026

Table 6 (continued): Multinomial Logit Coefficients Describing the Effects of Various Characteristics on the Log Odds of Severe Child Wasting (Compared to Mildly wasted/Normal)

(Standard errors in italics under coefficients)

Severely wasted

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Ages 5-9	1.792 **	2.023 **	2.022 **	1.969 **	2.014 **	2.006 **	2.039 **	2.482 **	2.484 **	2.489 **	2.207 **
	0.283	*0.405*	*0.411*	*0.414*	*0.414*	*0.415*	*0.416*	*0.720*	*0.720*	*0.676*	*0.746*
Ages 10-14	4.068 **	3.917 **	4.008 **	3.887 **	3.997 **	4.036 **	4.089 **	5.123 **	5.127 **	5.296 **	4.585 **
	0.266	*0.370*	*0.376*	*0.390*	*0.376*	*0.378*	*0.379*	*0.665*	*0.661*	*0.663*	*0.692*
Girls aged 1-4		0.260	0.264	0.284	0.237	0.232	0.24	0.405	0.644	-0.117	0.4
		0.469	*0.470*	*0.470*	*0.469*	*0.470*	*0.469*	*0.487*	*0.497*	*0.545*	*0.486*
Girls aged 5-9		-0.226	-0.242	-0.239	-0.243	-0.229	-0.217	-0.24	-0.022	-0.115	-0.056
		0.290	*0.298*	*0.298*	*0.300*	*0.302*	*0.300*	*0.300*	*0.342*	*0.416*	*0.322*
Girls aged 10-14		0.500 *	0.476	0.475	0.506 *	0.521 *	0.537 *	0.506 *	0.764 **	0.923 **	0.472
		0.253	*0.258*	*0.258*	*0.256*	*0.256*	*0.257*	*0.258*	*0.282*	*0.319*	*0.260*
Mother has some education			-1.020 **	-0.997 **	-1.022 **	-1.075 **	-1.049 **	-1.034 *	-1.041 **	-1.044 **	-0.993 **
			0.196	*0.197*	*0.196*	*0.178*	*0.178*	*0.182*	*0.181*	*0.180*	*0.182*
Father has some education			-0.330	-0.341	-0.324						
			0.189	*0.190*	*0.189*						
Mother's age				0.112							
				0.084							
MCH-FP area residence					-0.349 *	-0.347 *	-0.346 *				
					0.169	*0.169*	*0.168*				
Household income (1000 taka units)						-0.007 **	-0.007 **	-0.007 **	-0.007 **	-0.007 **	-0.007 **
						0.002	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Low maternal income contribution							0.036				
							0.309				
Medium maternal income contribution							0.002				
							0.308				
High maternal income contribution							-0.463	-0.496 **	-0.496 **	-0.485 **	-0.484 **
							0.301	*0.176*	*0.178*	*0.176*	*0.178*
Birth order * ages 1-4								0.238 *	0.233 *	0.343 **	0.248 *
								0.117	*0.118*	*0.127*	*0.117*
Birth order * ages 5-9								0.146 *	0.144 *	0.184 **	0.186 **
								0.061	*0.061*	*0.068*	*0.066*
Birth order * ages 10-14								-0.01	-0.016	-0.079	0.051
								0.052	*0.059*	*0.062*	*0.057*
Girl with older sisters(s)									-0.506 *		
									0.234		
Boy with two older brothers									0.201		
									0.253		
Second child with an older brother									0.287		
									0.321		
Girls aged 1-4 with older sister(s)										0.452	
										0.720	
Girls aged 5-9 with older sister(s)										-0.608	-0.73
										0.445	*0.413*
Girls aged 10-17 with older sister(s)										-0.378	
										0.431	
Boy aged 1-4 with 2+ older brothers										-0.919	
										0.761	
Boy aged 5-9 with 2+ older brothers										-0.082	
										0.486	
Boy aged 10-14 with 2+ older brothers										0.923 *	
										0.444	
Second child aged 1-4 with an older brother										0.763	
										0.759	
Second child aged 5-9 with an older brother										0.817	
										0.675	
Second child aged 10-14 with an older brother										-0.089	
										0.399	
Number of younger siblings in the household											0.253 **
											0.098
Constant	-2.722 **	-2.838 **	-2.203 **	-2.419 **	-2.02 **	-1.917 **	-1.86 **	-3.011 **	-3.097 **	-3.206 **	-3.132 **
Log likelihood	-3712.37	-3692.801	-3629.571	-3626.5	-3624.231	-3604.768	-3591.98	-3586.516	-3570.693	-3559.149	-3568.133
DF	4	10	14	16	16	16	22	22	28	40	26
Pseudo R squared	0.1051	0.1098	0.1251	0.1258	0.1264	0.1299	0.133	0.1343	0.1381	0.1409	0.1387

**Significant at .01, *Significant at.05

n=4249