Have Changes in Women's Status Led to Gains in Child Nutrition in Bangladesh?

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ABSTRACT

Since the 1990s researchers have noted massive improvements in women's education, employment, total fertility rate and median age at first marriage in Bangladesh. According to human capital literature, these improvements should have a profound impact on child nutrition. We use cross-sectional data from the 1999 and 2007 Bangladesh Demographic Health Surveys and employ multivariate regression and decomposition methods to test whether increases in women's status, as measured by improvements in socio-demographic characteristics, are associated with gains in child nutrition. We use a child's height-for-age Z-score (haz) to measure long-term nutritional status of children under age five. From 1999 to 2007, there has been a 12 percent reduction in child stunting in Bangladesh. The Oaxaca-Blinder decomposition showed that 48% of this reduction is due to improvements in women's status at the population level. Therefore, we conclude that improvements in women's characteristics in Bangladesh have led to gains in child nutrition.

1. Introduction

Nutritionists argue that child anthropometric[1] indicators ("stunting", "wasting" and "underweight") provide useful information about standards of living in developing countries (Waterlow et al., 1977, Martorell and Habicht 1986). When either measure is very low during childhood, mortality risks rises and a child's productivity as an adult decreases (Chen, Chowdhury, and Huffman 1980). Malnutrition is the main cause of poor growth among children, which leads to stunting, wasting and underweight. Therefore it is a close correlate of poverty, serving both as a cause and effect of poverty (Bhagowalia et al 2010). International aid organizations and local governments have made substantial progress in improving child nutrition in developing countries. From a welfare policy point of view, it is important to see whether determinants of child stunting has changed over time. It is also of interest to examine the sources of improvement in child nutrition overtime. Therefore, this study investigates the reduction in child stunting in Bangladesh from 1999 to 2007.

Past studies have shown that when women have relatively higher status in the household compared to their counterparts, children receive more resources and fare better in health and education (Schultz 1999; Smith et al., 2003). Women may derive higher social status from age, education, employment and non-labor income. Therefore, we should expect improvements in women's socioeconomic characteristics to have positive impact on the improvements in child stunting. However, these improvements occur simultaneously with economic development, therefore, improvements in infrastructure and household wealth should also be considered as a source of improvement in stunting.

[1] Anthropometric measures include three indicators: "stunting" – low height conditional on age, "underweight" – low weight conditional on height, and "wasting" – low weight conditional on age.

The data for this analysis derives from the 1999 and 2007 Bangladesh Demographic and Health Surveys (BDHS), which are nationally representative cross-sectional surveys. The BDHSs include detailed information about women aged 15-49 years, their partners and children. The empirical strategy is to first investigate whether there are significant improvements in women's socioeconomic characteristics from 1999 to 2007. The second step is to identify the determinants of child stunting and whether they have changed over time. The final step is to examine the reduction in stunting using the Oaxaca-Blinder decomposition.

2. Background

2.1 The Context

With over 140 million people squeezed into an area of 145,000 km^2, (i.e., about the size of Iowa state in the US), Bangladesh is one of the most densely populated countries in the world (UNFPA 2011). Until 1971, Bangladesh was part of Pakistan (1947-1971) and before 1947, part of India. Like its neighbors, Bangladesh has deeply rooted patriarchal ideals and relatively low women's status when compared with other less-developed countries. High levels of female infanticide, domestic violence against women and low resource allocation for girls are indicators of women's relative low valuation in this society (Chen, Huq and D'Souza 1981). Bangladesh is also one of the most malnourished countries in the world (Ramalingaswami et al 1996).

2.2 The Determinants of Child Malnutrition

Clinically, malnutrition is characterized by inadequate intake of protein, energy, and micronutrients; and frequent infections, gastrointestinal parasites and other childhood diseases. Children are also malnourished if they are unable to utilize fully the food

they eat, for example, due to diarrhea or other illnesses (secondary malnutrition). Malnutrition in all its forms increases the risk of disease and early death (WHO 2000). As a result of malnutrition, children may become stunted i.e. low "height-for-age", wasted i.e. low "weight-for-height" or underweight i.e. low "weight-for-age" (Mishra and Retherford 2000). Stunting is a long-term indicator of a child's nutritional status; which means that the child has not received adequate nutrition or was subject to frequent infections and diseases throughout his/her life. Stunted children are at a higher risk of early death. They are also more likely to be stunted as adults and have low productivity compared to adults who were not stunted during childhood (Strauss and Thomas 1998; Hoddinott et al 2008). Therefore, stunting has serious consequences for the economic growth of a country and the overall health of its population.

The South Asian region by far has the highest number and prevalence of malnutrition in the world. It is home to half of all underweight children under five years in the developing world. Sub-Saharan Africa, where roughly one child out of every three is underweight, has the second highest rate. But ironically South Asia appears to be doing better than Sub-Saharan Africa in terms of national per capita income, per capita food supplies, and education levels. Ramalingaswami, Jonsson, and Rohde (1996) argue that malnutrition in South Asia is due to extreme inequality between men and women, which leads to widespread destitution. They explain that low birth weight is the best single predictor of malnutrition; birth weights below 2,500 grams have been found to be very closely associated with poor growth, not just in infancy, but also throughout childhood. Approximately one third of all babies in India are born with low birth weight, in Bangladesh the proportion is one half, and in sub-Saharan Africa the proportion is about one sixth. Low birth weight indicates that

the infant was malnourished in the womb and/or that the mother was malnourished during her own infancy, childhood, adolescence, and pregnancy. The proportion of babies born with low birth weight therefore reflects the condition of women, and particularly their health and nutrition, not only during pregnancy, but also during their childhood and young lives (Ramalingaswami et al 1996). During the pregnancy itself, the average woman should gain about 10 kilos in weight. Most women in Africa come close to that figure, whereas most women in South Asia gain little more than 5 kilos (WHO 1995).

Even if children are not born with low birth weight, poor feeding practices and inadequate medical care may lead to stunting. Since women are the primary caregivers, they play an important role in preventing these conditions. T.P. Schultz (1993; 1999) formulated a human capital model that explains the determinants of children's health. He argued that at the household level, mother's education has a positive effect on the health of her child, whereas father's education does not. The importance of maternal education has been well documented in the child survival literature as well (Caldwell 1979; Schultz 1980; Mensch, Lentzner and Preston 1986). Schultz (1999) explains that education increases the chances of gaining outside employment for a woman. This means she will earn an income which she might be able to use at her discretion, thus giving her the financial power to purchase nutritional food, medicine, and visits to the doctor for her children as well as for herself.

A more direct mechanism by which education influences women's status is through the ability to process information regarding child care, nutrition, health, and diseases (Kesarda, Billy, and West 1986; Rosenzweig and Schultz 1983). For example, educated women are able to comprehend and follow instructions to give

correct amounts of medicine at the right time. Further, educated mothers understand the nutritional aspects of certain types of food and select the best available types to feed their children. They are also more likely to exclusively breastfeed their infants in the early months of life which offers considerable protection against diseases (both because of breast milk's inherent immunological properties and because breastfeeding minimizes the chances of infection through unclean water and contaminated foods). Educated mothers have access to more information on proper parenting techniques, nutritional guidelines, healthy hygiene practices and proper health care behavior (Thomas, Strauss and Henriques 1991). They are able to understand how infections and diseases are borne and take measures to prevent them (e.g. use of mosquito nets to prevent malaria and dengue, boiling and straining water before consumption to prevent diarrheal disease, typhoid and cholera). And they are also more likely to know how to navigate social institutions such as schools and health care facilities, and how to interact successfully with the staff (Casper and Kitchen 2008). Therefore, women's education, employment and overall status are the main source of variation in child malnutrition in developing countries.

2.3 Previous Research

Many cross-sectional empirical studies have shown the impact of women's status on children's health and nutritional status. Dyson and Moore (1983) found evidence that women's autonomy promotes child survival by comparing the northern states of India (where kinship structure is very patriarchal), to the eastern and southern states. Caldwell (1986) compared Muslim and non-Muslim populations in the world, where seclusion of women is common. He showed that child mortality rates are higher in Muslim countries than in non-Muslim countries. Using data from the 1986 Brazilian

Demographic and Health Survey, Thomas, Strauss and Henriques (1990) showed that mother's education has a large and significant impact on child height (conditional on household income and after controlling for intercommunity heterogeneity). They also show that almost all the impact of maternal education is explained by access to information—reading papers, watching television, and listening to the radio. In another study in Brazil, Thomas (1997) showed that income accruing to women has a statistically significant and larger positive impact on child nutrition's status than income accruing to men. Smith and Haddad (2000) using cross-country data from 63 developing countries during 1970-96, measured women's status as a ratio of female-to-male life expectancy. Their results showed that women's status has a negative effect on the percentage of children who are underweight. In a study in Egypt, Kishor (2000) used a variety of measures of women's "empowerment" available in Egypt Demographic and Health Survey 1995-96 to show that women's status is positively associated with child survival. Smith et al (2003) studied the relationship between women's status and children's nutrition in 36 countries in three developing regions: South Asia, Sub-Saharan Africa, and Latin America and the Caribbean. They use two measures of women's status, women's decision-making power relative to that of their male partners and the degree of equality between women and men in their communities. Their results confirm that women's status impacts child nutrition because women with higher status have better nutritional status themselves, are better cared for, and provide higher quality care to their children. In a more recent study, Bhagowaila and her colleagues (2010) used the BDHS 2007 to examine the relationship between gender inequality and nutrition using direct indicators of empowerment such as mobility, decision-making power and attitudes towards verbal and physical abuse. Their results indicate that a greater degree of women's

empowerment is associated with better long-term nutritional status of children. Tarozzi and Mahajan (2007) analyzed the improvements in child nutrition in India from 1992-93 to 1998-99. They found that mother's schooling had a positive impact on the reduction in child stunting. But they also found that nutritional status improved substantially more for boys than for girls, and this was especially true in rural areas and areas of North India where son preference is widespread.

In this study we exploit the significant change in child stunting and women's socioeconomic characteristics in Bangladesh. We attempt to measure how much of improvements child stunting can be explained by increases in women's socioeconomic status. We also investigate whether the determinants of child stunting have changed over time.

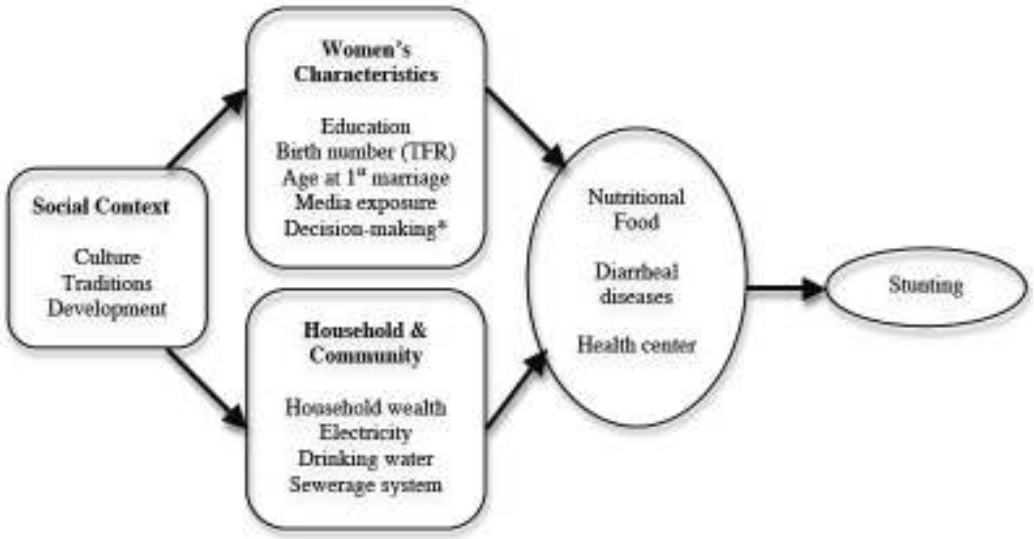
In addition to women's status, other factors such as household wealth and infrastructure play an important role in child stunting. For example, if the household doesn't have enough monetary resources to purchase nutritional food or to pay for doctor's visits, then even if the mother has high status in the household, a child's nutrition will be jeopardized. Similarly, not having access to infrastructure such as electricity, a sanitary environment or health centers also penalizes a child's nutrition regardless of the mother's status. Therefore, it is important to account for these household and community level changes.

2.4 Conceptual Framework

The UNICEF's conceptual framework on child malnutrition (UNICEF 1998) and the subsequent extensions of that framework (Engle, Menon and Haddad 1997) discuss the role of direct and indirect determinants that cause child malnutrition. Bhagowalia

and her colleagues (2010) further refined the UNICEF model by including variables such as attitudes towards domestic violence, control over cash and decision-making.

Figure 1. Conceptual Framework



*Decision-making was insignificant in the full multivariate regression model

Figure 1 illustrates a simple conceptual framework showing linkage between culture, economic development, women's socioeconomic characteristics, and child stunting. The extended UNICEF model highlights the importance of the physical and mental wellbeing of women, support from family and community, and education all of which directly impact their ability to care for children. The culture and traditions of the community such as *purdah*, economic development and modernization determine the relative status of women in a given time period. The status of women in turn can determine food intake, preventive care and visits to the doctor by participating in household decision-making (Bhagowalia et al 2010). Education of the woman (net of partner's education) is often used as a measure of relative status between husband and wife in the household (Frankenberg and Thomas 2003). Mother's age at first

marriage, exposure to media, and birth number of the child are considered to be pathways in which women's education affects child nutrition, however these variables also have an independent effect.

For instance, if the birth number of a child is high, we can assume that the mother had depleted energy/nutrition during gestation due to repeated pregnancies, this may lead to low birth weight which in turn lead to childhood malnutrition. Birth number also indicates woman's inability to control her fertility through contraceptive use, thus birth number serves as a proxy for total fertility rate of the mother. Further, households with many children need to share limited resources such as food, healthcare and parent's attention. A child with many siblings will receive a smaller share of these resources compared to a child with fewer siblings. Therefore birth number is an important predictor of child stunting.

Further, in a setting such as Bangladesh, age confers authority and status, age at first marriage in particular leads to greater authority because the age difference between the partner and the woman is smaller if the woman marries at a later age. Media exposure provides women with useful information about children's health and the ways in which they can prevent common diseases that cause malnutrition. The model also accounts for community level characteristics that were not included in Bhagowalia et al (2010); drinking water and sewerage system in particular has a direct impact on the children's health. Household wealth is an indication of the family's economic capability to purchase nutritional food or pay for visits to the health center (if they have one the in the community).

2.5 WHO Child Growth Standards

Previous research on the variation in early childhood growth and on the effects of experimental nutritional supplementation has shown that inadequate growth in young children in less-developed countries is generally the consequences of infectious diseases and of low nutrient in take (Martorell and Habicht 1986). These studies also indicate that genetic variation among ethnic groups plays a relatively minor role in early childhood growth patterns compared with factors related to diet and infection such as social class and economic status (Habicht et a. 1974; Martorell and Habicht 1986). Ethnic differentiation in growth potential appears to be more important during adolescence, than during infancy and early childhood (Martorell and Habicht 1986)

In 1977, the National Center for Health Statistics (NCHS) developed a child growth reference standard using a sample consisting of primarily white middle-class, formula-fed infants from southwestern Ohio. This reference was widely used to compare the nutritional status of populations and to assess the growth of individual children throughout the world. In 2006, the World Health Organization (WHO) published child growth standards for attained weight and height to replace the previously recommended 1977 NCHS child growth reference. These new standards are based on breastfed infants and appropriately fed children, of different ethnic origins raised in optimal conditions and measured in a standardized way. Six countries were used to create this reference: Brazil, Ghana, India, Norway, Oman and the United States.

The new WHO growth standards confirm earlier observations that, the effect ethnic differences on the growth of infants and young children in populations are small compared with the effects of the environment. Studies have shown that there may be some ethnic differences among groups, just as there are genetic differences

among individuals, but for practical purposes they are not considered large enough to invalidate the general use of the WHO growth standards population as a standard in all populations. These new standards have been endorsed by international bodies such as the United Nations Standing Committee on Nutrition, the International Union of Nutritional Sciences and International Pediatric Association and adopted in more than 90 countries (WHO and UNICEF 2009). Therefore, we use the WHO 2006 reference growth standard to calculate height-for-age z-scores for Bangladeshi children under-5 years.

3. Data

The Bangladesh Demographic and Health Survey is a nationally representative cross-sectional data set collected under the auspices of the ICF (Inner City Fund) International and United States Agency for International Development. It is suitable for examining nationwide trends and patterns in child malnutrition and how it correlates with women's status. All eligible women in each selected household were surveyed which includes women who were currently or ever married. The surveys are based on two stage sample designs. In the first stage, enumeration units or "clusters" were selected from larger regional units within a country. Next, households were randomly selected within clusters. Detailed information on women, their male partners (if they had one), and their children under age five were gathered. Our analytical sample comprises children less than five years of age with full anthropometric data, resulting in sample sizes of 5,313 in 1999 and 5,328 in 2007. The corresponding number of mothers with children under age five is 4,335 in 1999 and 4,530 in 2007; therefore on average each mother has 1.2 children under five.

3.1 Explanatory Variables

This study uses data on women's education, age at first marriage, television viewership, and partner's education. Mother's television viewership was recoded as '1' if she watches television at least once a week, else '0'. Participation in decision-making was recoded to create a combined variable, however this variable did not have an independent effect on child stunting and therefore was removed from this analysis. Detailed information on children under-five including: age in months, sex, birth number, height and weight were collected in the BDHS. We use this information to calculate the child-stunting (haz) variable (we describe this in detail in section 3.2).

As described in the previous section, household income and infrastructure are important determinants of child nutrition. But unfortunately BDHSs do not include household income or consumption data[2]. However, the surveys include detailed information on household assets such as chairs/tables, almirah (i.e. cupboard), radio, television, bicycle, etc. According to principal component factor analysis almirah, television and chair/table measure a common construct, however, since television viewership was already included in the analysis, we only use chair/tables and almirah as a measure for household assets[3]. As part of the 1999 BDHS, a Service Provision Assessment (SPA) survey collected information on the infrastructure and socioeconomic characteristics of communities as well as information on the accessibility and availability of health and family planning services. However, the SPA survey was not conducted in 2007. Therefore, we use the household

[2] The recoded wealth index provided in the BDHS data sets are not comparable across surveys (Rutstein 2008)

[3] Principal component factor analysis was performed separately for 1999 and 2007 data sets. According to the Kaiser criteria eigen value greater than one indicates good internal consistency within the factor. Factor loadings for the two items chair/table and almirah were greater than 0.8.

questionnaire in the BDHS to extract information on the availability of electricity[4]. In addition we use availability of a good source of drinking water and advanced sewerage systems, as proxies for community infrastructure. A good source of drinking water includes pipes inside or outside the dwelling or a tube well, an unsuitable source of drinking water includes open water sources such as a lake, pond or unprotected well. An advanced sewerage system includes a septic tank/toilet, water sealed/slab or flush toilets, as oppose to an open pit, bush or no facility.

3.2 Measuring Child Stunting

A child is classified as "stunted" if his height conditional on his age and gender z-score (haz) is below -2 standard deviations from the median of the 2006 World Health Organization international growth reference (this reference includes well-nourished children from six countries: Brazil, Ghana, India, Norway, Oman and the United States).

[4] This may or may not be a community level variable as some wealthy households may use a generator to produce electricity even if the village does not have a power line.

Figure 2A Height-for-Age Z-Score Distribution of Children Under 5 Years in Bangladesh

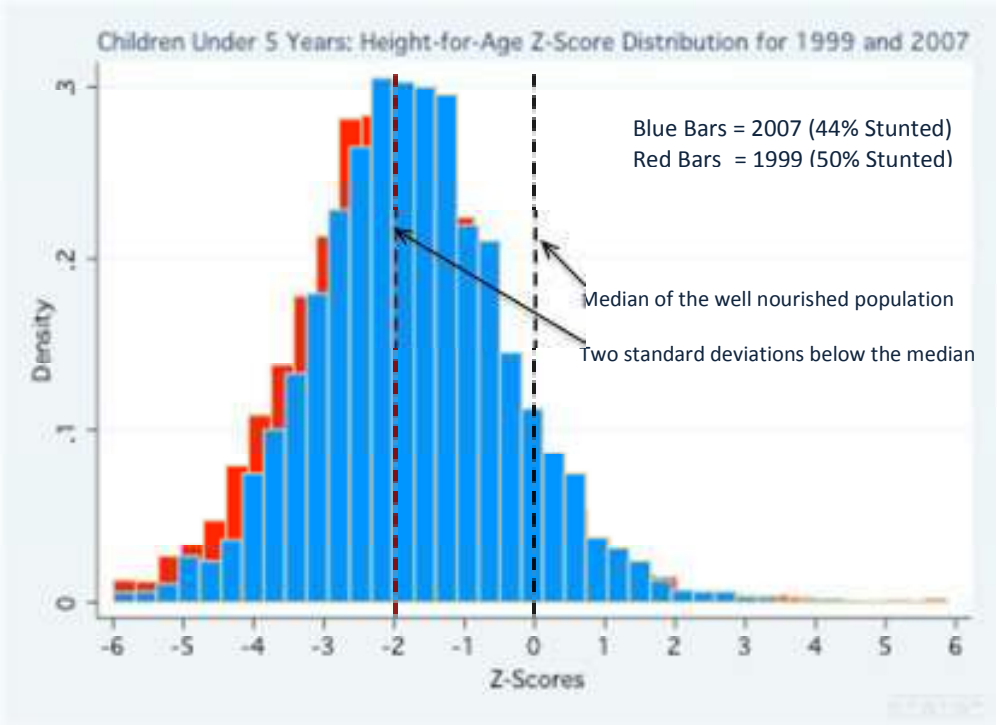
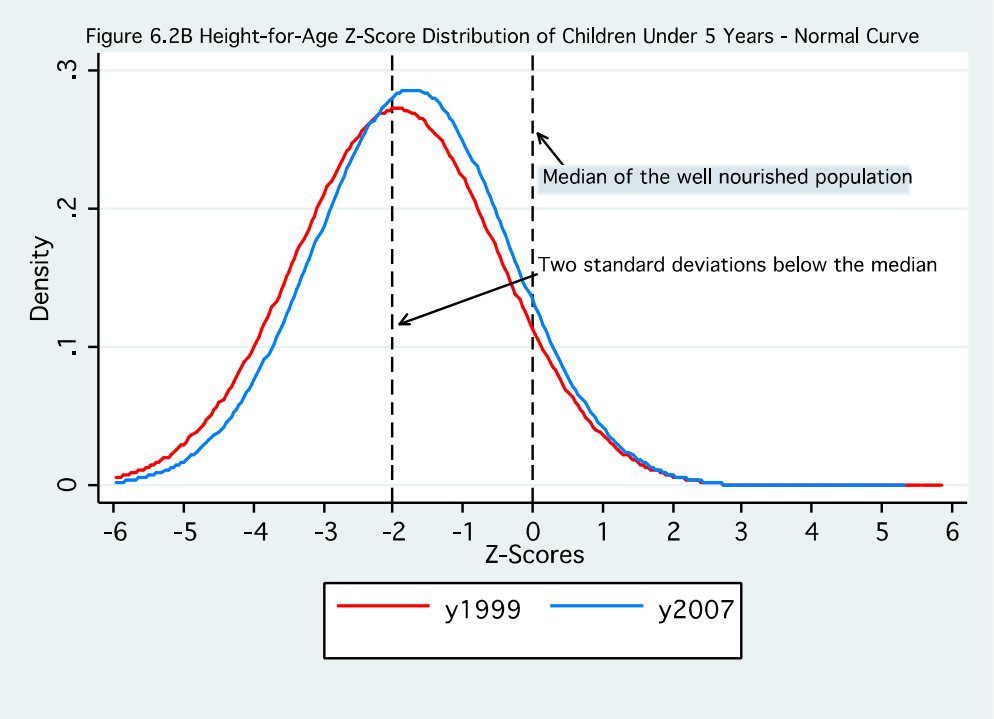
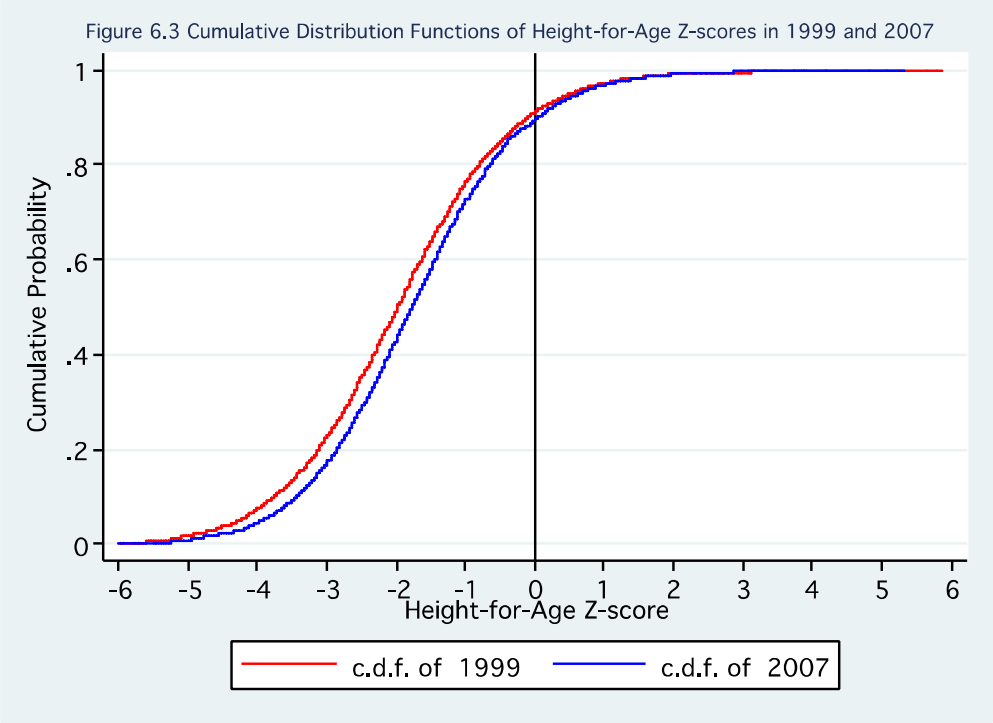


Figure 2B Height-for-Age Z-Score Distribution of Children Under 5 Years – Normal Curve



The histogram in Figure 2A and normal curves in Figure 2B show the prevalence of stunting among Bangladeshi children in 1999 and 2007. The black dashed line indicates the median of the well-nourished reference population and the red dashed line indicates the threshold for stunting (i.e. two standard deviations below the reference median). Children whose z-scores fall to the left hand side of this red dashed line are stunted. In 1999, 50 percent of Bangladeshi children under age five were stunted; in 2007 stunting declined to 44 percent. Not only did the percentage of children who were stunted decrease, but so did the percentage who were severely stunted as noted by the excess height in the red bars versus the blue bars to the left of the stunting threshold.

Figure 3 Cumulative Distribution Functions of Height-for-Age Z-scores in 1999 and 2007



In Figure 3, the Cumulative Distribution Functions (CDFs) of the two height-for-age (haz) distributions are illustrated. It is clear that $F_{2007}(haz) \leq F_{1999}(haz)$ for all haz, This amounts to saying that the CDF of 2007 is to the right of the CDF of 1999 in an ascending plot. That means the 2007 distribution of haz scores are superior to 1999 haz scores because for any cumulative probability value, it gives a higher haz score. This is knows as the "stochastic dominance" which indicates the superiority of one distribution over another. Further, Kolmogorov-Smirov test for equality of distribution functions also indicate that the 1999 and 2007 height-for-age z-scores are not equal at 0.001 confidence level (D=0.0686, p-value=0.000). Therefore these results show that not only the proportion of children who are stunted have reduced over time, but also the overall distribution of child haz scores have improved over time in Bangladesh.

4. Empirical Strategy

For the multivariate analysis, we specify a multivariate logistic regression model:

$$y = b_0 + b_1 WC + b_2 HCC + u \quad \text{.....Equation 1}$$

where 'y' denotes a binary variable which equals to one if the child has a z-score less than -2 (i.e., stunted), else zero. WC—are women's characteristics including education, partner's education, birth number of the child, age at first marriage and television viewership; and HCC— are household assets, availability of electricity, good source of drinking water and advanced sewerage system and 'u' is the error term.

This study investigates the changes in women's characteristics at macro level, and it compares two groups: one that lived in an era where women had less education, fewer employment opportunities and lower access to credit and social capital (i.e. 1999 survey); and another group that has enjoyed the fruits of economic development including gender parity in education, establishment of garment factories with female employees, more self-employment opportunities through microfinance, and fewer children to care for. Thus, it is suitable to use Oaxaca-Blinder decomposition (Oaxaca 1973; Blinder 1973) to compare these two groups. Let *D* denotes a dummy variable equal to one if the child is stunted, *X* denotes the mean of the explanatory variable(s), and *B* represents the coefficient:

$$D_{2007} - D_{1999} = [X_{2007} - X_{1999}]\, B_{1999} + [B_{2007} - B_{1999}]\, X_{1999} + \Delta X \Delta B \ldots\ldots\ldots \text{Equation 2}$$

The first component $[X_{2007} - X_{1999}]B_{1999}$ in Equation 2 can be interpreted as the predicted reduction in stunting in 1999 if women's characteristics were at 2007 levels (i.e., contribution of the mean differences in the predictors between 1999 and 2007). The second component $[B_{2007} - B_{1999}]X_{1999}$ can be interpreted as the predicted reduction in stunting in 1999 if the coefficients were same as 2007 (i.e., the contribution of the difference in the coefficients, including differences in the intercept[5]). The third component $\Delta X \Delta B$ is an interaction term $[(X_{i2007} - X_{i1999})B_{i1999} * (B_{i2007} - B_{i1999})X_{i1999})]$, which accounts for the residuals.

Note that, some explanatory variables (e.g. household assets, age at first marriage) maybe jointly determined by education level of the woman and her husband. Therefore one should be very cautious in interpreting the results in a causal

[5] This component subsumes the effects of group differences in unobserved explanatory variables (Jann 2008).

way. Most of the included predictors are, in fact, likely to be correlated with unobserved heterogeneity in preferences, cultural norms, or other location specific characteristics that may also have a direct impact on the dependent variables. For these reasons, we think that the interest of these results lie more in their descriptive content that in their causal meaning.

5. Results

5.1 Descriptive Statistics

Table 1 reports the summary statistics of the explanatory variables for each survey year, and the results of the two sample tests indicate the significance of the change over time. All variables indicate significant improvements from 1999 to 2007. The proportion of mothers with primary and secondary education increased from 29 to 32 percent and 21 to 35 percent respectively. Birth number of the child has reduced from 2.93 to 2.57; this is an indication of mother's lower fertility rate as well. Age at first marriage has risen from 14.99 to 15.41 years. Household asset scale has increased from 0.84 to 1.14, similar patterns can be seen the availability of electricity and sewerage systems, with access to good source of drinking water becoming almost universal in 2007. The dependent variable (haz) as discussed in section 3.2 declined from 50 to 44 percent in this time period.

5.2 Regression Results

The bivariate regressions presented in Table 2 are used to examine the effect of each explanatory variable individually (without controlling for other variables). Mother's and partner's secondary and higher education stand out as having the strongest negative effect on child stunting, followed by the availability of an advanced

sewerage system and electricity (-0.744 and -0.661 respectively). Birth number has a positive but weak impact on predicting child stunting. Age at first marriage leads to greater authority; therefore we see a negative impact of age at first marriage on child stunting (-0.078). This also supports the proposition that educated women are more likely to marry later, and therefore more likely to have higher agency in their lives, which positively affects child nutrition. Television viewership indicates mother's access to information regarding communicable diseases, methods to prevent diarrhea, or availability of vaccinations, and it is also an indication of mother's ability to control her leisure time. However, this variable is closely related to household wealth, as most women who watch television regularly have a television at home. Nevertheless we believe television viewership helps us to understand the pathways in which mother's status affect child stunting, therefore it is included in the multivariate analysis.

The results of the multivariate logistic regression for stunting are presented in Table 3. The first and third columns (i.e. Model 1 and 3) do not include birth number, age at first marriage and television viewership. As expected, parent's education remains significant in 1999 and 2007 even after controlling for household and community characteristics (Model 1 and 3). Controlling for partner's education, the mother's education can be interpreted as relative education (or measure of relative power). Since most men are better educated than their wives, when holding men's education constant, higher levels of education among women implies a reduction in the gap (Frankenberg and Thomas 2003). However, in model 4 the effect of mother's education disappears, while father's education remains significant. This implies that the effect of mother's education is completely explained by child's birth number, age at first marriage and television viewership in 2007. These variables are considered to

be pathways in which mother's education affects child stunting, and they seem to matter more in 2007 than in 1999.

The regression results of the household and community variables are less conclusive. In 1999, availability of electricity, good source of drinking water and advanced sewerage system had a negative impact on child stunting, however, in 2007 electricity and sewerage variables a not significant. This is because in 2007, availability of a good source of drinking water was nearly universal (97%), thus providing little variation for estimation. However, the non-significance of the sewerage variable is difficult to explain, it could be due its modest correlation (ρ = 0.49***) with the availability of electricity in 2007. The household furniture variable (a proxy for household assets) does not have a significant effect on child stunting in 1999, although it has a weak but significant in 2007. Although, some coefficients seem to differ in 1999 compared to 2007 (e.g. birth number of the child), the pooled sample chi-square test indicated that overall, the coefficients have not significantly changed over-time. This implies that, the reduction in stunting from 1999 to 2007 is mainly due to the changes in the means of the variables, and not due to the change in the relationship between the variables and stunting.

In a separate regression (not shown) we explored whether child's gender has any impact on the relationship between parent's characteristics and stunting. The results indicated that the effect of having a father who has primary education has a negative impact on boy's stunting, however, there is no significant effect for girls. Similarly, mothers who watch television at least once a week have a negative impact on boy's stunting, but not on girls. These results are congruent with earlier studies on son preference in Bangladesh. explore this further in the next section.

5.3 Oaxaca-Blinder Decomposition

In Table 4, we present the decompositions for all children under-5 years in Bangladesh. The proportion of stunted children decreases from 49.9% to 44.0% from 1999 to 2007; this is about 5.9 percentage point reduction (-0.059). Overall, about half (in bold 48%; -0.029) of the predicted reduction in stunting can be accounted for by the improvements in parent's education, birth number of the child, age at first marriage and television viewership. The other half (in bold 48%; -0.028) can be attributed to the predicted improvements in household wealth and community infrastructure from 1999 to 2007. Mother's education accounts for the largest predicted reduction in child stunting (-0.016) followed by access to good source of drinking water (-0.010). The main finding in this analysis is that, improvements in women's status are partly responsible for the predicted reduction in child stunting[6].

Gender differences in child stunting is explored in Table 5A and 5B. Overall, improvements in mother's characteristics from 1999 to 2007, account for 56% (-0.034) of the predicted reduction in stunting for boys. But for girls, improvements in mother's characteristics account for only 39% (-0.022). Further, improvements in maternal education have a significant impact on both boys and girls nutritional status; but improvements in paternal education only impacted boys' nutrition. Majority of the reduction in stunting for girls derived from improvements in household wealth and community infrastructure (59%; -0.034), which are generally available for all children in the household regardless of gender. This implies that although Bangladesh has progressed in terms of women's education, employment, access to credit and other demographic indicators; parents still favor sons over daughters.

[6] The second column labeled as $[B_{2007} - B_{1999}]X_{1999}$ does not have a significant cumulative effect on child stunting. However, if you look at the individual coefficients, you can see that the change in size of the coefficients in 2007 positively contributes to child stunting (0.197), but this is counteracted by the negative effect of the constant (-0.224). The interaction term $\Delta X \Delta B$ (i.e., residual) does not contribute to the overall reduction of stunting.

6. Discussion

As with any analysis based on cross-sectional survey data, this study has some limitations. The explanatory variables leave much of the actual change in the dependent variable unexplained as indicated by the low Pseudo R^2 of the multivariate logistic regression model. suspect that this may be due in part to a lack of information on village level variables such as number of hospitals, health clinics, pharmacies, midwives, etc which directly impacts child health and nutrition. As the goal of this study was to assess whether gains in women's status account for improvements in children's nutrition, we acknowledge this shortcoming but do not think it detracts from the findings shown here.

In addition to stunting, we attempted to investigate other indictors of child nutrition, including wasting i.e. weight-for-height (a short term indicator of nutrition) and birth weight as additional dependent variables. But wasting in Bangladesh increased by five percentage points from 1999 to 2007 and none of the variables in our model were able to explain this increase. It was found that in 2007 Bangladesh and two other South Asian countries experienced heavy monsoonal rains, which led to what is being described as the worst flood in living memory (UNICEF 2007). People suffered from diarrhea and waterborne diseases, crops and livestock were destroyed causing a food shortage and starvation. We assume that the increase in wasting might be due to this natural disaster because child's weight can temporarily fluctuate due to illness or famine. Birth weight, which is the best single predictor of malnutrition, is closely associated with poor growth. Birth weight indicates the condition of a woman during pregnancy and the quality of her life before the pregnancy. However, the BDHS data sets do not include information on the exact birth weight of the child.

7. Conclusion

Malnutrition is a close correlate of poverty, serving both as a cause and effect of poverty. Therefore, improvement in nutritional status of the population is a key factor in attaining a larger and sustained decline in poverty. This study attempted to analyze the sources of improvement (if any) in child nutrition in Bangladesh. We use child stunting, i.e. height conditional on age z scores (haz) as our measure of child nutrition. Although malnutrition rates are generally high in Bangladesh, we found significant reduction in stunting from 1999 to 2007. To explore the sources of this reduction in stunting, we first identified the predictors of stunting that have changed over time. Then we use Oaxaca-Blinder decomposition to analyze the key variables that have contributed to the reduction in stunting from 1999 to 2007.

The results indicated that women's education, their partner's education, age at first marriage, birth number of the child and television viewership improved significantly from 1999 to 2007 in Bangladesh. Additionally, indicators of economic development such as household assets, availability of electricity, good sources of drinking water and advanced sewerage system have also significantly improved in the same period. Multivariate logistic regression showed that mother's education, father's education, household assets and community infrastructure have an independent effect on child stunting. Birth number of the child, mother's age at first marriage and television viewership are pathways in which mother's education affects child nutrition. Therefore, when these variables are added to the logistic models, the effect of the mother's education diminished in 1999 and completely disappeared in 2007.

The results from the Oaxaca-Blinder decomposition revealed that almost half of the reduction in stunting is due to changes in women's characteristics. The other half is due to changes in household assets and community infrastructure. In a separate

analysis we explored the differences in the decomposition results by child's gender. For boys, improvements in parent's education accounted for a large portion of the reduction in stunting, but for girls the effect was smaller. In fact, the majority of the reduction in stunting for girls comes from improvements in household assets and community infrastructure, which are usually available for all children regardless of their gender. These results confirm two things: improvements in women's education (net of partner's education), age at first marriage, fertility (thus birth number of the child) and access to information through television viewership is partly responsible for the overall improvement of child nutrition. However, because parents still favor sons over daughters in Bangladesh, the effect of parent's education is weaker for girls than for boys.

From a welfare policy point of view, these results are encouraging, as empowering women through mandatory school enrollment, microcredit programs and distribution of contraceptives have benefited the nutritional status of children, which will ultimately impact the economic growth of the country. However, there is still work to be done in terms of improving norms and attitudes towards female children in Bangladesh.

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Table 1: Summary Statistics of the Explanatory Variables: Child Stunting

Explanatory Variables	1999 N=5,313	2007 N=5,328	Two Sample Test
Mother's Characteristics (age 15-49 years)			
Mother's education level			
No Education	0.46	0.27	***
Primary Education	0.29	0.32	*
Secondary Education	0.21	0.35	***
Higher Education	0.04	0.06	***
Partner's education level			
No Education	0.43	0.35	***
Primary Education	0.25	0.28	***
Secondary Education	0.22	0.26	***
Higher Education	0.10	0.11	+
Birth number of the child	2.93	2.57	***
Mother's age at first marriage	14.99	15.41	***
Mother watches TV at least once a week %	0.31	0.45	***
Household & Community Characteristics			
Household furniture as a proxy for assets (scale 0-2)	0.84	1.14	***
Household has electricity %	0.29	0.45	***
Access to a good source of drinking water %	0.71	0.97	***
Advanced sewerage system %	0.09	0.23	***

Notes: All parameters are weighted according to the survey design
***p<0.001, **p<0.01, *p<0.05, +p<0.10
Source: BDHS

Table 2: Bivariate Regression Predicting Child Stunting

Explanatory Variables	Bivariate	
	Coeff	Sig
Mother's Characteristics (age 15-49 years)		
Mother's education level		
No Education (Reference)		
Primary Education	-0.211	***
Secondary Education	-0.762	***
Higher Education	-1.517	***
Partner's education level		
No Education (Reference)		
Primary Education	-0.238	***
Secondary Education	-0.631	***
Higher Education	-1.365	***
Birth number of the child	0.085	***
Mother's age at first marriage	-0.078	***
Mother watches TV at least once a week %	-0.551	***
Household & Community Characteristics		
Household furniture as a proxy for assets (scale 0-2)	-0.396	***
Household has electricity %	-0.661	***
Access to a good source of drinking water %	-0.333	***
Advanced sewerage system %	-0.744	***

Notes: All coefficients are weighted according to the survey design

***p<0.001, **p<0.01, *p<0.05, +p<0.10

Source: BDHS

Table 3: Multivariate Logistic Regressions: Predicting Child Stunting in Bangladesh, 1999 and 2007

	Logistic Regression Coefficients				
	1999		2007		
	Model 1	Model 2	Model 3	Model 4	
Mother's Characteristics (age 15-49 years)					
Mother's education level					
No education (Reference)					
Primary Education	-0.139 +	-0.137 +	0.022	0.084	
	(0.076)	(0.078)	(0.090)	(0.093)	
Secondary Education	-0.380 ***	-0.346 **	-0.252 *	-0.145	
	(0.102)	(0.107)	(0.103)	(0.112)	
Higher Education	-0.797 **	-0.672 **	-0.404 *	-0.307	
	(0.233)	(0.241)	(0.204)	(0.218)	
Partner's education level					
No education (Reference)					
Primary Education	-0.140 +	-0.141 +	-0.079	-0.074	
	(0.080)	(0.080)	(0.089)	(0.089)	
Secondary Education	-0.299 **	-0.285 **	-0.281 **	-0.275 **	
	(0.094)	(0.094)	(0.101)	(0.101)	
Higher Education	-0.685 ***	-0.655 ***	-0.756 ***	-0.766 ***	
	(0.156)	(0.156)	(0.167)	(0.167)	
Birth number of the child		-0.011		0.054 *	ξ
		(0.016)		(0.022)	
Mother's age at first marriage		-0.025 *		0.008	
		(0.013)		(0.015)	
Mother watches tv at least once a week		-0.141 +		-0.071	
		(0.079)		(0.082)	
Household & Community Characteristics					
Household furniture as	-0.059	-0.055	-0.096 +	-0.101 *	
a proxy for assets (scale 0-2)	(0.049)	(0.049)	(0.051)	(0.051)	
Household has electricity	-0.238 **	-0.175 *	-0.277 **	-0.243 **	
	(0.077)	(0.082)	(0.081)	(0.087)	
Access to a good source of drinking water	-0.152 *	-0.158 *	-0.053	-0.044	
	(0.067)	(0.068)	(0.184)	(0.184)	
Advanced sewerage system	-0.287 *	-0.264 *	-0.104	-0.103	
	(0.123)	(0.124)	(0.091)	(0.092)	
Constant	0.554 ***	0.967 ***	0.334 +	0.027	
N Observations	5,304	5,304	5,323	5,323	
Wald Chi-square	252.58	258.81	179.67	190.42	
Pseudo R-square	0.040	0.042	0.036	0.038	

Pooled Sample F-test (Model 2 & 4):	13.45 (p value =0.4138)	
Joint Tests of Significance:	Model 2	Model 4
Mother's Education	12.98**	7.08+
Partner's Education	19.22***	23.08***

Notes: All coefficients are weighted according to the survey design; roubst standard errors are presented in parentheses
***p<0.001, **p<0.01, *p<0.05, +p<0.10

ξ = 1999 and 2007 coefficients significantly different from one another ($p <= 0.05$)

Source: BDHS

Table 4: Oaxaca-Blinder Decomposition: Child Stunting -- All Children

	$(X_{2007}-X_{1999})B_{1999}$			$(B_{2007}-B_{1999})X_{1999}$			$\Delta X \Delta B$		
Mother's Characteristics (age 15-49 years)	**48%**	**-0.029**	***	**-331%**	**0.197**	**	**-18%**	**0.011**	
Mother's education		-0.016	***		0.029			0.010	
Partner's education		-0.006	**		0.003			0.000	
Birth number of the child		0.001			0.046	*		-0.006	*
Mother's age at first marriage		-0.002	*		0.115			0.003	
Mother watches tv at least once a week		-0.005			0.005			0.002	
Household & Community Characteristics	**48%**	**-0.028**	***	**-13%**	**0.008**		**-10%**	**0.006**	
Household furniture as a proxy for assets		-0.004			-0.009			-0.003	
Household has electricity		-0.007	*		-0.005			-0.002	
Access to a good source of drinking water		-0.010	*		0.019			0.007	
Advanced sewerage system		-0.008	*		0.003			0.005	
Constant				**376%**	**-0.224**	**			
Change in stunting:					-0.059	***			
Due to change in all means $(X_{2007}-X_{1999})B_{1999}$					-0.057	***			
Due to change in all coefficients $(B_{2007}-B_{1999})X_{1999}$					-0.019				
Due to change in all interactions $\Delta X \Delta B$					-0.017				

Notes: All coefficients are weighted according to the survey design

***p<0.001, **p<0.01, *p<0.05, +p<0.10

Source: BDHS

Table 5A . Oaxaca-Blinder Decomposition: Child Stunting -- Boys

	$(X_{2007}-X_{1999})B_{1999}$		$(B_{2007}-B_{1999})X_{1999}$		$\Delta X \Delta B$	
Mother's Characteristics (age 15-49 years)	**56%**	**-0.034** ***	**-254%**	**0.156**	**-13%**	**0.008**
Mother's education		-0.020 **		0.033		0.011
Partner's education		-0.009 **		0.018		0.003
Birth number of the child		0.001		0.037		-0.004
Mother's age at first marriage		-0.001		0.076		0.002
Mother watches tv at least once a week		-0.005		-0.008		-0.004
						-0.004
Household & Community Characteristics	**37%**	**-0.023** **	**55%**	**-0.034**	**14%**	**-0.009**
Household furniture as a proxy for assets		-0.003		-0.018		-0.006
Household has electricity		0.000		-0.014		-0.007
Access to a good source of drinking water		-0.013 *		-0.007		-0.002
Advanced sewerage system		-0.007		0.004		0.007
Constant			**206%**	**-0.127**		
Change in stunting:			**-0.062** ***			
Due to change in all means $(X_{2007}-X_{1999})B_{1999}$			-0.057 ***			
Due to change in all coefficients $(B_{2007}-B_{1999})X_{1999}$			-0.004			
Due to change in all interactions $\Delta X \Delta B$			0.000			

Table 5B . Oaxaca-Blinder Decomposition: Child Stunting -- Girls

	$(X_{2007}-X_{1999})B_{1999}$		$(B_{2007}-B_{1999})X_{1999}$		$\Delta X \Delta B$	
Mother's Characteristics (age 15-49 years)	**39%**	**-0.022** **	**-387%**	**0.222** *	**-22%**	**0.013**
Mother's education		-0.013 *		0.023		0.009
Partner's education		-0.002		-0.013		-0.002
Birth number of the child		0.001		0.053		-0.007
Mother's age at first marriage		-0.003 *		0.142		0.004
Mother watches tv at least once a week		-0.004		0.018		0.009
Household & Community Characteristics	**59%**	**-0.034** ***	**-82%**	**0.047**	**-36%**	**0.020**
Household furniture as a proxy for assets		-0.005		-0.001		0.000
Household has electricity		-0.013 **		0.004		0.002
Access to a good source of drinking water		-0.006		0.042		0.016
Advanced sewerage system		-0.009		0.002		0.003
Constant			**530%**	**-0.304** *		
Change in stunting:			**-0.057** ***			
Due to change in all means $(X_{2007}-X_{1999})B_{1999}$			-0.056 ***			
Due to change in all coefficients $(B_{2007}-B_{1999})X_{1999}$			-0.035			
Due to change in all interactions $\Delta X \Delta B$			0.033			

Notes: All coefficients are weighted according to the survey design
***p<0.001, **p<0.01, *p<0.05, +p<0.10
Source: BDHS