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Neonatal Mortality and Inequalities in Bangladesh: Differential Progress and Sub-national Developments

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Abstract A rapid reduction in under-five mortality has put Bangladesh on-track to reach Millennium Development Goal 4. Little research, however, has been conducted into neonatal reductions and sub-national rates in the country, with considerable disparities potentially masked by national reductions. The aim of this paper is to estimate national and sub-national rates of neonatal mortality to compute relative and absolute inequalities between sub-national groups and draw comparisons with rates of under-five mortality. Mortality rates for under-five children and neonates were estimated directly for 1980–1981 to 2010–2011 using data from six waves of the Demographic and Health Survey. Rates were stratified by levels of rural/urban location, household wealth and maternal education. Absolute and relative inequalities within these groups were measured by rate differences and ratios, and where possible, slope and relative indices of inequality. National mortality was shown to have decreased dramatically although at differential rates for under-fives and neonates. Across all equity markers, a general pattern of declining absolute but constant relative inequalities was found. For mortality rates stratified by education and wealth mixed evidence suggests that relative inequalities may have also fallen. Although disparities remain, Bangladesh has achieved a rare combination of substantive reductions in mortality levels without increases in relative inequalities. A coalescence of substantial increases in coverage and equitable distribution of key child and neonatal interventions with widespread health sectoral and policy changes over the last 30 years may in part explain this exceptional pattern.

Keywords Bangladesh · MDG 4 · Under-five mortality · Neonatal mortality · Inequality

Introduction

Post-independence, Bangladesh is recognised as a leading example of the rapid gains made possible from investments in proven reproductive, maternal, newborn and child interventions [1, 2]. The pace of progress has been relatively rapid [3] and the country is on track to reach Millennium Development Goal 4 by 2015 [2–5]. The country went from having the 32nd highest global under-five mortality rate (U5MR) in 1971 to rank 61st in 2012 [6]. The neonatal mortality rate (NMR) in Bangladesh has also experienced significant reductions over the last few decades [5]. Although rapidly urbanising, Bangladesh remains majority rural at 72 % [6], while also being historically underscored by poverty, wealth inequality and low maternal education [6]. Child and neonatal mortality in the country has been traditionally associated with these sub-national groups [1, 4, 7].

In many situations, declining rates of mortality at the national level mask differential changes amongst sub-national equity groups [8]. Moreover, it is well known that the choice of absolute or relative measures to monitor patterns of inequalities can strongly influence conclusions regarding whether increases or decreases are observed [9]. Indeed, in many countries experiencing overall declines in

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the level of mortality, absolute decreases in inequalities coincide with relative increases [10–12]. Hence, robust conclusions on policies aimed at reducing health inequalities require the reporting of both absolute and relative measures [13].

The performance of Bangladesh is a unique case. Declines in rates of under-five mortality have been achieved in parallel to narrowing absolute inequalities and either declining or constant relative inequalities conditional on the equity marker [1]. These achievements have occurred in a context of slow economic growth and persistent poverty rates [2], which suggests important lessons for other low and middle income countries. Little is known, however, as to the extent to which reductions in equity gaps on any scale have occurred with respect to neonates in Bangladesh. Despite being only small proportion of under fives, neonates are increasingly accounting for large proportions of total under-five mortality [14, 15]. Despite an increased focus on neonatal health in the last 20 years, progress in neonatal outcomes is faltering across the globe [16, 17]. As such, we test whether significant reductions in the rate of neonatal mortality in Bangladesh have led to narrowing patterns of inequality. This is tested for both absolute and relative scales to offer insights into potential strategies for inequality reductions in other settings.

Methods

We disaggregated neonatal mortality rates by rural/urban location, household wealth and maternal education for the period 1980–1981 to 2010–2011 and made corresponding comparisons to under-five mortality rates. Absolute and relative inequalities were also assessed to monitor health inequalities over the 30 years period.

Data

Our analysis was conducted using the Bangladesh Demographic and Health Survey (BDHS) data series. This series collects nationally representative data utilising a two-stage stratified sampling methodology. Full details of the series are available elsewhere [4, 18–22]. A total number of 9,174; 8,862; 9,854; 10,500; 10,400 and 17,141 households were surveyed in the 1993–1994, 1996–1997, 1999–2000, 2004, 2007 and 2011 waves of the BDHS, respectively. Complete birth histories (CBH) were used as the inputs for the mortality estimations. This involved female respondents being surveyed about every child they have ever borne. The BDHS series collected additional demographic and socioeconomic indicators and each wave was cleaned by omitting observations with unfeasible birth dates and death ages and any duplicates. The combined dataset comprised of 203,788 children ever borne under the age of 5 years. The publicly available dataset used in this study was anonymous, with no identifiable information on the survey participants, and were obtained through online resources. As such Internal Review Board approval was not required.

Mortality Estimates

Direct estimates of death rates were computed using CBH pooled from all surveys following the methods set out by Rajaratnam et al. [23]. The estimation procedures used at both national and sub-national levels were identical. To arrive at the biennial mortality rates datasets were constructed detailing the life or death in each month of the first 5-year of each child's life, denoted as person-months. The total numbers of person-months where children were alive were divided by the total numbers of person-months to ascertain the mean survival probabilities for each of the following age groups: 0–1, 1–11, 12–23, 24–35, 36–47 and 48–59 months. The amalgamation of the survival rates of the associated age groups (subtracted from 1) were then used to derive the under-five mortality rate (U5MR) and neonatal mortality rate (NMR).

The estimation of 95 % confidence intervals (CI) involved taking 1,000 simulations of the age-group survival probabilities using a binomial distribution where the probability equalled the age-group mean survival probability and the sample size was the number of person-months observed in a time period/age category. For each time period in each simulation the death rates were estimated and the 2.5th and 97.5th percentiles were used to extract lower and upper confidence bounds.

Measures of Absolute and Relative Inequalities

The analysis focuses on trends in both absolute and relative inequalities in neonatal mortality with comparisons made to corresponding measures for under-five mortality. The stratifying variables for the equity analysis are: rural/urban sector, maternal education and wealth groups. These three groups, while interrelated, were chosen in order to reflect the current state of Bangladesh. Income and expenditure are not presently collected in the survey series. Instead, a wealth index is provided, constructed using principal components analysis (PCA) [24]. PCA is a popular statistical technique for data reduction by describing a series of uncorrelated linear combinations of the variables that capture the common information most successfully. The first principal component has maximal overall variance. In our case, based on housing materials, ownership of durable goods and access to improved water and sanitation facilities, each household is assigned a standardised score for

each asset depending on whether or not the household owned that asset. A linear index from these asset ownership indicators is produced by weighting each indicator variable by the first factor coefficient scores derived using PCA. The wealth index is partitioned placing households into quintiles to form the basis of a five tiered ranking system: poorest, near poor, middle, upper middle and high income. Further information on PCA can be found in the DHS series guide on constructing a wealth based index [25].

In order to assess the distribution of mortality and size of differences across the equity markers the absolute measures; rate differences (RD) and slope index of inequality (SII) and relative measures; rate ratios (RR) and relative inequality index (RII) were computed [26–28]. For wealth and education, the RR and RD measures are computed by taking simple ratios or the difference between the mortality rates of highest socio-economic position with those of lowest socio-economic position. In the case of the urban–rural equity marker a comparison between the two groups is computed. RIIs and SIIs are computed via weighted linear regression of the mortality rates on the mid-point of the cumulative relative position of each group with respect to a socio-economic marker. The need for ordinal rankings when using RIIs and SIIs implies that they can only be estimated for mortality rates stratified by wealth and education in our study. The advantages of using RIIs and SIIs over RDs and RRs are well known [26]. Most notably, the former measures reflect the experience of all sub-populations and is sensitive to changes in the distribution of population among the different equity marker categories. Methods outlined by Hayes and Berry [29] were used in constructing CI for RIIs and SIIs. Confidence intervals for RDs and RRs were based on the simulation processes described above and both measures are computed in reference to the following base groups: for rural/urban the urban population was the base group, while for wealth and education the highest ranked socioeconomic group was used (i.e. 'highest quintile' and 'secondary or more', respectively). Wealth groups were broken down to lowest, second, middle, fourth and highest quintiles. Maternal education was categorised as no education, incomplete primary, complete primary and, secondary+.

Tests for the statistical significance of linear trends in the inequality measures were estimated to gauge changes in disparities over time, using Newey–West heteroskedasticity–autocorrelation-consistent standard errors (using one lag). Natural logarithms were used in the cases of RRs and RIIs and exponential trend coefficients were reported, which may be interpreted as the average ratio change in RR or RII per period. For the RDs and SIIs, we report the trend coefficients, which can be interpreted as the average absolute change per period in these inequality measures.

Stata® 13 and *R* were used to conduct the statistical analyses.

Results

As a baseline, our analysis confirms that impressive declines in NMR have been seen in Bangladesh over the last 30 years. NMR stood at 84 (95 % CI 78–91) deaths per 1,000 live births in 1980–1981, dropping to 29 (95 % CI 22–37) in 2010–2011. These declines imply an average annual rate of reduction of 3.5 %. This rate of reduction in NMR is slower than that observed for U5MR (4.6 %), which has declined from 189 (95 % CI 181–199) deaths per 1,000 live births in 1980–1981 to 48 (95 % CI 41–59) in 2010–2011. As a result, the relative neonatal burden is increasing as a proportion of child deaths. The decline in NMR however has been substantial, particularly in the earlier years. These trends can be observed in Fig. 1.

Neonatal health outcomes over the study period have favoured the urban sector. As can be seen in Fig. 2, while disparities in neonatal mortality have reduced between the rural and urban sectors, a gap still remains. NMR for the rural and urban sectors were 88 (95 % CI 81–95) and 64 (95 % CI 52–79) in 1980–1981 and 30 (95 % 22–40) and 22 (95 % CI 13–33) in 2010–2011, respectively. To test the validity of mortality trends over time and assess relative changes in inequality, Table 1 presents measures of absolute (i.e. RD) and relative (i.e. RR) inequalities for the urban/rural equity marker. These measures are reported with 95 % CI for selected years as well as the linear trend coefficients of these measures over time with corresponding p values. All measures are provided for NMR and U5MR. NMR across the study period is experiencing an absolute reduction in inequality at significant levels, with a trend coefficient of -0.903 (p value 0.002). Relative differences in rural urban areas have shown a different pattern. Over the study period relative inequalities have remained roughly the same. The RIIs were 1.38 (95 % CI 1.1–1.72) and 1.36 (0.85–2.58) for NMR in 1980–1981 and 2010–2011, respectively. Trends for RR amongst rural urban were not significant at conventional levels. Similar findings are observed for U5MR.

Rates of neonatal mortality amongst different wealth groups are reported in Fig. 3. It can be seen that substantial reductions in NMR have been observed across the wealth gradient. While disparities have decreased, particularly the gap between low and middle income groups, higher wealth remains associated with better child mortality outcomes. Table 2 presents the full gambit of inequality measures across wealth and educational clusters. Both the absolute (i.e. RD and SII) and relative (i.e. RR and RII) measures are presented with 95 % CI for selected years and the trend

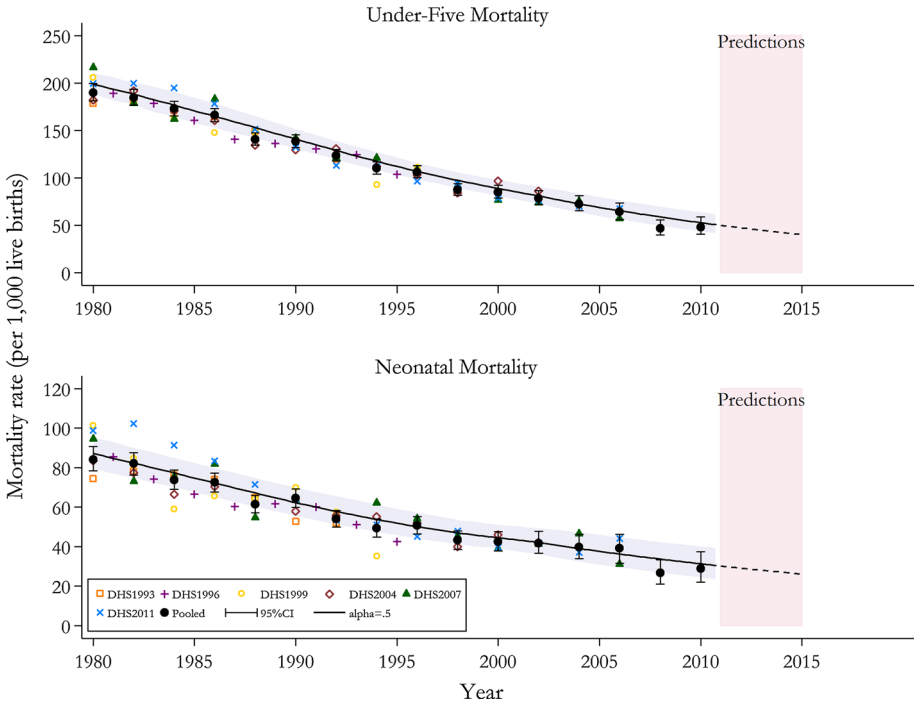

Fig. 1 National estimates of neonatal and under-five mortality (per 1,000 live births), 1980–1981 to 2010–2011. *Notes*: National estimates by source and using the pooled data are displayed. Loess regression was applied with a smoothing parameter of 0.5 to produce a continuous national series, with the last set of parameter estimates used to forecast to 2015 and standard methods employed to estimate the uncertainty in the forecast [43]. The *solid* and *semi-broken lines* represent the continuous mortality estimates calculated from the 2-year estimates, while the *shaded area* signifies the corresponding 95 % confidence intervals. *DHS* Demographic Health Survey, *CI* confidence intervals

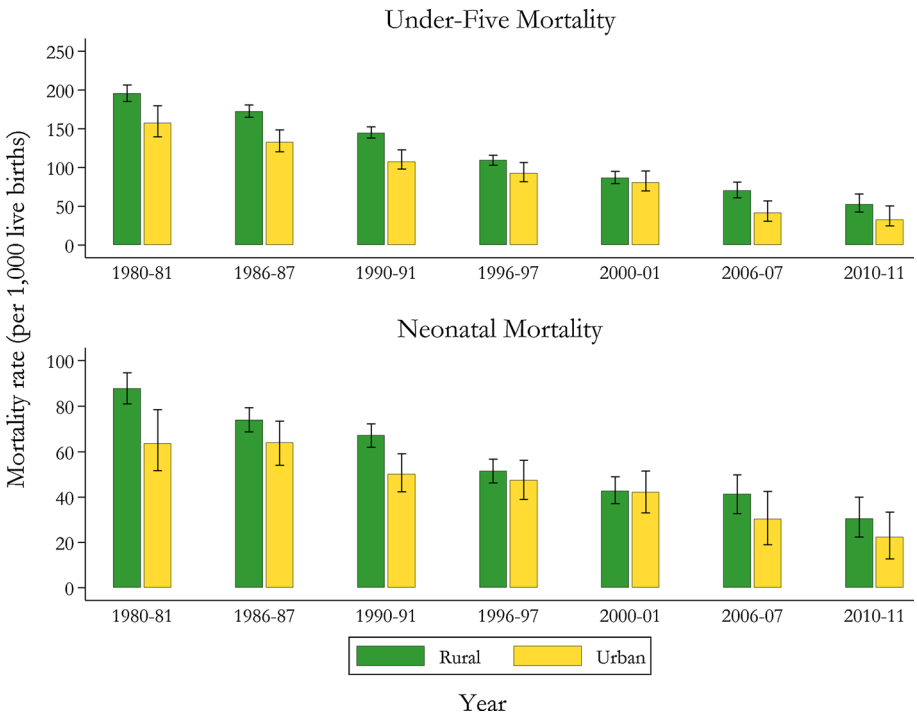

Fig. 2 Neonatal and under-five mortality rates (per 1,000 live births) by rural/urban location for selected years. *Notes*: See the web-appendix for full results

coefficients are again reported with corresponding *p* values. The trends in the RDs and RRs in neonatal mortality by wealth groups are reported in Fig. 4. A clear pattern is observed, with considerable reductions in absolute inequalities and relative inequalities largely unchanged. The trend coefficients for RD and SII were −2.18 (*p* value <0.0001) and −2.77 (*p* value <0.0001), respectively. Similar yet more accentuated downward trends were seen in U5MR, which were also highly statistically significant. While point estimates suggest some downward trajectories in relative inequalities, trends in RRs and RIIs were shown to be of mixed significance at conventional levels for both NMR and U5MR.

Table 1 Urban/rural absolute and relative inequalities for selected years with overall trend

Marker	Under-five mortality		Neonatal mortality	
	Rate ratio	Rate difference	Rate ratio	Rate difference
Rural (base = urban)				
1980–1981	1.24 (1.08; 1.41)	38.1 (13.14; 57.98)	1.38 (1.1; 1.72)	24.1 (8.17; 37.72)
1990–1991	1.35 (1.18; 1.51)	37.3 (21.42; 49.7)	1.34 (1.12; 1.62)	17.1 (6.76; 26.66)
2000–2001	1.07 (0.89; 1.29)	5.7 (−10.59; 20.33)	1.01 (0.79; 1.35)	0.6 (−10.16; 12.03)
2010–2011	1.60 (0.99; 2.28)	19.7 (−0.46; 33.77)	1.36 (0.85; 2.58)	8.0 (−4.23; 21.94)
Trend [*p* value]	0.998 [0.796]	−2.285 [0.000]	0.995 [0.347]	−0.903 [0.002]

See the web-appendix for full results. 95 % confidence intervals (CI) are reported in parentheses. The small number of observations and possible non-linear relationships implies that the trend estimates should be treated with caution. Additionally, since the bounds of the CI depend on the mean of mortality, comparisons over time must be treated cautiously

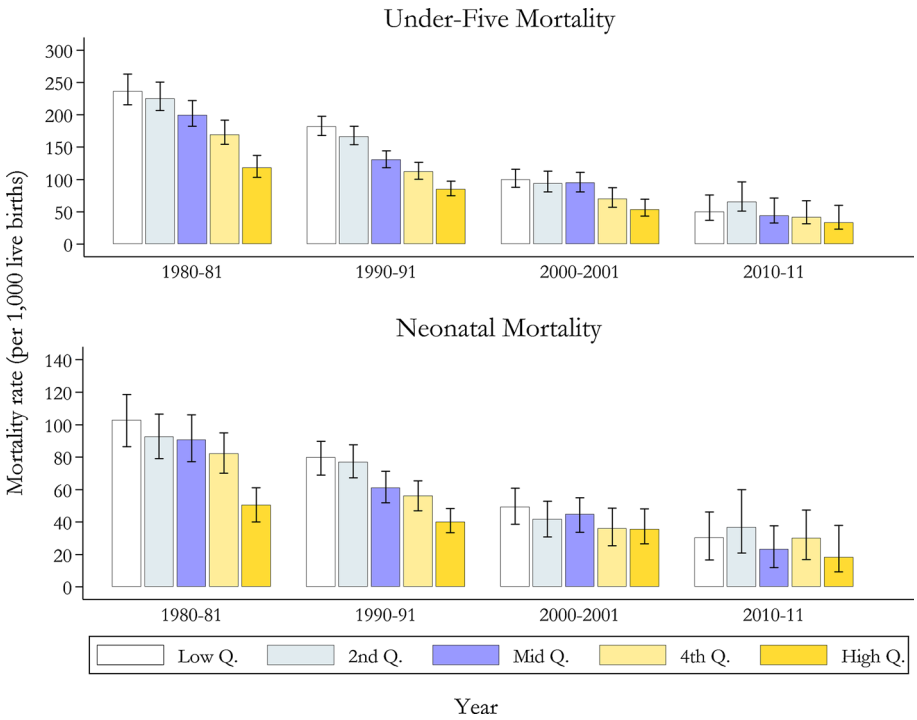

Fig. 3 Neonatal and under-five mortality rates (per 1,000 live births) by wealth for selected years. *Notes*: See the web-appendix for full results. *Q*. Quintile

A similar pattern is observed for mortality rates stratified by levels of maternal education. As reported in Fig. 5, children whose mothers who have had some primary or higher levels of education have had consistently lower NMRs over the study period. Absolute inequalities are again found to have reduced over time. The trends in RDs and SIIs for NMR, were −2.116 (*p* value <0.0001) and −2.632 (*p* value <0.0001), respectively. Relative differences have reduced overall, however, the reduction has not been uniform over the study period with increases generally seen from 1980–1981 to 1999–1991, followed by consistent yet small reductions from 1990 onwards. The trends over time for relative inequalities were shown to be of mixed significance with RRs and the neonatal RII showing a slight reduction at conventional levels.

Full estimates of 2-year mortality, absolute and relative inequalities, and trends are available in the web-appendix.

Discussion

Our analysis has shown the overall level of neonatal mortality in Bangladesh is reducing and the country is currently on track to achieve MDG 4 [2–5]. Following global trends, a greater reduction in U5MR has been observed over the study period. Neonatal mortality,

Table 2 Absolute and relative inequalities by wealth and education for selected year with overall trend

Marker	Relative inequalities		Absolute inequalities	
	Rate ratio	Relative index of inequality	Rate difference	Slope index of inequality
Wealth				
Under-five mortality				
1980–1981	2.00 (1.68; 2.39)	2.38 (1.55; 3.2)	118.3 (90; 147.9)	150.44 (98.18; 202.7)
1990–1991	2.14 (1.83; 2.51)	2.69 (2.05; 3.34)	96.9 (78.3; 116.2)	123.35 (98.68; 148.01)
2000–2001	1.87 (1.4; 2.4)	2.09 (0.78; 3.41)	46.5 (26.7; 63.8)	58.51 (14.08; 102.94)
2010–2011	1.51 (0.77; 2.59)	1.85 (−0.21; 3.92)	16.7 (−13.1; 41.9)	27.84 (−18.72; 74.4)
Trend [*p* value]	0.988 [0.251]	0.985 [0.079]	−6.759 [0.000]	−8.413 [0.000]
Neonatal mortality				
1980–1981	2.04 (1.59; 2.64)	2.17 (0.72; 3.61)	52.4 (33.4; 70.9)	60.22 (14.17; 106.27)
1990–1991	1.99 (1.57; 2.5)	2.33 (1.43; 3.23)	39.6 (26; 52.1)	50.01 (30.21; 69.82)
2000–2001	1.38 (0.95; 1.96)	1.50 (0.93; 2.07)	13.6 (−2.3; 28.2)	16.65 (1.49; 31.81)
2010–2011	1.66 (0.65; 3.83)	1.77 (−0.35; 3.9)	12.1 (−11.7; 29.6)	15.43 (−14.9; 45.77)
Trend [*p* value]	0.983 [0.141]	0.979 [0.073]	−2.180 [0.000]	−2.770 [0.000]
Education				
Under-five mortality				
1980–1981	1.91 (1.52; 2.27)	1.95 (0.07; 3.83)	99.5 (69.8; 120.4)	120.38 (−39.78; 280.53)
1990–1991	1.92 (1.62; 2.25)	2.12 (0.42; 3.82)	75.0 (58.4; 89.6)	98.50 (4.45; 192.56)
2000–2001	1.81 (1.44; 2.23)	2.47 (2.13; 2.8)	47.5 (31.6; 62.6)	71.74 (62.62; 80.86)
2010–2011	1.35 (0.83; 2.28)	1.45 (0.07; 2.83)	15.8 (−8.8; 51.2)	17.96 (−26.63; 62.55)
Trend [*p* value]	0.984 [0.025]	0.996 [0.755]	−5.407 [0.000]	−6.844 [0.000]
Neonatal mortality				
1980–1981	1.39 (1.04; 1.86)	1.41 (0.11; 2.71)	24.5 (3.6; 42.1)	28.47 (−45.84; 102.78)
1990–1991	1.50 (1.21; 1.91)	1.61 (0.64; 2.59)	23.4 (11.8; 34.4)	30.13 (−6.4; 66.66)
2000–2001	1.26 (0.92; 1.69)	1.39 (1.22; 1.56)	9.5 (−3.5; 21.3)	13.90 (8.9; 18.91)
2010–2011	0.83 (0.34; 1.77)	0.83 (−1; 2.66)	−5.0 (−22.5; 17.5)	−5.42 (−68.25; 57.41)
Trend [*p* value]	0.965 [0.039]	0.963 [0.097]	−2.116 [0.000]	−2.632 [0.001]

See the web-appendix for full results. 95 % confidence intervals (CI) are reported in parentheses. The small number of observations and possible non-linear relationships implies that the trend estimates should be treated with caution. Additionally, since the bounds of the CI depend on the mean of mortality, comparisons over time must be treated cautiously

differing from global patterns, has shown a strong downward trend. This is despite often requiring a greater health system strengthening component and larger investments in infrastructure and human resources [30, 31]. The impressive reductions in mortality have coincided with significant health sector reforms over the last 30 years specifically targeting reproductive, maternal, child and neonatal health [1, 32]. They have also taken place despite persisting poverty and sluggish economic growth, presenting an encouraging situation not seen in other countries within the region [2]. These health sector reforms have been noted to contain three important traits, which may have contributed to the country's rapid decline in child and neonatal death. These traits being scale of intervention to match disease burden, speed of roll out able to meet expectations and selectivity of targeting the intervention to equity groups where the burden is greatest [1, 2]. Coverage of many key interventions, often responsible for rapid reductions in child health, have increased while equity gaps have been narrowed. The reduction in under-five mortality in Bangladesh has been explained in greater detail elsewhere [1].

Importantly neonatal targeted evidence-based interventions have also shown substantial increases in coverage and may have led to significant decreases in NMR in Bangladesh. At a national level, coverage of mothers receiving at least one antenatal visit prior to birth has increased from 58 % of live births in 2004 to 67.9 % in 2011 [4, 21]. Those receiving four or more antenatal visits have also increased from 17 to 25.5 % in the same period [4, 21]. While a full spectrum of care may not always be possible in resource constrained settings, having at least one antenatal visit can greatly increase the likelihood of neonatal survival [33]. This increase is achieved by treating potentially fatal conditions such as syphilis, providing advice on safe birth

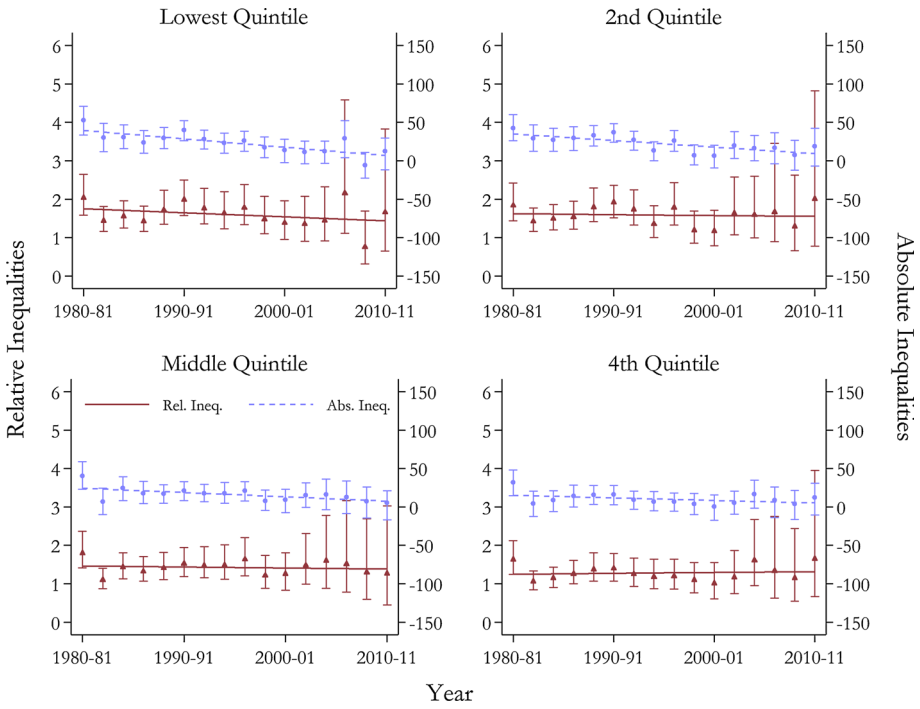

Fig. 4 Trends in absolute and relative inequalities, neonatal mortality by wealth. *Notes*: Relative and absolute inequalities are measured using rate ratios and rate differences, respectively. The base group is highest wealth quintile. The small number of observations and possible non-linear relationships implies that the trend estimates should be treated with caution. *Rel. Ineq.* relative inequality, *Abs. Ineq.* absolute inequality

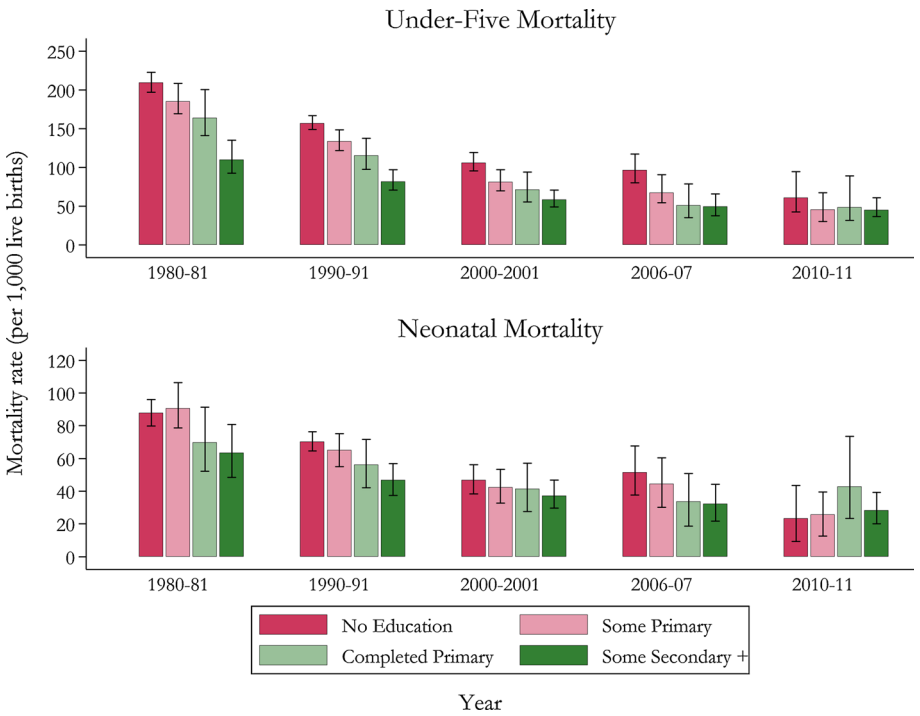

Fig. 5 Under-five and neonatal mortality rates (per 1,000 live births) by maternal education for selected years. *Notes*: See the web-appendix for full results

practices and nutrition and, by recognising mothers likely to experience birth complications. Skilled birth attendance has also increased drastically [4, 34]: from 13.7 % in 2004 to 31.7 % in 2011 [4, 21]. This has coincided with an increase in facility-based birth deliveries from 9.3 % in 2004 to 28.8 % in 2011 [4, 21]. As with antenatal visits, skilled birth attendance greatly increases the likelihood of neonatal survival [30]. This is achieved by providing a clean and sterile birth while also nutritional and newborn care advice. Additionally the presence of a medically trained professional can recognise signs of birth complications and recommend the best course of action in handling them [30]. Post-natal care has also increased significantly since 2004 as only 17.2 % of mothers

received at least one post natal check-up within 41 days of birth, while in 2011 this has increased to 30 % [4, 21]. Postnatal care is best applied multiple times with the most efficacious interventions occurring soon after birth [35]. The significant increases in family planning programs along with women's education may provide an explanation for the decreases in NMR. It has been shown elsewhere that an accelerated fertility transition is often associated with an equally rapid reduction in neonatal mortality [16]. Similarly many components of the health sector reforms have targeted gender equity which can often coincide with greater neonatal reductions.

Reductions in equity gaps amongst different groups have also been observed during the study period. Often in the context of declining overall mortality rates, a pattern of reducing absolute but rising relative inequalities is observed [10–12]. In Bangladesh this has not been the case. Relative differences have remained roughly uniform or even decreased suggesting that those groups that are worse off may be improving at a greater rate relative to their other equity group counterparts. Several other studies have noted that this reduction in equity and indeed child and neonatal mortality presents a paradoxical situation in Bangladesh [1, 2, 36].

As with virtually all countries with high neonatal health burdens, those who are better off usually live in urban areas, are richer and better educated. The NMR improvements seen between these groups in Bangladesh have been in line with improvements in equity of coverage. A difference of 23.9 % between urban and rural areas receiving at least one antenatal visit in 2004 has reduced to 19.7 % in 2007. Coverage of both a medically trained professional present at birth and, receiving a post natal check-up within 42 h of birth increased almost twice as quickly in the rural areas than in urban [4, 21]. The expansive door-to-door style community health worker campaigns rolled out through collaboration between MOH departments and NGOs may have contributed to this increasing equity [2, 37]. Hard to reach areas have been given access to service through the training of large numbers of community health workers. Indeed a large number of innovative community based approaches capitalising on non-governmental partnerships have been recognised as distinct features of Bangladesh's successful approach to health service delivery [37]. NGOs recognising the majority rural burden of disease have helped to provide training of many of these workers [32, 37, 38]. Despite national plans addressing the rural urban divide, allocation of resources in Bangladesh remains urban dominated [7]. In 2005 the average per capita expenditure in the public sector in urban areas was 197 TK (2.96 USD) for combined in-patient and out-patient services while in the rural areas the average was only 78 TK (1.47 USD) [39]. Furthermore, rural residents face frequent problems such as large travel distances, fewer health facilities per capita and less medical personnel per capita [39, 40].

Inequalities in NMR based on socioeconomic status have also been improving. As an example, iron supplementation for mothers as a component of ANC increased by over 7 % in the lowest wealth quintile between 2004 and 2007 alone while in the highest quintile coverage remained stagnant. The number of facility based births in the lowest and second lowest wealth quintiles improved three and six times respectively, while in the highest wealth quintile it less than doubled. Skilled birth attendance has also improved at similar rates amongst the wealth groups. As a key component of increased NMR wealth equity family planning has increased in coverage to have <1 % difference in met need between the richest and poorest quintiles [4]. It is possible that various factors have contributed to the wealth equity improvements such as direct targeting of the poor by national plans, NGO poor-focused health services and social mobility programs such as microcredit [2, 36, 38]. However, we should note that despite the encouraging reduction in inequity, substantial disparities still remain. Coverage of key interventions across the wealth divide show that while some interventions are roughly evenly distributed, others such as ante-natal care or skilled birth attendance, remain highly inequitable across the wealth divide [15]. A recent report suggests catastrophic out of pocket expenditures might be the driving force behind this trend in Bangladesh [41, 42]. Additionally children from richer families still appear to receive preferential treatment over their poorer counterparts when attending a private health facility [42].

A significant increase in education amongst women has occurred throughout Bangladesh over the study period. DHS estimates show that the percentage of women who have not received any education has dropped from 58 to 28 % between 1993 and 2011 [4, 18]. Additionally, neonatal mortality rates amongst the non-educated have continued to decline, with reductions in both absolute and relative inequalities in child mortality amongst education groups. These reductions have coincided with a decrease in unmet need for family planning interventions in the non-educated from 16.6 % in 2000 to 12 % in 2011 [4, 20]. Uneducated mothers delivering at health facility also increased from 3.1 to 11.2 % in the same time period.

Study Limitations

Several key limitations were noted while performing this study. While mortality data were used to show changes in U5MR and NMR over time, without longitudinal data for health coverage we are unable to examine their effect on mortality rates and inequities. Therefore, the proposed

potential explanations for the observed shifts in health and equity in Bangladesh should be considered with caution. Additionally, recall bias and under reporting of deaths may have an effect on the estimated child mortality rates. To manage this issue data were pooled from multiple surveys. Finally, sizable sampling errors tend to occur where the number of observations is limited; necessitating caution when interpreting results.

Conclusions

Significant reductions in neonatal mortality have occurred nationally in Bangladesh. Disparities between subnational groups have also seen encouraging absolute and relative reductions. Large reforms since independence with a heavy focus on proven reproductive, maternal, newborn and child health interventions may have contributed to this improvement. These reforms have been a mix of large scale programs such as family planning and focused plans such as the targeting of increased human resource support to underserved areas. The neonatal and child health improvements have occurred despite persisting poverty and low national income. While Bangladesh may demonstrate that rapid child and neonatal health improvements are possible, some challenges still remain. These challenges include the remaining child and neonatal mortality burden and low levels of coverage of key interventions such as the presence of skilled birth attendants. A continued push may contribute to a continued and sustained reduction in under-five and neonatal mortality.

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Conflict of interest The authors declare that they have no competing interests.

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