

REVIEW PAPER

Child survival revolutions revisited. Lessons learned from Bangladesh, Nicaragua, Rwanda and Vietnam

Lars Åke Persson^{1,2}, Anisur Rahman³, Rodolfo Peña^{1,4}, Wilton Perez¹, Aimable Musafili^{1,5},
Dinh Phuong Hoa⁶

¹ International Maternal and Child Health (IMCH), Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden, ² Department of Disease Control, Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, U.K., ³ International Centre for Diarrhoeal Disease Research (icddr,b), Dhaka, Bangladesh, ⁴ Pan American Health Organization, San Salvador, El Salvador, ⁵ Pediatric and Child Health Department, University of Rwanda, Kigali, Rwanda, ⁶ Hanoi School of Public Health, Hanoi, Vietnam

Short title: Child survival revolutions revisited

Correspondence:

Professor Lars Åke Persson MD PhD,
Department of Disease Control, Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT, United Kingdom

Phone +46 70 2870357

Email: lars.persson@lshtm.ac.uk

ABSTRACT

Analysing child mortality may enhance our perspective on global achievements in child survival. We used data from surveillance sites in Bangladesh, Nicaragua and Vietnam and Demographic Health Surveys in Rwanda to explore the development of neonatal and under-five mortality. The mortality curves showed dramatic reductions over time, but child mortality in the four countries peaked during wars and catastrophes and was rapidly reduced by targeted interventions, multi-sectorial development efforts and community engagement. **Conclusion.** Lessons learned from these countries may be useful when tackling future challenges, including persistent neonatal deaths, survival inequalities and the consequences of climate change and migration.

Key notes

- This review analysed child mortality in different settings to examine global achievements in child survival
- It found that child mortality in Bangladesh, Nicaragua, Rwanda and Vietnam peaked during wars and catastrophes and was rapidly reduced by targeted interventions, multi-sectorial development efforts and community engagement
- The lessons learned may be useful for tackling future challenges, such as persistent neonatal deaths, survival inequalities and the consequences of climate change and migration

Key words: child mortality, migration, Sustainable Development Goals, natural catastrophes, war.

In September 2000 the largest gathering of world leaders in history adopted the United Nations' Millennium Declaration, committing their countries to a new global partnership to reduce extreme poverty by 2015.

At the end of the Millennium Development Goal era, reports assessed the progress that had been made and the challenges that remained. Extreme poverty had been halved and global mortality in children below five years of age had dropped from 90 per 1,000 live births in 1990 to 43 per 1,000 in 2015 (1,2). This review focuses on four examples of child survival development that underpinned this global progress. These cases emanated from countries with impressive improvements in child survival: Bangladesh, Nicaragua, Rwanda and Vietnam. Authors from these four countries, and Sweden, have worked together on different collaborative child survival projects over the past few decades. The aim of this review was to describe the development of child mortality in these settings over recent decades and to reflect on the possible mechanisms behind the progress that took place against a background of war, catastrophes and human suffering. The four settings, and the data sources from Bangladesh, Nicaragua, Rwanda and Vietnam are presented in the Appendix.

Child survival patterns

A first look at the mortality graphs may give the impression of bedside body temperature curves of febrile children, who successfully recover, with dramatic peaks, rapid changes and large differences between the high initial levels and the lower levels towards the end of the study periods (Figures 1 to 4).

In 1970 the mortality of children under the age of five years in Matlab, Bangladesh, was above 200 per 1,000 live births (Figure 1). Higher peaks followed at the time of the 1971

liberation war and the 1974 flooding and famine. A Shigella outbreak in 1984 led to a high death toll among children. From the late 1980s, comprehensive maternal and child health services, including door-step family planning services and adequate immunisation coverage, resulted in great improvements in child survival (10). Within the time window of the Millennium Development Goals from 1990 to 2015, the targeted two-third reduction in under-five mortality was reached.

The Nicaraguan story starts with an under-five mortality level of around 100 per 1,000 live births (Figure 2). There were, in spite of an overall downward trend, some increases in mortality at the time of the liberation from the Somoza dictatorship in 1979 and during a period of the US-backed Contras war in the following decade. At the end of the study period in 2005, the under-five mortality rate was approaching 20 per 1,000 (6,7).

Rwanda's under-five mortality level in 1990 was estimated to be around 80 per 1,000 live births, but the 1994 genocide tripled this figure (Figure 3) (8). Immediate efforts to improve security and international assistance reduced the child mortality in the post-genocide period. A second peak in the late 1990s coincided with the withdrawal of some of the international support and a temporary re-introduction of user fees in the health service. A number of initiatives, such as the millennium efforts to achieve universal coverage of essential maternal and child health services and targeted interventions aimed at vulnerable groups - combined with multi-sectorial development investment - resulted in an under-five mortality rate of around 50 per 1,000 in 2010 (8).

The Vietnam data from the Red River delta area showed an under-five mortality rate of around 50 per 1,000 in 1970 (Figure 4). President Nixon's order to re-start and intensify bombings over the north of Vietnam in December 1972 almost doubled the mortality rate of newborn infants, as the bombardment made it difficult to access perinatal health services (9). At the end of the war in 1975, the under-five mortality rate had reduced. However, the following years were characterised by limited rice production, an economic crisis and increased poverty and were accompanied by higher mortality rates in children. The expansion of the immunisation programme and other vertical interventions in the early 1980s, and the *doi moi* reforms that aimed to create a market economy from the mid-1980s, resulted in a rapid decrease in under-five mortality rates.

The neonatal mortality level was consistent over the three decades – 1970 to 2000 - covered by the Ba Vi data from Vietnam (Figure 4). These recorded deaths during the first 28 days of life have frequently been invisible in official statistics in low-income settings (11,12). The Millennium Development Goal agenda did not include a neonatal mortality target from the start (13). Births are often not officially counted until it is evident that the newborn child is surviving. The families may not approach the local authorities for a birth certificate for one to a few months and the deaths of young infants are frequently missing from the official data.

A continuum of good healthcare for all pregnant and delivering women and their children is needed to cope with perinatal health problems and prevent deaths (14,15). Examples from other countries illustrate the difficulties in reducing the number of

deaths during the first month of life in comparison to post-neonatal health problems. Perinatal health concerns cannot be managed by vertical approaches, such as vaccinations, or single standardised treatments such as oral rehydration therapy. They require health system approaches with good coverage, quality and continuity (16).

Wars, catastrophes and mortality

The four countries we focus on in this review show, with terrifying clarity, how children become victims of wars and catastrophes. In the years before the genocide in Rwanda, the political turmoil and suffering of the population had already resulted in increasing under-five mortality (Figure 3). We also observed rapidly increasing child mortality in Somalia, whose society was collapsing before the onset of war. The dominating causes of death in such situations are preventable and treatable, namely diarrhoea, pneumonia, and other vaccine preventable diseases (17). The Rwanda example also illustrates a scary new phenomenon that continues to be reported from several conflict countries: children become specific targets in armed conflicts (18).

Usually, the youngest infants are relatively protected from the consequences of war and unrest. The high peaks of mortality in Bangladesh in the early 1970s (Figure 1) and in Rwanda in the 1990s (Figure 3) were not accompanied by corresponding increases in neonatal mortality. The data from the war in Vietnam in the early 1970s were an exception (Figure 4). Bombing prevented access to perinatal health services, mothers had to deliver without skilled attendance and an increased death toll was seen among newborns infants (9).

There was a remarkable reduction in under-five mortality in the Nicaraguan data starting when the Somoza dictatorship fell in 1979 and continuing throughout the following decade, despite the US-backed Contras war (Figure 2). People were mobilised by literacy and vaccination campaigns and primary healthcare was expanded into rural areas that previously had no access to health services. Under-five mortality was reduced by half during this period of war and unrest (6).

The Bangladesh 1974 famine caused many deaths, shown in the high peak of mortality after the neonatal period (Figure 1). It should be noted that even children conceived or born at the time of the famine continued to have increased mortality risks during the first few years of life (19). There is also accumulating evidence of chronic disease risks associated with intrauterine exposure to famine, as demonstrated by studies of the Dutch famine in 1944-45 (20), the Chinese famine in 1959-61 (21) and the Biafra famine in 1968-70 (22).

Health sector reforms, multi-sectorial development and mortality

Which characteristics of a successful health system performance have resulted in reduced child mortality? The Nicaraguan experiences from the revolution and the Contras war, tell us that even a few targeted and prioritised preventive and curative interventions delivered by motivated primary care workers can be successful if there is high child mortality (6). Essential health services were made available free of charge to previously underserved parts of the population, resulting in a dramatic improvement in child survival during a period of war and unrest (6). The improved education levels of

girls and women also contributed substantially to the improvement in child health and survival (7,23).

From the end of the 1990s, the Rwandan Government initiated a series of health system reforms. These built on the experiences of other countries, but were innovative in how they adapted and combined approaches to strengthen all the building blocks of the health system (8). New additional services were piloted, documented, published and - after modifications - scaled-up in the system. These included interventions by community health workers, performance-based finance and health insurance. The combination of the interventions and their comprehensive coverage were part of the success story (24). The health system reforms were also combined with developmental initiatives in other sectors of society, to enhance equity and eradicate poverty (8).

The Matlab achievements in child survival should be related to the high coverage of essential health services in combination with socioeconomic development efforts (25,26). In this sub-district of Bangladesh, as in all parts of the country, the national development organisation BRAC has been running development activities, including micro-credit programmes and educational activities. A population-based analysis of these activities and child mortality data from Matlab illustrate the benefits that development activities focused on women have had on child survival (26). Several innovative interventions in Bangladesh have also proven to be effective and been scaled up to national programmes with high coverage and effects. One such example is the doorstep delivery of family planning, which was developed and evaluated in Matlab and later implemented throughout the whole country. This programme has had huge effects on demography, women's health and child survival (10). Another example is the oral

rehydration therapy that was developed by the researchers in Dhaka. This intervention was evaluated in clinical and population-based studies before being scaled-up nationally and globally. Millions of lives have been saved and there is still large potential to save more children by using this simple solution (27).

Community engagement and child survival

The Matlab experience of rapidly improving child survival illustrates the progress made in the whole of Bangladesh. The remarkable education achievements, the progress in gender equity, sustained fertility reduction, improved child survival and the reductions in maternal mortality have been labelled the Bangladesh paradox (28). These advancements are in contrast to a continued burden of infectious diseases, malnutrition, poverty and a fragile political system. Several factors may explain the progress, for example an engaged civil society with powerful non-governmental organisations, an equity orientation in development efforts, increasing proportions of educated women and a skilled cadre of female community health workers.

The Bangladesh community health workers, including those called Shasthya Shebikas, have been potent agents for achieving almost universal immunisation coverage, the world's highest coverage of oral rehydration therapy use, the success of the family planning programme (29) and successful experiments that provide community-based management for sick newborn infants (30). Community health workers appear in different guises and may deliver impressive results if they are given well-defined tasks and are properly trained and supervised, remunerated and integrated into a functioning health system (31). The Brigadistas of Nicaragua, who were community volunteers, immunised, treated dehydration and pneumonia and saved child lives during the time of

war (6). The Binome and other categories of community health workers in Rwanda have been judged to have played a significant role in the country's progress in child survival (24,32).

Community engagement for maternal and child health was an important ingredient in all four country examples. In Vietnam, as well as in other Asian countries, intervention studies have shown that participatory approaches to community engagement can solve some of the local problems that threaten perinatal survival and thereby reduce neonatal mortality and increase equity in survival (33-36). A number of organisations have played important roles in the child health revolutions in these countries, including the civil society and non-governmental organisations in Bangladesh (26), the strong Women's Union in Vietnam (33) and communities that have engaged in development and welfare in Rwanda (8).

Future challenges

As illustrated in all four countries, increasing proportions of deaths under the age of five occurred during the first month of life (Figure 1-4). In the Nicaragua and Vietnam settings with the lowest under-five mortality levels, more than three-quarters were neonatal deaths at the end of the study period. In Bangladesh, a half took place during the first month of life, while in Rwanda - with an under-five mortality level of around 50 per 1,000 - slightly more than a third was due to neonatal mortality. The global research and advocacy for improved child survival that took place after the Millennium shift was mainly giving priority to post-neonatal and child health problems (37) and the potential for change by a series of cost-effective, evidence-based interventions (38). Later, more emphasis was given to neonatal deaths (13) and the strategies to prevent these by

establishing a continuum of maternal and newborn care (39). The huge problem of preventable fresh stillbirths in low-income settings has now been added to the agenda (40). As with neonatal deaths, there is an urgent need to identify and register these cases to identify the problems (41).

The Nicaraguan graph shows the lowest population-based figure of neonatal mortality for some years in the mid-1990s (Figure 2). This low level reflected quality improvements in maternal and neonatal services in the regional hospital in León, which lowered the hospital-based early neonatal mortality rate from 56 to 11 per 1,000 live births over the course of a few years (42). The improved survival was the result of a participatory process, including all staff, which identified and acted upon fundamental problems related to the separation of the mother and baby, hygiene, temperature control, feeding and invasive procedures. The later increase in neonatal mortality, when almost all of the women in the area delivered their babies at the hospital, may again be due to problems in the quality of care. Such tendencies of increasing time trends in neonatal mortality, when more women delivered at health institutions, were also seen in the Vietnam data (Figure 4). It is not sufficient just to increase the number of institutional deliveries, resources must also be made available to maintain and improve the quality of perinatal care that the health centre or hospital can offer (43).

It has been reported that rapid progress in child health outcomes can increase health inequities (44), but that is not always the case. The investments in health during the Nicaraguan revolution prioritised the underserved rural population and the poorer segments of society, resulting in a reduced social gap in child survival (6). Similarly, the pro-poor investments in health in Rwanda not only lowered under-five mortality, but

also increased equity in survival (8). Towards the end of the Millennium Development Goal era, the global community identified the need to monitor the social distribution in the coverage of interventions and effects on outcomes, such as under-five mortality, as well as the averages in process and outcome indicators (45). Abolishing inequity is not just fair in terms of considering the rights of the child, it is a prerequisite for poverty reduction and the continued reduction of child deaths (46).

Matlab, Bangladesh, is one of the areas in the world where the consequences of climate on its inhabitants are visible. The increasing flooding of the area, the erosion along the river banks, the villages that are taken by the rivers and the people that have no option but to live in the slums in Dhaka when they have lost their land (28). The surveillance systems have shown that the frequency and magnitude of extreme weather have been associated with the occurrence of childhood diarrhoea (47).

An equity lens should not only be used to visualise gender differences and socio-economic gaps in child health (44). In some parts of the world, urban-rural differences are increasing, with the urban poor often living in the huge slum settlements of the mega cities in Asia, Africa and Latin America (48). In such settings, innovative approaches are needed to engage the urban poor communities in the provision of low-cost, high-quality maternal and child health services (49).

The eight Millennium Development Goals had a strong focus on health, with maternal and child health and survival represented by two separate goals. The world has now committed itself to reaching 17 Sustainable Development Goals by 2030, and there is only one specific health goal, number three, that focuses on good health and wellbeing,

(50). On the one hand, this change in focus may threaten further progress if the previous achievements are forgotten and not sustained (51,52). On the other hand, it may lead to a positive paradigm shift towards prevention and extensive multi-sectorial efforts that target poverty alleviation and improved health and welfare (50). Rwanda is one of the countries with a very clear agenda for the years to come, not only in poverty alleviation, but in building systems for further advancements in health (53). The Sustainable Development Goal 2030 Agenda integrates poverty, health and welfare perspectives with the need to counteract climate change and achieve peace and planetary stability, which may be the greatest prerequisites for continued improvements in child survival in the years to come (54).

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Figure 1. The under-five mortality rate (circles) and the neonatal mortality rate (squares) in Matlab, Bangladesh, 1970-2015.

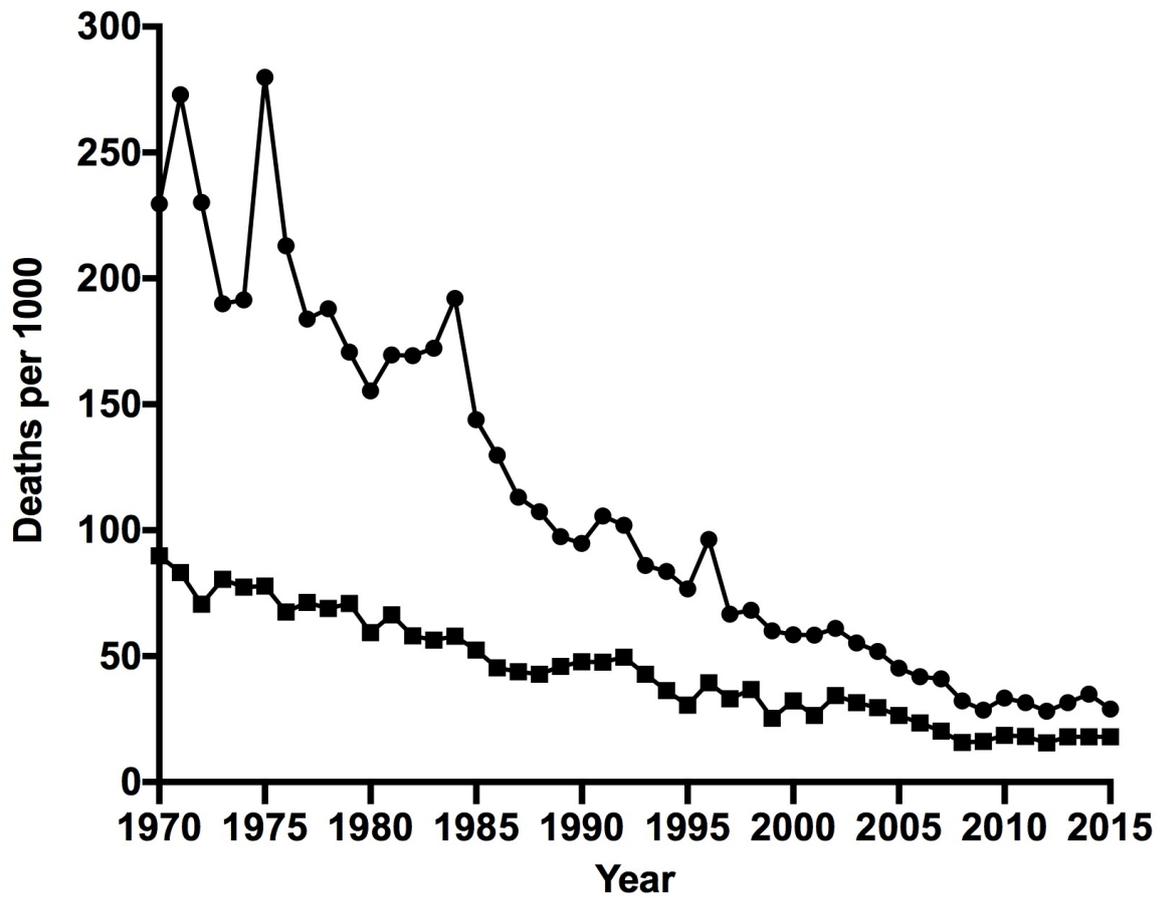


Figure 2. The under-five mortality rate (circles) and the neonatal mortality rate (squares) in León, Nicaragua, 1970-2005.

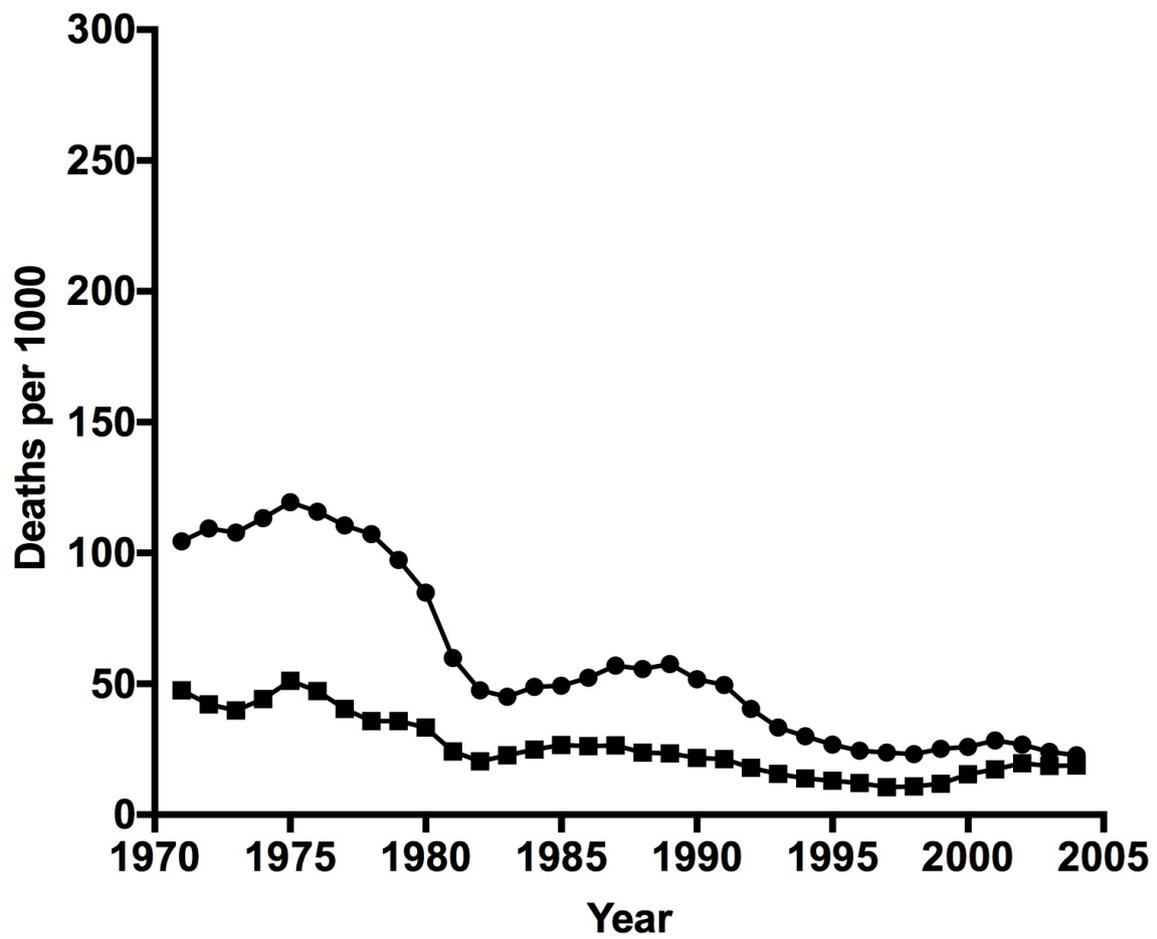


Figure 3. The under-five mortality rate (circles) and the neonatal mortality rate (squares) in Rwanda, 1990-2010.

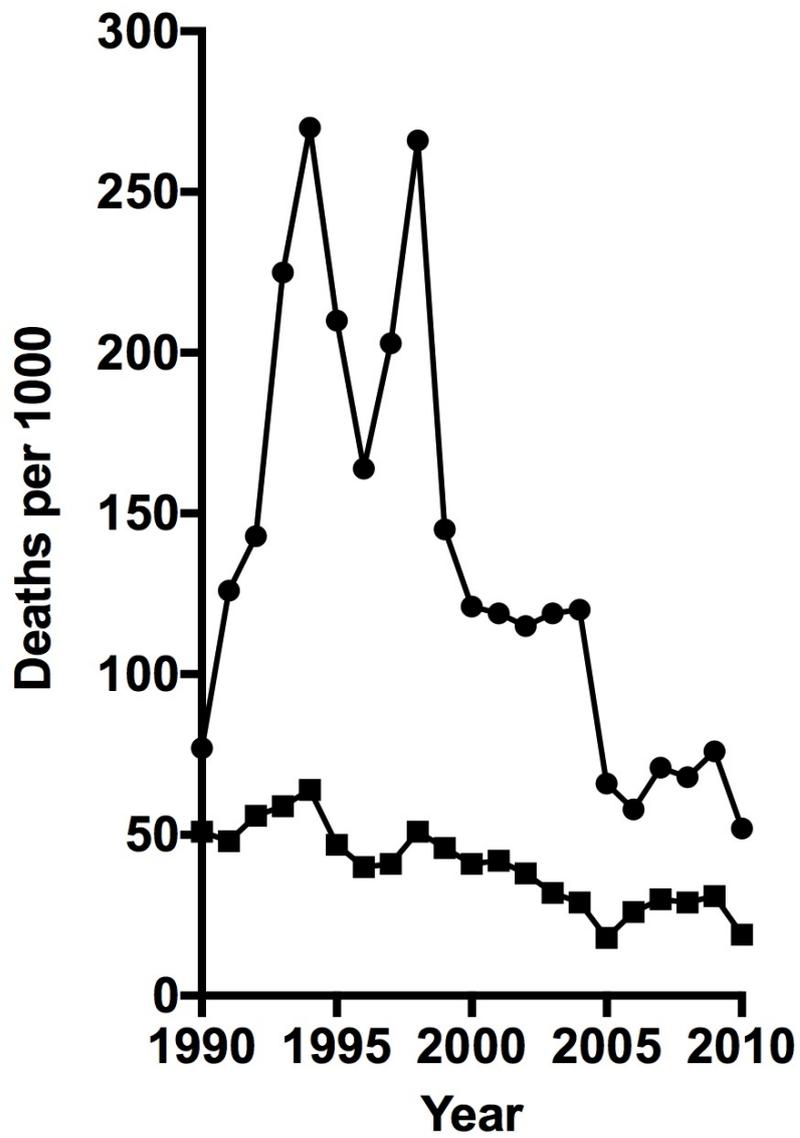
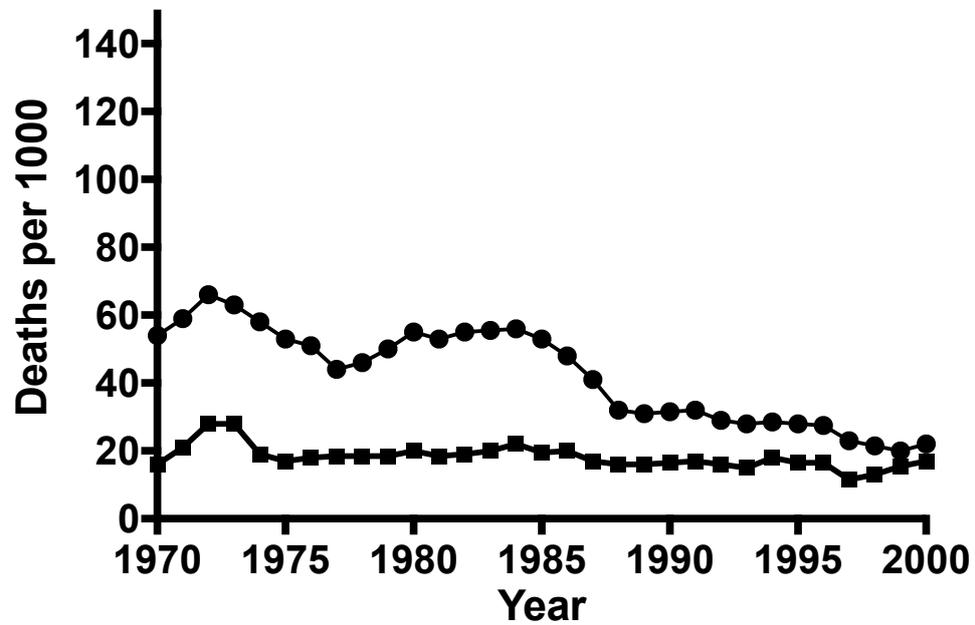


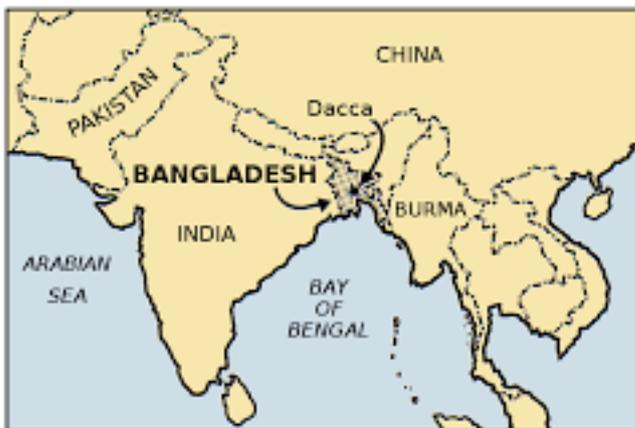
Figure 4. The under-five mortality rate (circles) and the neonatal mortality rate (squares) in Ba Vi, Vietnam, 1970-2000.



Appendix

Bangladesh

The Matlab Health and Demographic Surveillance System was established in 1966 and includes a 220,000 rural population in the delta area 50 km south of the capital, Dhaka (3,4). The data used for this paper covered the period 1970-2015. The under-five mortality rate is shown for the entire population up to 1978 and thereafter for the 110,000 population area, where the International Centre for Diarrhoeal Disease Research provides selected health services, including the prevention and treatment of infectious diseases and maternal and child health services. The Matlab sub-district is representative of the rice-cultivating delta area of Bangladesh.



Nicaragua

The Nicaraguan data were derived from the Health and Demographic Surveillance System in the city and surrounding countryside of León, a university town north of the capital, Managua (5-7). The study period covered 1970-2005. The surveillance sample included a population of around 55,000 inhabitants in 11,000 households. The surveillance system was established in 1993, followed by repeated updates that provided information on births, deaths, and migration in the study area (5). Retrospective reproductive life interviews with women aged 15-49 years in 1993 formed the basis for the analysis of earlier births and deaths. The area is relatively typical for the more densely populated western part of Nicaragua towards the Pacific coast.



Rwanda

The Rwanda data emanated from three consecutive Rwandan Demographic and Health Surveys conducted in 2000, 2005 and 2010 (8). These data were representative of the whole of Rwanda. In sampled households, 35,413 women aged 15 to 49 years were interviewed. The analysis covered the period from January 1990 to December 2010. The weighted sample size was 15,198 births in the 2000 survey, 8,753 in 2005 and 10,848 in 2010.



Vietnam

The Vietnam data come from the Health and Demographic Surveillance System in the Ba Vi District, a rural area situated 70 km west of Hanoi. The district includes lowland and highland areas and some islands in the Red River Delta. The area is representative of the northern parts of Vietnam regarding geography, demography, disease pattern and administrative structure (9). It provided the retrospective reproductive life experiences of 14,329 women aged 15– 54 years, including 26 796 live births, and covered the period 1970 to 2000.

