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HEDG Working Paper 10/07

The Impact of Macroeconomic Policies on the Anthropometric Measures of Children: Evidence from Bangladesh

Mohammad Iftekher Hossain

June 2010

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Mohammad Iftekher Hossain

University of York

Email: mih501@york.ac.uk

Abstract

In this paper we investigate the associations between macroeconomic policies and the health status of children in Bangladesh. We use three waves of a repeated cross-section dataset: Bangladesh Demographic and Health Survey 2000, 2004 and 2007. We measure the health status of children by their anthropometric measures. The policies we evaluate are the Millennium Development Goals Focused Comprehensive Maternal Care Policies and the Poverty Reduction Strategy. Using the method of difference-in-differences we find positive impacts of the policies in improving the anthropometric measures of children. To account for the distributional consequences of the policies we also assess the impacts of the policies using the weighted-difference and difference-in-weighted-differences estimators. The weighted-difference estimator for a given policy and period is the difference between the average health of treatment and control children adjusted by inequality indices. We compute the difference-in-weighted-differences estimator for a policy by taking the difference between the weighted-difference estimators in the post- and pre-policy periods. Applying this method we also observe positive associations between the policies and indicators of health. In this study we find that, in a developing country like Bangladesh, well-designed macroeconomic policies targeting the socioeconomic and health needs of children can lead to a substantial benefit to their health status.

Keywords: Difference-in-differences; Weight-for-age z-scores; Height-for-age z-scores; Poverty Reduction Strategy (PRSP); Difference-in-weighted-differences

Acknowledgement: I am extremely grateful to Andrew Jones and Nigel Rice for their detailed reading and extensive comments.

1. Introduction

Malnutrition is a major contributor to high infant and under-five mortality rates and the poor level of childhood health in Bangladesh (BBS, 2009; Nasreen et al., 2007). Since 1990, various macroeconomic policy initiatives have been devoted to reducing the prevalence of malnutrition. However, currently over one-third of the children in Bangladesh are severely malnourished (BBS, 2009). In this paper we test the hypothesis that although macroeconomic policies have failed to reduce levels of malnutrition in Bangladesh to a desired level, some of the policies have had some degree of success in improving childhood health. Well-designed macroeconomic policies that focus on socioeconomic, genetic or biological determinants of child health could improve the health of target children greatly.

An important factor affecting the health stock of a child is the use of maternal health care services by his/her mother. This has been well documented in the recent literature (Nilsson, 2008; Almond and Majumder, 2008). Unfortunately, more than one-third of mothers in Bangladesh do not make use of antenatal health care services and three-quarter of them do not have access to a skilled attendant at birth (BBS, 2009). Levels of utilization of prenatal health care and the quality of prenatal care provided were extremely poor prior to 2000 (BDHS, 2000). In response to the low utilization rate of maternal health care services and to attain the Millennium Development Goals (MDG)[1] regarding mother and child health, the Government of Bangladesh, together with bilateral and multilateral organizations such as US Aid, DFID, WHO, and the World Bank have been implementing a number of programmes since 2000 (UNDP, 2007). The Rights-Based Comprehensive National Maternal Health Policy was adopted in 2001 and included in the Health and Population Sector programme (HPSP 1998-2003). The objectives of the policy were to ensure a better quality of basic services including family planning and safe motherhood programmes, and youth services and child care. The policy aimed to provide these services at the primary health care level, through health facilities. Since the HPSP came to an end in June 2003, the Government of Bangladesh has been implementing the Health, Nutrition and Population Sector programme (HPNSP 2003-2011).

[1] Health related Millennium Development Goals are to reduce child mortality, to improve maternal health and to combat against HIV/AIDS, malaria and other diseases by 2015 (UNDP, 2005).

Poverty is another important factor having a negative influence on child health and development (Bradley and Robert, 2002). 40% of the total population in Bangladesh are living below the poverty line with a per capita expenditure of less than one dollar per day (BBS, 2009). To eradicate poverty the Government of Bangladesh has taken a sector wide approach (SWAP) and a Poverty Reduction Strategy. The Interim Poverty Reduction Strategy Paper (IPRSP) and Poverty Reduction Strategy Paper (PRSP), published in 2003 and 2005 respectively, set out the government's commitment to reducing poverty in Bangladesh. The government allocated the annual budgets from 2003-2004 to 2006-2007 in light of the policies set out in the IPRSP and PRSP, with the objective of reducing poverty by improving the health, nutrition and family well-being of the vulnerable: the poor, women, children and the elderly.

Progress made through implementation of these programmes has been observed and reported. The infant mortality rate has decreased from 92 per 1000 live births to 45 per 1000 in the last two decades (UNDP 2007, BBS 2009) and the under-five child mortality rate declined from 146/1000 to 67/1000 during this period (BBS, 2009). However, no studies have used anthropometric indicators or direct measures of health status to assess the impact of these policies. Our paper represents a first attempt to do so.

In this paper we begin by explaining the trends and distributions of the height-for-age and weight-for-age z-scores of children. We then describe the associations between the anthropometric indicators of the children and contributing factors, such as height-for-age z-score of mothers, education of parents, asset index scores, and utilization of health care services. The descriptive analysis is in accordance with the standard hypothesis that the health stock of children is significantly associated with the use of maternal health care services and poverty. We, therefore, select two broad policies that target the utilization of maternal health care services and eradication of poverty. The first policy we select for evaluation is the MDG-focused Comprehensive Maternal Care Policy which was implemented between 2001 and 2004. The second policy we select for evaluation is the Poverty Reduction Strategy that was implemented between 2003 and 2007. We analyse the impacts of these policies using the methods of difference-in-differences (Card, 1990; Card and Krueger, 1994; Blundell, Duncan and Meghir, 1998), differential-in-total-differentials and difference-in-weighted-differences analysis.

In this study we use information on the most recent child in each household from the repeated cross-section waves of Bangladesh Demographic and Health Survey. Our study is based on similar groups of children to represent groups before and after the interventions. For the maternal care policies children who received maternal care represent the treatment group and children who did not receive maternal care make up the comparison group. Poor children comprise the treatment group for the poverty reduction policies and non-poor children constitute the comparison group. The policies considered here are broad macroeconomic policies and are not randomised. Members of the comparison groups are not strictly prohibited from accessing the benefits of the programmes. The results, therefore, provide a narrative justification for the macroeconomic development programmes that target children's health, but do not offer rigorous causal impacts of the policies.

The paper is organized as follows. The use of difference-in-differences and difference-in-weighted-differences to assess the broad health policies is described in Section 2. Section 3 describes the data, variables and policies. Section 4 presents the descriptive analysis for the anthropometric measures of child health in Bangladesh. Section 5 is devoted to the effects of the policies studied. Section 6 contains the summary and concluding remarks.

2. Evaluation of Macroeconomic Policies

2.1 Average Health

The main purpose of our study is to describe the impact of two broad non-randomised macro policy interventions on child health. We differentiate between target and control groups of children, on the basis of utilization of services for policies focusing on maternal health care services. On the other hand, target and control groups are differentiated on the basis of the weights placed on them in the PRSP.

The use of randomised controlled trials to evaluate broader health policies is rare and instead quasi-experiments (Jones and Rice, 2009; Gertler, 2004; Bleakley, 2007; Pop-Elaches, 2006; Almond, 2006; Lien 2005). To estimate policy impacts these experiments often use econometric approaches such as instrumental variables (IV), regression discontinuity, propensity score matching or difference-in-differences. Several studies in economics and health economics use difference-in-differences analysis to evaluate the impacts of programmes and policies (Card, 1990; Ashenfelter, 1978; Heckman and Rob, 1985; for a review read Jones, 2009).

In this study we denote the outcome of interest as h. The treatment effect of interest is the change in the potential outcome for a child exposed to an intervention in comparison to exposure to the alternative:

$$\Delta_i = h_i^1 - h_i^0 \qquad (1)$$

Where, 1 denotes treatment and 0 denotes the alternative.

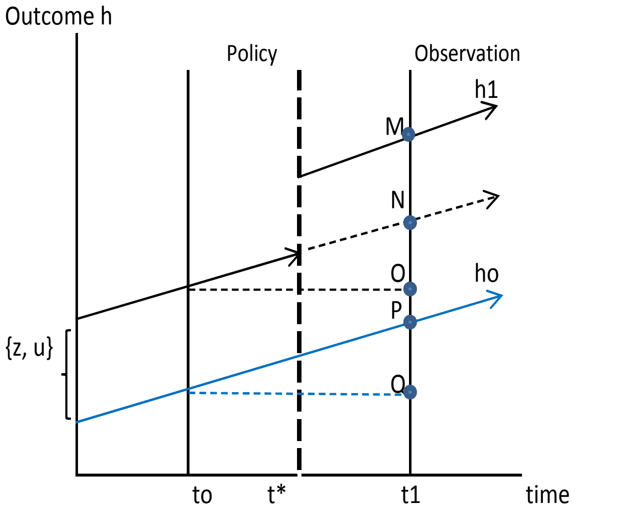


Figure 1: A simple example of potential outcomes
[Group difference favouring treatment children]

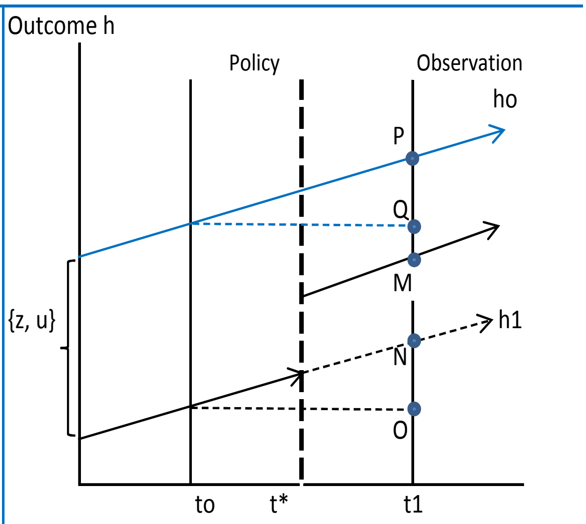


Figure 2: A simple example of potential outcomes
[Group difference favouring control children]

We also face the typical evaluation problem specified by Rubin (1974) that a subject cannot be observed to be under the control and under the treatment at the same time. In our study, a child cannot be observed to be under the treatment and under the control in the same period. The problem is even greater in our study as a particular child is less likely to be observed in both periods. To deal with these issues, we use the difference-in-differences analysis using repeated cross-section waves of the BDHS. Figure 1 and Figure 2 illustrate possible outcomes of the difference-in-differences analysis and the limitations of other approaches such as a simple comparison between treatment and alternative using a cross-section dataset in the post-policy period and a before and after comparison using only the average treatment effect on the treated using repeated cross-section waves.

Figure 1 plots the potential outcomes for the treated (h^1) and control (h^0) children plotted against time by assuming a common linear trend over time. The policy is implemented at t*, whereas, t_0 and t_1 denote the pre-policy and post-policy period respectively. There is a potential outcome gap between the groups due to observed and unobserved confounders prior to the policy {z,u}. A simple comparison of the mean outcomes for the treated and the control children using a cross-section dataset at the time t_1 will overestimate the true treatment effect MN by the amount of selection bias NP. On the other hand, a 'before and after' comparison using repeated cross section waves only for the treatment will overestimate the true treatment effect by the vertical distance ON. Figure 2 displays the situations when the potential outcome gap before the policy is in favour of the alternative group. In such case, a simple comparison of the mean outcomes for the treatment and the control children using a cross-section dataset at the time t_1 will totally misrepresent the treatment effect. On the other hand, a 'before and after' comparison using repeated cross section datasets only for the treatment will overestimate the true treatment effect as before. The difference-in-differences analysis can account for these potential biases.

For the difference-in-differences analysis, we assume a parallel trend between the groups in the absence of the policy intervention. Graphically this estimates the treatment effect by taking the difference between the change over time for the treated (MO) and the difference over time for the control (PQ=NO). As specified by Jones and Rice (2009) at the presence of common trend between the groups, the resulting difference-in-differences, MN [=MO-PQ=MO-NO], equals the true treatment effect of the policy.

More formally, the treatment effect is (see Jones and Rice, 2009):

$$\tau = E[h^1 - h^0 | C = 1] - E[h^1 - h^0 | C = 0] \quad (2)$$

It is worth mentioning that we use repeated cross-section waves to obtain data for the pre-policy (t_1) and post-policy (t_0) periods on the treated (C_1) and control (C_0) groups. Assuming the validity of additive structure of the model and no correlation between the error term and other variables, we define the expected outcomes as:

$$E[h|t_0, C_0] = \alpha \quad (3)$$

$$E[h|t_0, C_1] = \alpha + \gamma \quad (4)$$

$$E[h|t_1, C_0] = \alpha + \beta \quad (5)$$

$$E[h|t_1, C_1] = \alpha + \gamma + \beta + \tau \quad (6)$$

Where γ, β, and τ stand for the group difference, common time trend and treatment effect respectively. Then the difference-in-differences estimator (Card, 1990; Card and Krueger, 1994) can be obtained from:

$$E[h^1 - h^0|C_1] - E[h^1 - h^0|C_0] = \{[\alpha + \gamma + \beta + \tau] - [\alpha + \gamma]\} - \{[\alpha + \beta] - \alpha\} = \boldsymbol{\tau} \quad (7)$$

In this study we derive the difference-in-differences estimator of a policy, $\hat{\tau}$,using the Ordinary Least Square (OLS) approach (see Athey and Imbens, 2006; Jones and Nigel 2009). The regression model used to estimate $\hat{\tau}$ is:

$$h_i = \alpha + \beta t + \gamma c_i + \tau W_i + e_i \quad (8)$$

Where W_i is the interaction term between the group indicator c_i and time indicator t_i.

The difference-in-differences approach to assess the impact of broader policy interventions on health is applicable for these policies and available repeated cross-section waves. It is possible to identify the children before and after the policy interventions eligible for treatment and control. The policies considered here are directed to children with certain characteristics. In the Poverty Reduction Strategy (IPRSP and PRSP) greater focus is given to poorer children. Children who received maternal health care services are only benefited from the maternal health care policy. For the Poverty Reduction Strategy, the composition of the observations in the two waves has not changed over time. On the other hand, for the MDG focused maternal care policies the composition of the observations has changed over time. However, in terms of other observable characteristics the groups remain similar in both periods.

2.2 Distribution of Health

The evaluation of a policy using the difference-in-differences analysis can be used to describe the average gain in children's health due to the policy intervention. One of the problems with this approach is that it fails to account for the distributional impact of the policy, which is also an important area of concern for a broad health policy. A macroeconomic policy in a developing country is less likely to have a homogeneous effect on each target child. In a national policy, which places higher weights on the target children compared with the control children, it is more plausible that during the implementation stages different weights are indirectly placed on different children in the treatment group. One way to address the distributional impact of a policy intervention is to calculate inequality indices for each group and period and to use those indices to calculate the differential-in-total-differentials estimators.

This approach is an extension to the total-differential approach of Wagstaff, van Doorslaer and Watanabe (2003). Using data from Vietnam they estimate the total-differential estimator between the concentration indices for child health in 1998 and 1993 to describe the changes in distribution of health over time. Following and extending their approach, we can first estimate the concentration index or the health pseudo-Gini index to measure inequality in health within each group and period. The convenient cumul test regression method of calculating the concentration index can be used to measure and compare the degree of socio-economic inequalities in child health (Gwatkin et al., 2003; Wagstaff et al., 2003; Kakwani, Wagstaff and Doorslaer 1997):

$$2\sigma_r^2\left(\frac{h}{\mu}\right)|C,t = \beta_0 + \beta_1 r + \varepsilon|C,t \qquad (9)$$

Here r is the fractional rank variable and σ_r^2 is the variance of the fractional rank. The sample analog of above equation is:

$$2\hat{\sigma}_r^2\left(\frac{h}{\mu}\right)\Big|C,t = \hat{\beta}_0 + \hat{\beta}_1 r + e\Big|C,t \qquad (10)$$

The estimated coefficient of the rank variable, $\widehat{\beta}_1$, is the concentration index given C_i and t_i and the SE[$\widehat{\beta}_1$] is the approximated standard error of the concentration index. After estimating the concentration indices for each group and period, the simple differential-in-total-differentials estimator can be computed using these inequality indices which could describe the changes in distribution after implementation of the policy.

Similarly, by ranking the children according to their health, the health pseudo-Gini index $(G(h^j))$, a measure of inequality of outcomes, (Fleurbaey and Schokkaert, 2007) can be computed. According to the egalitarian-equivalence principle, inequality is zero if two children with similar demographic and biological conditions are able to reach the same health status. This can be measured using the health pseudo-Gini index, which can be computed applying equations (9) and (10), however, their health status is used as the rank variable instead of a measure of assets. Then the estimated coefficient of the rank variable, $\hat{\beta}_1$, is the health pseudo-Gini index given C_i and t_i and the SE[$\hat{\beta}_1$] is the approximated standard error. By applying the simple differential-in-total-differentials analysis using the health pseudo-Gini indices it is possible to describe changes in the distribution of health in the target group of a policy from the egalitarian equivalence perspective.

2.3 Link between average health and distribution of health

A potential downside of the ordinary least squares based difference-in-differences method and inequality indices based differential-in-total-differentials method is that they fail to create a link between the average outcome and the distributional impact of the policy. The weighted-difference estimators such as the CI-based weighted-difference estimator or the health pseudo-Gini based weighted-difference estimator can be used to develop a link between the average outcomes and distributional consequences. The health pseudo-Gini index based weighted-difference estimator between the treatment and control for a given period can be computed following the Sen Index (Sen and Foster, 1997):

$$[G_i^*|t_i] = [\mu_{C=1}(1 - G_{C=1}) - \mu_{C=0}(1 - G_{C=0})]\ \ |t_i\ ; i = 0, 1 \tag{11}$$

$$\tau_{G*} = \Delta G_i^* = G_1^* - G_0^* \tag{12}$$

Where μ denotes the mean of health and G denotes the health pseudo-Gini coefficient.

The difference-in-weighted-differences estimator τ_{G*} can be derived by taking the difference between the weighted-difference estimator in the post-policy period (G_1^*) and the weighted-difference estimator in the pre-policy period (G_0^*). The estimated $\hat{\tau}_{G*}$ can be defined as the sample health pseudo-Gini index adjusted treatment effect. The sample CI-adjusted treatment effect can be derived by replacing the pseudo-Gini indices in equation (11) by the corresponding concentration indices and then applying a before and after comparison:

$$[CI_i^*|t_i] = [\mu_{C=1}(1 - CI_{C=1}) - \mu_{C=0}(1 - CI_{C=0})]\ \ |t_i\ ; i = 0, 1 \tag{13}$$

$$\tau_{CI*} = \Delta CI_i^* = CI_1^* - CI_0^* \tag{14}$$

Equations (12) and (14) estimate the treatment effect by estimating the changes between the weighted-difference among treatment and control groups in the post-policy period and the weighted-difference among treatment and control groups in the pre-policy period. The resulting difference describes the adjusted association between the policy and health status of the target group.

3. Data, Variables and Policies

3.1 Bangladesh Demographic and Health Survey

We use data from the Bangladesh Demographic and Health Surveys (BDHS). BDHS has been important sources of individual and household-level health and health care data since 1993. Since the beginning of the Demographic and Health Survey (DHS) in the 1980s, a recode file is designed to maintain consistency and comparability across the surveys. Our study use three repeated cross-section waves of BDHS: BDHS 2007, BDHS 2004 and BDHS 2000. Each wave is nationally representative with a sample size of around 10000 households. Our study makes use of data from children under 5-years. To take full advantage of the data we use the most recently born child. The BDHS waves include information on anthropometric measures of children's health, their socio-economic background, use of health care and an asset index score. More information about the survey, indicators and quality can be found at http://www.measuredhs.com.

3.2 Variables: Child Health and Circumstance Factors

We make use of height-for-age z-scores (HAZ) and weight-for-age z-scores (WAZ) to measure the health outcomes. Though the infant mortality rate is a widely used indicator of child health in developing countries (Jones et al., 2003), there are also examples of the use of anthropometric measures (Wagstaff, van Doorslaer and Watanabe, 2003). Assessing the anthropometric indicators of children is important .due to a number of reasons. The weight-for-age z-scores are indicative of the long-term and short-term effects of the covariates and height-for-age z-scores can explain the long-term consequences of the covariates on child health (O'Donnell et al., 2007). Both indicators are indicative of a wider health environment that determines the adult health of the surviving children and the initial health stock of the next generation. Children with poor anthropometric measures usually grow up with greater morbidity and have a lower life expectancy.

We follow the conventional approach in calculating z-scores for the anthropometric measures (see Alderman, 2000; Owen O'Donnell et al. 2007). The US National Centre for Health Statistics (NCHS) is the reference population for our study. We first calculate the difference between the health score of a child and the median value of the NCHS children from the same sex and age. We then divide the score by the standard deviation of the reference children. This produces the continuous values of z-scores, with low values denoting bad health.

We apply the regression analysis to describe the state of child health by waves. The regressors included in the analysis are: child is a twin; age of the child; age squared of the child; height-for-age z-score of mother; sex of the child; education of mother; education of father; breastfeeding; utilization of antenatal care; utilization of a skilled attendant at birth; and an asset index factor score of the household. We use 'whether the child had been ill recently' as an additional regressor in the models for the weight-for-age z-scores. This variable indicates the experience of any illness such as fever or diarrhoea prior to the survey. We use variables such as age, height-for-age z-score of mother, and the gender dummy as the genetic and biological factors (vector X). The vector of circumstance factors (Z) includes the remaining variables. Educated parents have an important influence on the health of children (T Adam et al., 2005) and we use years of education as a measure of parental education. Several studies report that use of maternal care is related to the development of child health (Holian J., 1989; Paul, 1991; P. Gertler et al., 1993). Our models use variables such as utilization of prenatal health care services and use of a skilled attendant at birth as two of the key independent variables.

Our study use an asset index score to measure the socio-economic position of the household within which the child resided. We obtain the concentration indices by ranking the children by their asset index scores. Generally, income or expenditure data is used to rank the population by their living standards to derive inequality indices. When those data are not available, many studies use asset index scores to rank the population by their socio-economic status (Montgomery et al., 2000; Filmer and Pritchell, 2001; Wagstaff and Watanabe, 2003).

3.3 Selection of the Policies and Groups for the Evaluation

We select two macroeconomic policies, one of which targeted the use of maternal care, and the other which targeted the eradication of poverty. After 2000, the government and donors were committed to providing better quality maternal care with the objective of achieving the MDG goals. However, a proportion of mothers did not use those maternal care services, which creates a natural experiment to assess the impacts of the Millennium Development Goals (MDG) focused maternal care policies on child health. Similarly, greater weight on the poverty-focused projects through the Poverty Reduction Strategy between 2003 and 2007 creates a natural experiment in which to assess the impacts of the PRSP on child health.

The Government of Bangladesh signed the Millennium Development Goals (MDG) in September 2000. The MDG goals aim to improve the health of mothers and children by ensuring the provision of improved quality maternal and child care services nationwide. Health Sector policies incorporated the commitment of the government, non-governmental organizations and donors immediately after the MDG. The government gave more emphasis to providing training for health care providers, to ensure responsiveness of the services and to make potential mothers aware of the importance of utilization of frequent maternal and child health care services. After the signing of the MDG in 2000, the overall health system responded to the provision of quality maternal care.

The Poverty Reduction Strategy (PRSP) was aimed at the eradication of poverty as a whole by providing a sector-wide focus on the poor. The IPRSP and PRSP were mostly implemented through the annual budgets from 2003-04 to 2006-07 by providing greater weights to projects aimed at the poor. Not all projects were directly intended for poor children, they were designed so that poor children would benefit through a better targeting of poor households.

We use repeated cross section waves to identify treatment and control children. Assignment to treatment and comparison groups is based on utilization of the policy for the MDG interventions. From the BDHS 2000 we select children who received maternal care to comprise the treatment group before the policy ($C_1|t_0$). Children who did not receive maternal care in the pre-policy period (BDHS 2000) constitute the alternative before the policy ($C_0|t_0$). Further, children who did not receive maternal care after the policy (BDHS 2004) constitute the alternative in the post-policy period ($C_0|t_1$). To evaluate the PRSP (IPRSP and PRSP), poor children in the pre-policy period (BDHS 2000) are eligible for treatment before the policy and poor children in the post-policy period (BDHS 2007) are eligible for treatment after the policy. To adjust for selection bias, non-poor children are selected to constitute an alternative group before and after the policy. Table 1 summarizes the children and cross-section waves eligible for the 'before and after' comparisons.

Table 1: Target and Comparison Groups for the Difference-in-Differences Analysis

Policy	Control group T0	Benefitted/ Target group T1	BDHS Datasets Before (t0)	After (t1)
MDG	Children not receiving maternal care Children aged 7-36 months	Children receiving maternal care Children aged 7-36 months	2000	2004
PRSP	Children from non-poor households Children aged 0-59 months	Children from poor households Children aged 0-59 months	2000	2007
PRSP -2005	Children from non-poor households Children aged 0-24 months	Children from poor households Children aged 0-24 months	2000 2004	2007

4. Descriptive Statistics

Table 2 summarizes the anthropometric measures in Bangladesh between 2000 and 2007. The average values of the anthropometric measures are less than -1.5 in each survey year. From the data a severe prevalence of stunting and wasting is evident, according to the WHO classification system (WHO, 1995). In each survey year, more than one-third of the children were stunted and approximately two-fifths of them were wasted. Table 2 shows two other striking features. First, severe malnutrition in children compared with the reference was common in Bangladesh. Second, though there was some progress over time in reducing the prevalence of stunting, there was no visible progress in reducing the prevalence of wasting between 2000 and 2007.

Table 2: Descriptive Statistics for Child Malnutrition in Bangladesh, 2000-2007
Sample of Most recent child of the household aged 0-59 months

	HAZ 2000	HAZ 2004	HAZ 2007	WAZ 2000	WAZ 2004	WAZ 2007
μ (Mean)	-1.729	-1.67	-1.508	-1.796	-1.806	-1.788
S.D.	1.322	1.281	1.266	1.104	1.097	1.091
% below -2 S.D.	41.088	39.433	33.936	45.842	45.256	45.129
% below -3 S.D.	15.817	14.023	10.935	12.281	12.401	10.893

We also describe the distribution of health of children using the concentration curves (Figure 3-6) for child malnutrition. The health variables used in this study are negative except for a few children. Hence, the concentration curves for the malnutrition above the line of equality indicate evidence of pro-poor concentration of malnutrition. We also apply dominance tests between the

Figure 3:Concentration Curve for Child Malnutrition (HAZ)

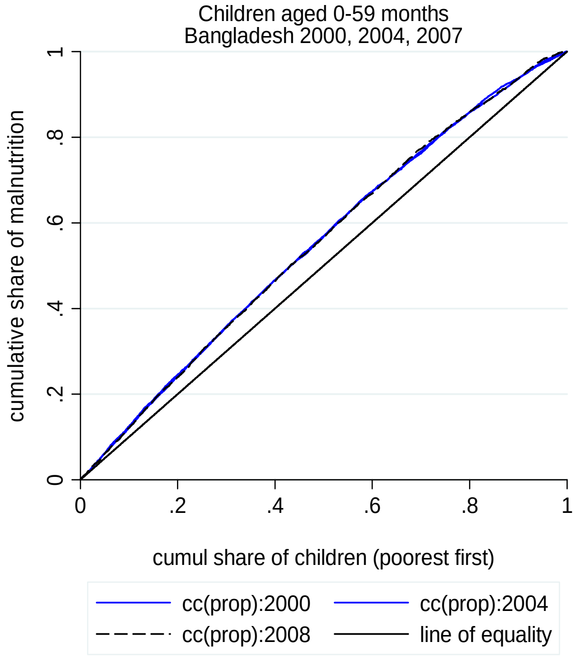


Figure 5:Concentration Curve for Child Malnutrition (WAZ)

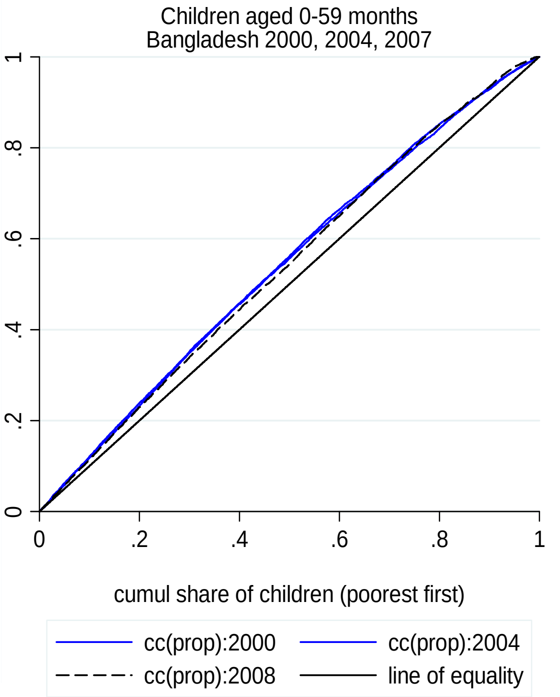


Figure 4:Concentration Curve (Mean) for Child Malnutrition (HAZ)

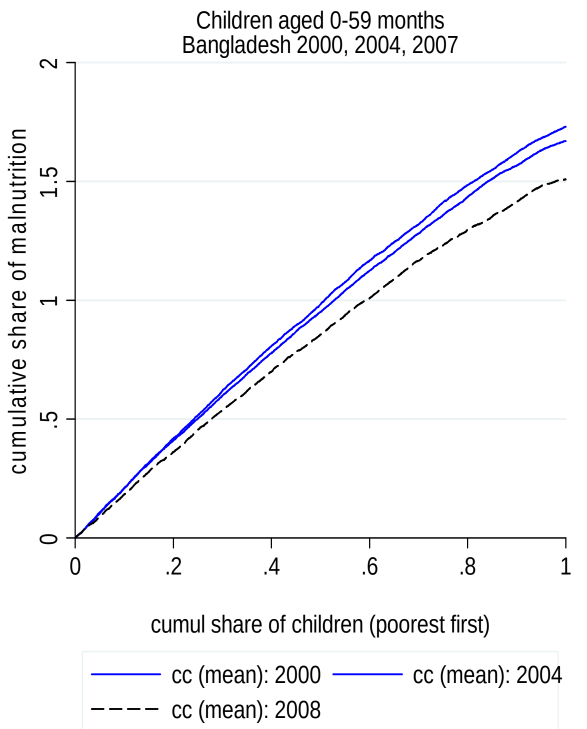
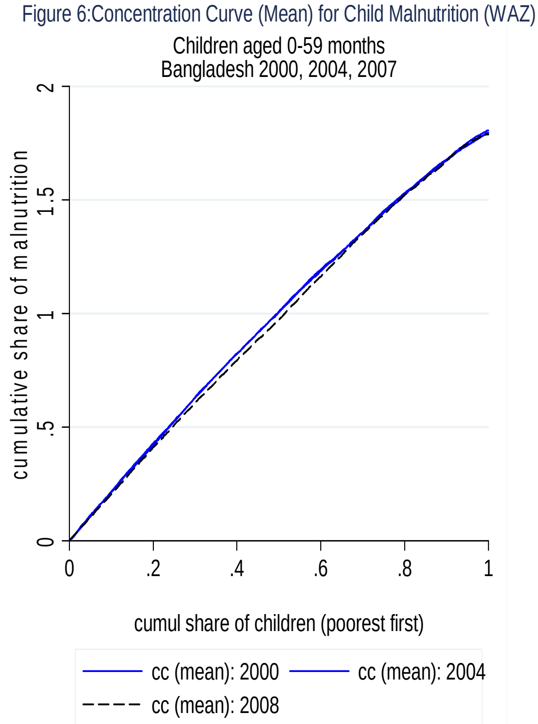


Figure 6:Concentration Curve (Mean) for Child Malnutrition (WAZ)



concentration curves for malnutrition and the line of equality for each wave. The findings confirm the existence of pro-rich inequality in the health of children. This is evident from the findings of both the multiple comparison approach (mca) and intersection union principle (iup) of dominance test proposed by Dardanoni and Forcina (1999). Both approaches of the dominance test suggest that the line of equality is dominated by the concentration curves at 5% significance level. On the other hand, when we compare between the concentration curves, we find evidence of non-dominance between them. The concave shape of the concentration curves in Figure 3 and Figure 5, and the dominance tests between them, confirm that the pro-poor inequalities in malnutrition are almost the same between 2000 and 2007. From the generalized concentration curves plotted in Figure 4 and Figure 6 it is clear that although some progress is made in improving the mean height-for-age z-scores of the children, no visible progress is made in the area of the weight-for-age z-scores over time.

Table 3: Regression Analysis of the Anthropometric Measures
Bangladesh 2007, 2004, 2000 (Children aged 0-59 months)

Survey Year	2000		2004		2007		2000		2004		2007	
Health indicators/ covariates	HAZ		HAZ		HAZ		WAZ		WAZ		WAZ	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Child is a twin	**-0.9554**	0.2327	**-0.6046**	0.2500	***-0.4496***	0.2694	**-0.7866**	0.1949	**-0.6661**	0.2025	**-0.4665**	0.2077
Age: 0-11 months							**1.0285**	0.0558	**1.0224**	0.0529	**0.9138**	0.0581
Age of the child	**-0.0699**	0.0045	**-0.0672**	0.0046	**-0.0634**	0.0044	**0.0027**	0.0013	**0.0030**	0.0011	0.0004	0.0014
Age squared	**0.0009**	0.0001	**0.0009**	0.0001	**0.0008**	0.0001						
HAZ of mother	**0.4405**	0.0396	**0.4367**	0.0366	**0.4532**	0.0391	**0.3114**	0.0307	**0.2967**	0.0323	**0.2961**	0.0340
Child is a male	0.0524	0.0399	**0.0794**	0.0390	**0.0934**	0.0398	**0.0801**	0.0343	**0.0868**	0.0298	**0.1164**	0.0325
Asset	**0.1794**	0.0306	**0.2185**	0.0304	**0.1576**	0.0288	**0.1886**	0.0258	**0.1717**	0.0256	**0.1767**	0.0253
Mother education in year	**0.0241**	0.0085	**0.0205**	0.0071	0.0018	0.0073	**0.0197**	0.0064	**0.0190**	0.0059	0.0052	0.0056
Father education in year	**0.0185**	0.0068	**0.0144**	0.0061	**0.0183**	0.0059	**0.0140**	0.0053	***0.0100***	0.0052	**0.0080**	0.0044
Breastfeed: yes	-0.0484	0.2022	**0.5717**	0.2580	0.1771	0.2347	0.2218	0.1649	0.2778	0.3386	0.0871	0.1554
Prenatal care: yes	0.0121	0.0109	***0.0160***	0.0097	**0.0406**	0.0094	0.0090	0.0086	0.0092	0.0085	**0.0263**	0.0087
Skilled attendance: yes	**0.1332**	0.0634	***0.1155***	0.0673	**0.1758**	0.0665	***0.1235***	0.0648	**0.1236**	0.0630	**0.2675**	0.0577
Disease recently: yes							**-0.2319**	0.0342	**-0.1768**	0.0353	**-0.1396**	0.0311
_cons	**-0.6778**	0.2114	**-1.2664**	0.2725	**-0.7001**	0.2374	**-2.2055**	0.1767	**-2.2993**	0.3507	**-2.0428**	0.1725
Number of obs.	4067		4723		4353		4064		4721		4352	
R-squared	0.1833		0.1781		0.1889		0.2543		0.2274		0.2261	
Reset: F	0.24		0.01		0.02		2.46		1.74		0.03	
Prob>F	0.6222		0.9723		0.8859		0.1177		0.1883		0.8538	

Note: Those are bold are statistically significant.

Finally, we apply the regression analysis to provide a general picture of the association between the health outcomes and contributing factors to find the potential determinants. Table 3 summarizes the regression results. For the regression results for height-for-age z-scores, the coefficients of the genetic and biological factors display the anticipated association with the prevalence of malnutrition. As expected, stunting of a mother had a significant association with the likelihood of reduced growth of her child. The positive coefficients of the height-for-age z-score of mothers reveal that the height of mothers and children are positively associated. The negative coefficients for the age of the child and the positive coefficients for the age squared reveal a non-linear relation between the age and height of the children which is in line with the findings of Owen O'Donnell et al. (2007). Conditional on genetic and biological factors, socioeconomic factors have significant associations with the prevalence of malnutrition. Education levels of parents are significant for the development of children's health in each wave. Asset index scores have a significant association with the prevalence of stunting. Positive coefficients of the asset index scores indicate that the greater the assets the lower the deviations of health from reference children in each wave. Utilization of health care during pregnancy has a significant and negative association with the prevalence of stunting of the children. On average, children who received prenatal care and skilled attendance at birth had a smaller deviation of health than children without receiving maternal care. Breastfeeding is only found to be significant in 2004.

Turning to the regression analysis for the weight-for-age z-scores, qualitatively the relationships between the prevalence of wasting and the regressors are similar as the results for height-for-age z-scores. However, genetic factors, such as height-for-age z-scores of mothers were less significant. In addition, prevalence of common illness, such as fever and diarrhoea had a negative association with weight-for-age z-scores in each survey.

Looking at the results of the descriptive analysis, in this study we cover two important areas of child health. Use of maternal care has a significant association with the long-term health of children, in particular, with their height-for-age z-scores. Asset index scores, which are the proxy measures of poverty, are also significant for child health in each wave. In this study we choose the broad macroeconomic policies directed towards these areas. We next focus on these two potential determinants by evaluating policies aimed at increasing the use of quality maternal health care services and the poverty reduction.

5. Evaluation of the Policies

5.1 Average Health

Table 4 summarizes the results of the difference-in-differences analysis. Each regression subtracts the average health gain over time in the non-exposed group from the average health gain over time in the exposed group. The treatment indicator of the difference-in-differences, τ, is the interaction of the time component and the group component. The regression models calculate the treatment indicators by double differences to remove the biases due to permanent differences between the groups and the time trends unrelated to the policy shown in Equation (8).

5.1.1 *MDG-Focused Maternal Care Policies*

Height-for-age z-score

Beginning with the impact of MDG-focused maternal care policies on the height-for-age z-scores of the children, the coefficient of the time indicator is insignificant. The coefficient of the group component is positive and significant, which is in line with the standard hypothesis that children who received maternal care enjoyed better health. The difference-in-differences estimator is positive, 0.1526, and corresponds to a relatively smaller standard error, 0.077. This suggests that policies adopted between 2001 and 2004 had a positive association with the height-for-age z-scores of the treatment children.

Weight-for-age z-score

In the analysis of weight-for-age z-scores, the coefficient of the time component, -0.0964, with a relatively small S.E, 0.0430, shows a downward trend in the health of children over time, which is in line with the findings of the World Health Organization (2004) that between 2000 and 2004 the prevalence of wasting increased in Bangladesh. The coefficient of the group component is also statistically significant with a value of 0.025 and S.E. 0.05, which is clearly in the treatment group's favour. After indirectly standardising for the time trend and group difference, the difference-in-differences estimator, 0.054, is significant at 10% significance level. These results together indicate that the MDG-focused maternal care policies had a positive association with the weight-for-age z-scores of the treatment children.

Table 4: DID Estimators for Child Health Indicators

Impact of the MDG & PRSP on the Anthropometric Measures of Children

Policy	MDG	MDG	PRS	PRS	PRSP	PRSP	PRSP	PRSP	
hj	HAZ	WAZ	HAZ	WAZ	WAZ	WAZ(F)	WAZ(M)	WAZ (t=3)	
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	y
	S.E	S.E	S.E	S.E	S.E	S.E	S.E	S.E	
								0.0030	t1
								0.0373	
t_i	-0.0461	**-0.0964**	**0.1943**	-0.0499	-0.0350	-0.0320	-0.0397	-0.0185	t2
	0.0556	0.0430	0.0392	0.0345	0.0505	0.0729	0.0699	0.0484	
C_i	**0.3040**	**0.2520**	**-0.4519**	**-0.4260**	**-0.5178**	**-0.5009**	**-0.5374**	**-0.4868**	Ci
	0.0553	0.0452	0.0438	0.0358	0.0541	0.0786	0.0745	0.0376	
τ_{did}	**0.1526**	**0.1155**	0.0367	**0.1074**	**0.2016**	0.1519	**0.2544**	**0.1706**	τdid
	0.0770	0.0630	0.0625	0.0517	0.0785	0.1122	0.1100	0.0682	
_cons	**-1.9979**	**-2.1427**	**-1.5237**	**-1.6014**	**-1.4065**	**-1.4324**	**-1.3784**	**-1.4230**	α
	0.0369	0.0282	0.0275	0.0238	0.0345	0.0484	0.0492	0.0313	
n	5110	5110	8585	8585	4521	2273	2248	6806	n

PRS: combination of i-PRSP & PRSP; Target group: Poor (Wealth index quintile: poorest and lower middle Comparator group: Non-poor (Wealth index quintile: Middle or above); WAZ (F) Subsample of female WAZ (M) Subsample of male child

***5.1.2** PRSP*

PRSP & IPRSP

The difference-in-differences analysis finds no significant association between the PRSP and the prevalence of stunting of the treatment group. However, it identifies that PRSP, as a combination of IPRSP and PRSP, had a great and statistically significant success in reducing the prevalence of wasting among them (Table 4). The time component indicates a downward trend in the health of children in line with the findings of the WHO (2004). As expected, the evidence regarding the group difference is significant and pro-rich. The coefficient of the group component is negative, -0.46, indicating a higher deviation of health in the poor children from the reference children. The difference-in-differences estimator is significant and positive, 0.2016, and indicates a significant increase in the weight-for-age z-scores of the poor children after the interventions based on the PRSP.

PRSP (2005)

We identify that PRSP (2005) had a big, statistically significant success in reducing the prevalence of wasting among the treatment group as well. The prevalence of wasting among the poor children reduced significantly due to the policy, as did the prevalence of wasting among male children. However, the reduction of deviation of weight-for-age z-scores among the poor female children was not significant (Table 4).

5.2 Distribution of health

The downside of the simple difference-in-differences estimator of a policy is that it cannot capture the distributional impact of the policy on the treatment children. One way to overcome this limitation is to use the differential-in-total-differentials estimator of the policy which can be computed using the inequality indices.

To start with the asset-based inequalities in health, each of the estimated concentration indices has a relatively small standard error that provides evidence that the inequalities in the health of children between 2000 and 2007 were significant (Table 5). The negative concentration indices show that higher malnutrition was common to those with lower assets. The health pseudo-Gini index, which ranks a child by his/her health score, shows that inequalities increased over the years for the anthropometric measures. The values of health variables are negative except for a few children. Therefore, the health pseudo-Gini indices are negative. As expected, the health pseudo-Gini index is negative in each survey year. The findings based on the concentration indices and health pseudo-Gini indices indicate that the better-off children had a significantly lower concentration of malnutrition.

5.2.1 *Distribution of Health: MDG-Focused Maternal Care Policy*

We then focus on the findings of the asset related inequalities in malnutrition following interventions based on the MDG-focused maternal care policies. The findings show an evidence of significant inequalities among the treatment and comparison children before and after the interventions. The treatment children before the MDG-focused policies had the most unequal distribution of long-term malnourished. The inequalities in malnutrition among them decreased marginally after the policy. By contrast, the control children had a lower level of health inequalities in both periods. These apparent differences between the groups raise a question about the distributional impact of the policy. The findings, however, suggest that the policy failed to improve the distribution of health among the treatment children. This is evident from the concentration indices and pseudo-Gini indices based differential-in-total-differentials estimators which are -0.0136 and -0.0453 respectively.

Table 5: Total differential-in-differentials of inequality indices
Anthropometric measures of children in Bangladesh

			CI	S.E[CI]	$\Delta=CI_{C1}-CI_{C0}$	$\Delta\Delta[CI]$	G(h)	S.E(G(h))	$\Delta=G(h)_{C1}-G(h)_{C0}$	$\Delta\Delta[G(h)]$
Wave	HAZ	2007	-0.0999	0.0084			-0.4677	0.0033		
Wave	HAZ	2004	-0.1021	0.0067			-0.4288	0.0027		
Wave	HAZ	2000	-0.0983	0.0069			-0.4246	0.0031		
Wave	WAZ	2007	-0.0737	0.0061			-0.3345	0.0028		
Wave	WAZ	2004	-0.0793	0.0054			-0.3373	0.0023		
Wave	WAZ	2000	-0.0877	0.0055			-0.3423	0.0023		
MDG	HAZ	t_0, C_0	-0.0629	0.0103			-0.3597	0.0049		
MDG	HAZ	t_0, C_1	-0.1384	0.0126	-0.0755		-0.3988	0.0063	-0.0391	
MDG	HAZ	t_1, C_0	-0.0383	0.0117			-0.3447	0.0049		
MDG	HAZ	t_1, C_1	-0.1274	0.0113	-0.0891	-0.0136	-0.4291	0.0052	-0.0844	-0.0453
PRS	WAZ	t_0, C_0	-0.0797	0.0081			-0.3817	0.0035		
PRS	WAZ	t_0, C_1	-0.0334	0.0076	0.0463		-0.293	0.003	0.0887	
PRS	WAZ	t_1, C_0	-0.0834	0.0088			-0.3683	0.0043		
PRS	WAZ	t_1, C_1	-0.0242	0.008	0.0592	**0.0129**	-0.2896	0.0032	0.0787	-0.01
PRSP	WAZ	t_0, C_0	-0.0885	0.0137			-0.4724	0.0051		
PRSP	WAZ	t_0, C_1	-0.0203	0.0123	0.0682		-0.3432	0.0047	0.1292	
PRSP	WAZ	t_1, C_0	-0.0804	0.0144			-0.4403	0.0065		
PRSP	WAZ	t_1, C_1	-0.0433	0.0137	0.0371	-0.0311	-0.3587	0.0051	0.0816	-0.0476

For Gini indices, dominance test is applied which shows that the Gini indices are significantly different than the equal distribution o
t_0 Pre-policy period; t_1 Post policy period; C_0 Non-target group; C_1 Target group

5.2.2 Distribution of Health: PRSP

We also assess asset related inequalities in malnutrition after the PRSP, which demonstrate that there were significant inequalities among the poor and non-poor children before and after the interventions. However, in both periods the inequalities were comparatively lower among the poor children. The findings give an idea that the PRSP, as a combination of IPRSP and PRSP (2005), had some success in improving the asset-based distribution of health among the treatment children.

5.3 Difference-in-Weighted-Differences

A weighted-difference estimator is a mean difference between two groups of children adjusted for the distributional indices (Equations (11) & (13)). A positive weighted-difference estimator suggests that on average the health status of the treatment group is better after adjusting for the inequality indices. On the other hand, a negative weighted-difference estimator reveals that on average the health status of the alternative group is better after adjusting for the inequality indices. A 'before and after' analysis, using the weighted-difference estimators, provides the difference-in-weighted-differences estimator (Equation 12 & 14). It is worth mentioning here that the anthropometric measures are constructed in such a way that the lower the z-score, the greater the prevalence of malnutrition. A positive value of the difference-in-weighted-differences estimator therefore favours the policy and vice versa. Table 6 summarizes the findings of these analyses.

Table 6: Difference-in-Weighted-Difference Estimators for the Child Health Indicators
Impact of the Macroeconomic Policy on the Anthropometric Measures of Child Health
[Based on the weighted-difference estimators capturing the mean and distribution of health togethe

	MDG (HAZ)	MDG (WAZ)	PRSP (WAZ)	PRSP 2005 (WAZ)
CI_1^*	0.3956	0.2998	-0.2584	-0.2775
CI_0^*	0.2612	0.1703	-0.3435	-0.4982
τ_{CI*}	**0.1344**	**0.1295**	**0.0851**	**0.2207**
G_1^*	0.5501	0.3699	-0.3254	-0.3403
G_0^*	0.4310	0.2886	-0.4134	-0.5758
τ_{G*}	**0.1192**	**0.0813**	**0.0880**	**0.2355**
CI_i^*	CI-based weighted-difference estimator in period i			
τ_{CI*}	CI-based difference-in-weighted-differences estimator			
G_i^*	Health pseudo-Gini-based weighted-difference estimator in period i			
τ_{G*}	Health pseudo-Gini-based difference-in-weighted-differences estimator			

***5.3.1** Difference-in-Weighted-Difference: MDG-Focused Maternal Care Policies*

Table 6 first displays the inequality-adjusted impacts of the MDG-based interventions. The weighted-difference estimators for the height-for-age z-scores are positive in both pre-policy and post-policy periods. They are also positive for the weight-for-age z-scores. Positive values of the weighted-difference estimators indicate that both in the pre-policy period and post-policy period, treatment children enjoyed a lower health deviation from the NCHS children, compared with the comparison children.

Using the weighted-difference estimators, we calculate the corresponding difference-in-weighted-differences estimators which are also positive for both anthropometric measures. The CI-based difference-in-weighted-differences for the height-for-age z-score and weight-for-age z-score are 0.1344 and 0.1295, respectively. On the other hand, the health pseudo-Gini index adjusted difference-in-weighted-differences estimators for the height-for-age z-score and weight-for-age z-score are 0.1192 and 0.0813, respectively. The difference-in-weighted-differences estimators show that in the post-policy period, and after adjusting for the distributional consequences of the policy, the mean deviation of health of the treatment children from the NCHS children decreased further.

5.3.2 *Difference-in-Weighted-Differences: PRSP*

Table 6 next displays the impacts of the Poverty Reduction Strategy. The negative weighted-difference estimators provide evidence that higher malnutrition was concentrated among the treatment children in both periods. However, the difference-in-weighted-differences estimator that is adjusted for the asset-related inequalities is positive and quite large, 0.0851, and offers evidence that malnutrition among the treatment children decreased after the PRSP-based interventions. The difference-in-weighted-differences estimator for the PRSP (2005) is also positive and large, 0.2207, and presents evidence of improving health status through a reduction in malnutrition among the treatment children. The findings of the weighted-difference and difference-in-weighted-differences analysis that are based on the health pseudo-Gini indices are qualitatively similar, as are those based on the asset-related inequalities. To sum up, the findings exhibit that the poverty reduction strategies had some success in improving the inequality-adjusted weight-for-age z-scores of the target children.

5.3.3 *Difference-in-Differences and Difference-in-Weighted-Differences*

Like the findings of the conventional difference-in-differences analysis, the findings of the difference-in-weighted-differences analysis also suggest positive associations between the policies and the health of the target children. The difference-in-weighted-differences estimators are used to adjust for the inequalities in distribution that may result due to the broader and heterogeneous nature of the macroeconomic policies during their implementation. Even after adjusting for the inequalities in the distribution of health, we observe clear positive associations between the policies and the anthropometric measures of the children.

6. Conclusion

In this paper we aim to evaluate two broad macroeconomic policies that are related to the development of child health. We observe that circumstance factors, for example education of parents, asset and utilization of health services are significant for the development of child health. We then evaluate the impacts of the MDG-focused maternal care policies which aimed at the utilization of maternal health care services and the impacts of the PRSP which aimed at the eradication of poverty. We first use the difference-in-differences method for evaluation which finds that the policies are successful in reducing the prevalence of malnutrition in the treatment children. The limitation of this approach is that it cannot account for the distribution of outcomes due to the policy. We, therefore, apply a differential-in-total-differentials approach using the health inequality indices. We find that the policies are not successful in improving the distribution of malnutrition among the treatment. Following that we estimate the difference-in-weighted-differences estimators which indicate that the MDG-focused maternal care policies were effective for the development of child health, and the IPRSP and PRSP policies were particularly effective in improving the weight-for-age z-scores of poor children.

Our study has some limitations. It is based on the subsample of the most recent children of the households. The macroeconomic policies that are evaluated are very broad and are not randomised. Some of the findings may also be subject to confounding bias. Despite these limitations, our study has several strengths. Firstly, we provide statistical evidence that in a developing country like Bangladesh circumstance factors are important for the development of child health. Secondly, we provide a way to identify the association between two broader health policies and their outcomes applying the difference-in-differences. We develop a framework to create groups and to run the analysis using repeated cross-section waves. We apply a difference-in-weighted-differences approach to create a link between the average and distributional impacts of the policies. The findings are striking and favour the hypothesis that macroeconomic policies that link socioeconomic and health needs of the children would be effective to reduce the malnutrition of children.

The results suggest clear policy implications. Access to quality maternal care for all mothers can improve the health of newborns significantly. In a developing country like Bangladesh, the Government should play the key role in providing quality maternal care through macroeconomic development programs. Similarly, a well-designed and properly implemented macroeconomic policy is also important to improve the health of poor children.

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