

# ANALYZING BENEFIT-COST RATIO OF HEALTH INTERVENTIONS FOR IMPROVING MATERNAL AND CHILD MORTALITY AND CHILD IMMUNIZATION IN BANGLADESH:

JAHANGIR A. M. KHAN, LIVERPOOL SCHOOL OF TROPICAL MEDICINE, U.K AND KAROLINSKA INSTITUTET, STOCKHOLM, SWEDEN

SAYEM AHMED, INTERNATIONAL CENTRE FOR DIARRHOEAL DISEASE RESEARCH, BANGLADESH (ICDDR) DHAKA AND KAROLINSKA INSTITUTET, STOCKHOLM, SWEDEN



Benefits and Costs of Reducing Maternal and Neonatal Mortality and Increasing Child Immunization in Bangladesh



SMARTER SOLUTIONS FOR  
BANGLADESH





# Estimating Return on Investment in Health Maternal and Neonatal Mortality Reduction and Child Immunization in Bangladesh

---

## Bangladesh Priorities

**Jahangir A. M. Khan**

*Liverpool School of Tropical Medicine, U.K and Karolinska Institutet, Stockholm, Sweden*

**Sayem Ahmed**

*International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, Dhaka and Karolinska Institutet, Stockholm, Sweden*

© 2016 Copenhagen Consensus Center

[info@copenhagenconsensus.com](mailto:info@copenhagenconsensus.com)

[www.copenhagenconsensus.com](http://www.copenhagenconsensus.com)

This work has been produced as a part of the Bangladesh Priorities project, a collaboration between Copenhagen Consensus Center and BRAC Research and Evaluation Department.

The Bangladesh Priorities project was made possible by a generous grant from the C&A Foundation.

Some rights reserved



This work is available under the Creative Commons Attribution 4.0 International license ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)). Under the Creative Commons Attribution license, you are free to copy, distribute, transmit, and adapt this work, including for commercial purposes, under the following conditions:

#### Attribution

Please cite the work as follows: #AUTHOR NAME#, #PAPER TITLE#, Bangladesh Priorities, Copenhagen Consensus Center, 2016. License: Creative Commons Attribution CC BY 4.0.

#### Third-party content

Copenhagen Consensus Center does not necessarily own each component of the content contained within the work. If you wish to re-use a component of the work, it is your responsibility to determine whether permission is needed for that re-use and to obtain permission from the copyright owner. Examples of components can include, but are not limited to, tables, figures, or images.

<b>LIST OF ABBREVIATIONS .....</b>	<b>2</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>2</b>
<b>INTRODUCTION .....</b>	<b>5</b>
<b>BACKGROUND .....</b>	<b>6</b>
<b>OBJECTIVES.....</b>	<b>9</b>
<b>METHODS .....</b>	<b>9</b>
<b>INTERVENTIONS.....</b>	<b>9</b>
MATERNAL AND NEONATAL HEALTH.....	9
CHILD IMMUNIZATION.....	10
ESTIMATING COSTS.....	11
ESTIMATING BENEFITS.....	12
RETURN ON INVESTMENT.....	13
<b>RESULTS.....</b>	<b>13</b>
<b>FACILITY DELIVERY WITH SKILLED BIRTH ATTENDANTS.....</b>	<b>13</b>
<i>Costs of interventions.....</i>	<i>13</i>
<i>Benefits of interventions.....</i>	<i>13</i>
<i>Maternal deaths reduction and benefits.....</i>	<i>14</i>
<i>Neonatal deaths reduction and benefits.....</i>	<i>14</i>
<i>All deaths averted and total benefits.....</i>	<i>14</i>
<i>Return on investment.....</i>	<i>15</i>
<b>TRAINED BIRTH ATTENDANTS.....</b>	<b>16</b>
<i>Costs of intervention.....</i>	<i>16</i>
<i>Benefits of intervention.....</i>	<i>16</i>
Maternal deaths reduction and benefits.....	16
Neonatal deaths reduction and benefits.....	16
All deaths averted and total benefits.....	17
<i>Return on investment.....</i>	<i>17</i>
<b>NEONATAL HOMECARE.....</b>	<b>18</b>
<i>Costs of intervention.....</i>	<i>18</i>
<i>Benefits of intervention.....</i>	<i>18</i>
<i>Return on investment.....</i>	<i>18</i>
<b>CHILD IMMUNIZATION .....</b>	<b>19</b>
<i>Rural Slums.....</i>	<i>19</i>
Costs of intervention.....	19
Benefits of intervention.....	19
Return on investment.....	20
<i>Rural hard-to-reach areas.....</i>	<i>20</i>
Costs of intervention.....	20
Benefits of intervention.....	21
Return on investment.....	21
<b>DISCUSSION .....</b>	<b>21</b>
<b>REFERENCES.....</b>	<b>24</b>
<b>APPENDIX 1: DESCRIPTION OF STUDIES EMPLOYED IN THE ANALYSES .....</b>	<b>27</b>

## List of abbreviations

DALY	Disability Adjusted Life Years
DGHS	Directorate General of Health Services
EPI	Expanded Immunization Programme
GoB	Government of Bangladesh
H&FWC	Health and Family Welfare Centre
H2R	Hard-to-reach
MDG	Millennium Development Goals
MMR	Maternal Mortality Ratio
MNCH	Maternal, Newborn and Child Health
MMEIG	Maternal Mortality Estimation Inter-agency Group
NGO	Non-Governmental Organization
SBA	Skilled Birth Attendant
SDG	Sustainable Development Goals
TBA	Trained Birth Attendant
YLL	Years of Life Lost
YLD	Years Lost Due to Disability
USD	United States Dolla

## EXECUTIVE SUMMARY

The first World Development Report in 1993 was devoted to the importance of investing in health. Cost containment was strongly advocated in the report and cost-effectiveness was recommended as a tool for prioritizing health interventions. During the era of Millennium Development Goals (2000-2015), Bangladesh demonstrated remarkable success in health indicators in relation to the goals on maternal and child mortality, among others. The current report thus intends to analyze the return on investment for reducing maternal and neonatal mortality as well as child immunization, based on evidence from Bangladesh and other relevant low- and middle-income countries.

The future priority of the Bangladesh government in maternal and child health is to improve coverage of effective newborn health interventions, increase skilled birth attendance and facility deliveries. Furthermore, the future priorities for healthcare in general address “increased access to quality health services by strengthening the health workforce and provision of health services”; and “support the equitable delivery of health interventions and services, particularly for underserved populations and marginalized groups”. In addition, widespread application of large-scale community-based approaches, especially investment in community health workers using a doorstep delivery approach, has been recommended by a Lancet series on Bangladesh. Challenges and priorities in health sector by the Government of Bangladesh and evidence from research initiatives mainly in Bangladesh and in some other low- and middle-income countries were used as the basis for analyzing the returns on investment in maternal and neonatal health and child immunization.

Our analysis assumes a service target scenario that 80% of the currently unattended births (1.5 million) would be covered by facility delivery with presence of skilled birth attendants and 20% (374.2 thousand) would be attended by trained birth attendants at the community level. Forty percent of neonates (748.5 thousand) would also get homecare by trained attendants at the community level.

Children in urban slums and rural hard-to-reach areas were identified as under-served population of EPI in Bangladesh. Our estimation took an approach to expand the coverage of children in urban slums and rural hard-to-reach areas. An estimated 665 thousands under-five children live in urban slums, of which 57% or 372.4 thousands are currently unvaccinated. Of the estimated 1.2 million under-five children in the rural hard-to-reach areas, 49.3% or 592.5 thousands were unvaccinated. We posit that the coverage in urban slums would be expanded to the national full immunization coverage level at 84.7% and in rural hard-to-reach areas to 83.5% as found in a research initiative.

The costs of the interventions were calculated by using cost data extracted from previous studies carried out in Bangladesh. Since the health system of Bangladesh is considered to be well structured for providing health maternal and neonatal services to populations in rural, suburb and urban areas through Family Health and Welfare Centres, Upazila (sub-district) Health Complexes, district hospitals as well as regional and tertiary level hospitals, additional costs for infrastructure development was not considered in the analysis. Direct medical costs (medicine, diagnostic tests, surgical procedure) and out-of-pocket spending of the patients (mainly for medicine, travels, food) and if applicable training costs (like, for health workers) were considered in the costs of intervention.

For estimating the economic benefits of interventions Disability-Adjusted Life Years (DALYs) averted were calculated by multiplying the number of deaths with the difference in years between life expectancy of target population and average age of death. It needs to emphasis here that DALYs includes years of life lost (YLL) due to premature death and years lost due to disability (YLD). In this current analysis, we included only YLL because of lack of data on disability in connection with morbidity in all except homecare for neonates. Finally, for estimating the economic benefits of averting the DALYs due to reduction in deaths, we adopted the method of estimating statistical years of life, i.e. multiplying the total DALYs averted with GDP per capita (1,235 USD) of Bangladesh.

The estimates showed that providing facility-based delivery with skilled birth attendance (SBA) to pregnant women would cost \$115 million USD in total and \$77.0 USD per woman served. Such intervention was estimated to save 3,260 maternal and 37,727 neonatal mortality cases which would avert 2.56 million DALYs, resulting in \$1.33 billion USD in total economic benefits. One USD investment on this intervention would get a return on investment of 11.5 USD. Child deliveries to 374.2 thousand pregnant women with trained birth attendance (TBA) would cost \$7 million USD, which would avert 344 maternal and 5,988 neonatal deaths and consequently 455,635 DALYs. The estimated total benefits would be \$227.4 million USD. A return of \$32.5 USD was estimated from each USD invested in this intervention. Homecare package for 748,492 neonates would cost 8.1 million USD in total, with a unit cost of \$10.9 USD per neonate served. A total of 8,907 deaths and 636,169 DALYs would be averted, which would result in total benefits of \$326.9 million USD. One USD investment in homecare would save \$40.2 USD.

Child immunization in rural slums would cost 18.0 USD for full immunization of each child, which would cost \$2.67 million USD for immunizing 148,367 children through the intervention under study. A total 1,710 death cases and 117,985 DALYs could be averted by the intervention, which would result in total estimated economic benefits of \$61.2 million USD. Our estimates show that each USD invested



in the intervention would give a return of \$23.0 USD. In the rural hard-to-reach areas, the intervention under study cost \$24.5 USD for vaccinating one child and the total costs for vaccinating additional 263,782 children would cost \$6.46 million USD. An estimated 2,430 deaths would be prevented, which would avert 167,639 DALYs. The total estimated benefits would be \$87.0 million USD. Each USD investment thus resulted in a return of \$13.5 USD.

The economic estimates show incentives for investing in the health interventions with higher expected return than required investment. Bangladesh has long-time experience in health service deliveries through public, NGO, private organizations and public-private partnership (PPP). However, how these interventions should be organized for reaching the target populations is out of scope of this report. The level of intervention costs through public and NGO providers are generally comparable. To keep the costs of service deliveries low, even for for-profit/private providers, market competition should be created while making any public-private partnership.

In sum, investments in reducing maternal and neonatal deaths and child immunization were estimated to have large returns. Inclusion of disability due to morbidity would be useful for getting a more complete picture. Data from several countries have been employed, though efforts were made to utilize Bangladesh specific data. Usage of more Bangladesh specific data could make the estimation more robust. However, despite certain limitations, evidence-based findings of this report should be useful in the health sector of Bangladesh, especially on best ways to allocate limited resources.

## INTRODUCTION

During the era of the Millennium Development Goals (2000-2015), Bangladesh demonstrated remarkable success in health indicators. However, economic analyses of interventions that were conducted in Bangladesh were not enough as evidence for policy-makers so that government could be able to make investment plans for improving the healthcare delivery system using limited resources. A systematic review of the studies on economic evaluations of health interventions in Bangladesh, covering the period between 1971 and 2008, found only 12 full economic evaluations, though with variable quality of the studies (Hoque et. al. 2011). Further, cost-benefit analysis that compares the costs of an intervention with its economic benefits was rarely found. Insufficient economic studies of health interventions thus evoke a strong motivation for creating new evidence of return on investment in health in Bangladesh.

Success in health outcomes in Bangladesh has been observed in a number of areas, especially in maternal, newborn and child health as well as in immunization during MDG era 1990-2015 (GoB, 2015a). The new Sustainable Development Goals, which replaced MDGs, put emphasis on financial sustainability of development programmes. A future vision for continuation of health improvement in the country thus requires evidence on economic benefits in addition to health benefits, which would be necessary for the investment plan of the government.

The findings from this report, which compared economic benefits of specific health interventions with their costs, would be useful for priority-settings and resource allocation in healthcare sector. While the report estimated the return on investment in particular health interventions, the deliveries of such interventions could be implemented by the public sector in collaboration with non-governmental organizations and the private sector for successful outcomes.

The 'Background' section of the report describes the health improvement (MNCH and immunization) in Bangladesh during the MDGs era and the policy direction of the Government of Bangladesh for future work. The 'Method' section explains how information on health interventions and benefits were collected and used for estimating the return on investment. The outcomes are presented in the 'Results' section, followed by a 'Discussion' and a 'Concluding Remarks' section.

## BACKGROUND

Bangladesh made tremendous improvements in health during Millennium Development Goals (MDGs) era (2000-2015). The improvement in Bangladesh has been praised by international development organizations, including the World Bank, the World Health Organization, the United Nations and governments in many other countries, both regionally and globally. It is generally believed that an integrated approach involving the government, NGOs and private sector actors contributed to this success (GoB, 2015b).

The public infrastructure for health service delivery is spread all over the country for providing services to people from ward level to higher levels, including union, sub-district (upazila), district, division and national (GoB, 2015c). Health services are provided to the population through community clinics, Union Health and Family Welfare centres, Upazila Health Complexes, district level hospitals, tertiary level medical college hospitals and specialized hospitals. Maternal, new-born and child health services are provided at all levels, and the Expanded Immunization Programme (EPI) has been undertaken successfully by using the health infrastructure of the country. Along with the public health service system, private and non-governmental organizations played strong complementary roles in providing health services to the people.

The progress report of Bangladesh on Millennium Development Goals stated that in the area of 'child mortality' (MDG 4), three indicators were used for observing progress, namely, under-five mortality rate, infant mortality rate and immunization against measles (GoB, 2015c). The under-five mortality rate was 151 per 1,000 live births in 1990, which was reduced to 41 per 1,000 live births in 2013. The infant mortality rate dropped from 94 to 32 per 1,000 live births between 1990 and 2013. The successful programs for immunization, control of diarrheal diseases and Vitamin-A supplementation have been considered to be the most significant contributors to the decline in child and infant mortality. Along with health programs, steady economic and social development has also been regarded as contributors to such success. While significant improvement in child health was observed, drowning is increasing as a reason of deaths in children at age 1-4 years in Bangladesh. Further, the successful maternal, newborn and child health outcomes are inequitably distributed across socioeconomic groups (Bredenkamp et al. 2012; World Bank, 2015).

Success in maternal mortality reduction in Bangladesh has also been well recognized (GoB, 2015a). Bangladesh experienced a Maternal Mortality Ratio (MMR) of 574 per 100,000 live births in 1990/91, which was among the highest in the world. Between 2001 and 2010, Bangladesh observed a significant

reduction in MMR, from 322 to 194 per 100,000 live births. The Maternal Mortality Estimation Inter-agency Group (MMEIG), however, observed that the MMR in Bangladesh was lower, at 170 per 100,000 live births in 2013. A reduction from 574 to 170 per 100,000 live births corresponds to a 70% fall in MMR from 1990/91 to 2013, a remarkable progress. It has been argued that an increase in the proportion of births attended by skilled health personnel and increased coverage of antenatal care might have contributed to such improvement. During the period of 1991-2014, the proportion of births attended by skilled health personnel increased from 5.0% to 42.1% and antenatal care coverage increased from 27.5% in 1993-94 to 78.6% in 2014 (GoB, 2015c).

The EPI in Bangladesh was launched on April 7, 1979 (World Health Day). During the period of 1985-1990, EPI was intensified throughout 476 Upazila (sub-districts), 92 major Municipalities and 6 City Corporations. EPI was made available to all target groups (infants and pregnant mothers) by 1990. During the last few years, based on the disease burden data, new vaccines for selected emerging diseases such as Hepatitis- B (2003) and Hib Disease (2009) have been introduced into the EPI schedule. Hepatitis B vaccine was incorporated into the program with GAVI phase 1 support bundled with injection safety supply, later followed by the introduction of Hib antigen. Vitamin A supplementation was added to the program in 1990. From 1995 to 2010, 18 National immunization days were conducted with very high (around 90%) coverage in Bangladesh in view of eradicating polio. A measles catch-up program was conducted in 2005 (GoB, 2011). It needs to be noted here that until 1985 the vaccination coverage in general was 2%. The proportion of fully vaccinated children increased after the involvement of the government of Bangladesh to 84.3% in 2012, which demonstrates a greater success than many other low- and middle-income countries, including neighboring India and Pakistan.

Bangladesh has shown remarkable coverage of immunization against preventable diseases through its Expanded Programme for Immunization (EPI). The Government of Bangladesh is the main driver of the programme where NGOs and the private sector play complementary roles in vaccinating people. The weaknesses in the EPI are reflected in low coverage in rural hard-to-reach areas and urban slums in the country. While the full immunization reached 84.7 percent at the national level, the rural hard-to-reach (H2R) areas observed coverage between 29 percent (in low-lying areas) and 67 percent (hills) (Uddin et al. 2012; Uddin et al. 2010). Coverage in urban slums reached 43 percent only. Research initiatives were undertaken for creating evidence of interventions in order to increase the level of coverage in rural H2R areas and urban slums (Uddin et al. 2009; Uddin et al. 2012). Interventions in both rural H2R areas and urban slums used both supply and demand-side interventions to expand the

coverage of full immunization in these areas. However, much emphasis was placed in improving the supply-side by, for instance, training field staff and their supervisors on invalid doses, appropriate management of side-effects, the supply of vaccines through maintaining cold-chain, modified EPI session schedule with extended time for vaccination and immunization screening tool in health centres other than EPI sessions. The demand-side interventions include community support groups to create awareness for vaccination, support health staff for night stay in vaccination sites, identify children whose vaccination were incomplete and encourage mothers to fully vaccinate their children, and organize meetings with service providers to review and monitor EPI activities.

Despite this progress, it was acknowledged that one single problem, is the inability to address the problem of under coverage in specific geographic locations in Bangladesh (Uddin et al. 2012; Uddin et al. 2010). Multiple-intervention packages were applied for increasing the coverage in those areas.

The infant mortality rate of people in the richest and poorest quintiles were 36.4 and 68.5 per 1,000 live birth and under-five mortality were 44.5 and 89.8 per 1,000 live birth, respectively (World Bank, 2015). However, inequality in immunization was remarkably low at 88.4% and 79.6% for the richest and poorest quintiles, respectively. Similarly, the utilization of treatment of diarrhea also showed low inequality, referring to 85.9% utilization by the richest and 75.6% by the poorest sections. However, high inequality was observed in antenatal care and skilled birth attendance. While the richest people accessed antenatal care and skilled birth attendance by 46.7% and 50.7% in 2003, the poorest did so by only 6.7% and 4.9%.

Despite inequalities of different degrees across socioeconomic groups, success has been made in several health indicators of child and maternal health. In addition to the successes in the health sector of Bangladesh in the last few decades, new recommendations have been made for further improvements addressing mainly universal health coverage. The new Sustainable Development Goals (SDGs) put high emphasis on sustainability of development programs, including its financial sustainability and affordability. SDGs (3.1 and 3.2) aim at reducing maternal mortality ratio to less than 70 per 100,000 live births, neonatal and under-five mortality to at least as low as 12 and 25 per 1,000 live births (United Nations, 2015). For reaching the relevant sustainable development goals with economic sustainability and affordability, creation of evidence of value for money of development programs is important.

The interventions that have been employed in this report for estimating their return on investment were selected on the basis of government's future challenges and priorities, and recommendation for

achieving universal health coverage as well as other research outcomes of the interventions from previous studies.

## OBJECTIVES

The main objective of this study is to estimate the return on investment in maternal and neonatal mortality reduction and child immunization.

## METHODS

Incremental costs and benefits of health interventions were calculated from the most recently available (2014) coverage of maternal and neonatal health services and child immunization by health sector of Bangladesh.

## INTERVENTIONS

In this report, we estimated the costs of interventions (and mix of interventions) for providing maternal and neonatal care and child immunization to those who were not covered by the health system of Bangladesh. It means that we captured the data of service coverage gap and estimated the costs for filling the gaps with evidence-based efficient interventions. According to Bangladesh Demographic and Health Survey (BDHS), 42% of child deliveries are currently assisted by medically trained birth attendants. It implies that of the total 3.2 million child births in a year, 1.8 million remain unattended by any types of skilled or trained attendants. Further, while 84.7% children (12-23 months) were fully immunized in Bangladesh, only 43% and 50.8% of children in urban slums and rural/remote areas were found respectively fully immunized. In this report, for estimating the return on investment, incremental costs and benefits of health interventions were calculated on top of currently (year 2014) available coverage of maternal and neonatal health services and child immunization by health sector of Bangladesh.

### Maternal and neonatal health

A number of maternal and neonatal health interventions which demonstrated significant effect on health improvement (mortality reduction) and were in line with health sector priorities of Bangladesh (table 1). The costs of interventions for bringing a share of currently unattended number of pregnant women and neonates were calculated. Further, the economic benefits of interventions were

estimated by quantifying the monetary value of averted maternal and neonatal deaths as a result of interventions (detail in ‘Estimating benefits’ section below). Total benefits and costs were compared by a benefit-cost ratio for calculating the rate of return on investment in health interventions. Table 1 below describes the current population under service coverage, intervention programs, characteristics and size of target populations. For detail of the studies which were employed in the analysis, the readers are referred to appendix 1.

**Table 1. Description of intervention, target population**

Current coverage <sup>1</sup>	Proposed Intervention	Description of intervention	Possible target population	
			Size	Characteristics
Covered: 1.36 million births covered by trained/skilled/facility services  Uncovered: 1.87 million births	Facility delivery with skilled birth attendants	Skilled attendants and doctors providing Basic Emergency Obstetric care; Doctors providing Comprehensive Emergency Obstetric Care <sup>1</sup>	80% of uncovered births: 1.5 million	Urban, suburb and rural areas proximate to H&FWC, Upazila (sub-district) health complex; district hospitals
	Trained (traditional) birth attendants	Involving trained traditional birth attendants and perinatal, neonatal and maternal mortality <sup>2</sup>	20% of unattended births: 374,246	Rural hard-to-reach and remote rural areas
	Neonate homecare	Neonatal care package: Sub-district Health Complexes and Health and Family Welfare Centres secure Training, essential drugs and supplies for neonates, tracking neonatal care utilization, Community mobilizers, Community Health Workers	40% of all neonates: 748,492	Two lowest socioeconomic quintiles

<sup>1</sup> BDHS, 2011. Value adjusted for year 2014 with 1.2% population growth

<sup>2</sup> Brouwere VD, Lerberghe WV (ed.). 2001.

<sup>3</sup> Jokhio et al. 2005

<sup>4</sup> LeFevre et al. 2013

## Child immunization

Children in urban slums and rural hard-to-reach areas were identified as under-covered population by EPI in Bangladesh. Our estimates took an approach to expand the coverage of children in urban slums and rural hard-to-reach areas. An estimated 665,000 under-five children live in urban slums, of which 57% or 372,000 are currently unvaccinated. Of the estimated 1.2 million under-five children in the rural hard-to-reach areas, 49.25% or 592,500 are unvaccinated. We assumed in the analysis that these

unvaccinated under-five children would be brought under immunization using a highly effective intervention as described in Uddin et al. (2010) and presented below in Table 2. The costs for vaccinating additional children and the associated benefits due to deaths averted were estimated.

**Table 2. Description of intervention, target population and health and economic outcomes**

<b>Immunization coverage*</b>	<b>Estimated number of fully immunized**</b>	<b>Estimated number of Unimmunized</b>	<b>Intervention</b>	<b>Targeted additional children for immunization</b>
Urban slums: 43%	285,966	379,071	Extended EPI service schedules; Training for service providers; Use of a screening tool in non-EPI centers; EPI support group <sup>1</sup> .	277,321 (if achieves national level of coverage, 84.7%)
Rural hard-to-reach: 50.8%	610,596	592,549	Group A: Training of field staff and their supervisors on valid doses; Policy change to eliminate barriers relating to geographical boundaries; Modified EPI session schedules; Community support groups Group B: Training of field staff and their supervisors on valid doses; Policy change to eliminate barriers relating to geographical boundaries; Use of a screening tool in health centers other than EPI session <sup>2</sup> .	394,030 (if achieves the coverage like research trail, 83.5% <sup>2</sup> )

\* Fully immunized at national level: 84.7%; \*\* Among children under 5; <sup>1</sup> Uddin et al. 2010; <sup>2</sup> Uddin et al. 2012

### Estimating costs

The costs of the interventions were calculated by using cost data extracted from previous studies carried out in Bangladesh. Since the health system of Bangladesh is considered to be well structured for providing health in maternal and neonatal services to populations in rural, suburb and urban areas through Family Health and Welfare Centres, Upazila (sub-district) Health Complexes, district hospitals as well as regional and tertiary level hospitals, additional costs for infrastructure development were not considered in the analysis. Direct medical costs (medicine, diagnostic tests, surgical procedure) and out-of-pocket spending of the patients (mainly for medicine, travels, food) and if applicable training costs (for healthcare workers, for instance) were considered in the costs of intervention. Costs were adjusted for inflation at the 2014 price level and a discounting rate of 3% was used for estimating the present value of the future costs in the base-case analysis. For a sensitivity analysis, 5% and 10% discounting rates were applied.



The health system in Bangladesh has successfully developed a strong network for providing maternal, neonatal and child health services across the country. However, the additional costs required for interventions were reflected, such as on salary for staffs, training costs, transport, supplies and communications etc.

### Estimating benefits

Reduction in maternal and/or neonatal deaths due to health interventions were used for estimating the number of deaths that would be averted in the target population, i.e., those who are unattended by any trained or skilled birth attendants. We made assumptions on what the intervention mix would be for all currently unattended pregnant women and neonates. We assumed that 80% of currently unattended pregnant women and neonates will be covered by facility delivery with SBA and the remaining 20% will be covered by services from trained traditional birth attendants. It is argued that this 20% target population either live in remote rural places (distant from Family Health and Welfare Centres) or in hard-to-reach areas (low-lying land or hills). Additionally, homecare for neonates will cover 40% of the currently unattended population who belong to lower socioeconomic groups. The effects of facility deliveries with SBA, deliveries by trained TBA and Homecare of neonates on reduction of maternal and neonatal deaths were found from previous studies (Appendix 1). The mortality rate reduction of these three different interventions was applied on the target populations (pregnant women and neonates) in order to estimate the actual number of deaths that would be averted.

Total averted Disability-Adjusted Life Years (DALYs) were calculated then. DALYs include years of life lost (YLL) due to premature death and years lost due to disability (YLD). In this current analysis, we include only YLL because of the lack of data on disability in connection with morbidity. DALYs averted were thus calculated by multiplying the number of deaths with the difference in years between life expectancy of target population and average age of death. Finally, for estimating the economic benefits of averting the DALYs due to reduction in deaths, we adopted the method of estimating statistical years of life, i.e. multiplying the total DALYs averted with GDP per capita (1,235 USD<sup>1</sup>) of Bangladesh (Nugent, 2015). Using a discounting rate of 3%, the present value of the benefits was calculated in the base case. In a sensitivity analysis, 5% and 10% discounting rates were applied.

---

<sup>1</sup> Assumed by Copenhagen Consensus.

## Return on investment

In order to measure the return on investment in health intervention (MNH services and child immunization) through the proposed interventions, benefit-cost ratios were calculated by dividing the total benefits with the total intervention costs. This ratio or return on investment presents how much economic benefits would be realized for each dollar invested.

# RESULTS

## Facility delivery with skilled birth attendants

Safe motherhood has multiple immediate consequences. It saves the lives of pregnant women and their neonates. Facility delivery with involvement of skilled birth attendants has demonstrated effects on maternal and neonatal mortality reduction (Brouwere and Lerberghe, 2001; Tura et al. 2013). Using evidence from sources in Bangladesh and other developing countries, the costs of interventions and their economic benefits in terms of health outcomes (deaths and DALYs averted) show that such interventions have high returns on investment.

### Costs of interventions

A study on costs of pregnancy and puerperium related care in a public facility in Bangladesh found that a treatment episode with C-section and normal delivery would cost \$89.98 USD and \$43.63 USD respectively at price level of 2007 (Sarowar et al. 2010). In this cost estimation, direct medical costs (doctors' time, diagnostic tests, medicine, and surgical intervention) were considered. For estimating the costs per service in a facility, we used weighted average of C-section (22.9% of all deliveries) and normal delivery (76.1% of all deliveries) costs, which was estimated to be \$77.0 USD at the price level of 2014. The total intervention costs would thus be \$115,200,178 USD for providing services to 1.5 million targeted pregnant women.

### Benefits of interventions

Facility deliveries with SBA have shown reductions in both maternal and neonatal deaths (Brouwere et al., 2001; Tura et al., 2013). In this analysis, we assumed that 80% of all unattended deliveries would be targeted by facility delivery service with SBA.

### Maternal deaths reduction and benefits

An estimation of safe motherhood using facility delivery with SBA found that 97% of obstructed labour, 48% of Eclampsia, 49% of Puerperal sepsis and 48% of Haemorrhage, which together cause 60.5% of maternal deaths could be averted with secondary prevention where SBA undertake the delivery in facilities (Appendix 1, Brouwere et al., 2001). We considered the maternal mortality ratio of 360 per 100,000 live births on the 80% estimated unattended births, which means that a total of 3,260 deaths would take place without the intervention. This rate was observed in a control population while studied impact of an intervention on pregnant women in Pakistan (Appendix 1: Jokhio et al. 2005). It might be justifiable in Bangladesh context since the MMR in Bangladesh was close to this figure (322 per 100,000 live births in year 2001).

Bringing the target population under facility delivery with skilled birth attendants we can avert maternal deaths by 60.5%, which means that 1,757 deaths in total could be averted. Considering the average age of maternal death at 32 years and average life expectancy of women at 72.6 years, the DALYs averted per death is 40.6 years. It means that by reducing 3,260 deaths, a total of 132,373 DALYs would be averted. Total economic benefits from the averted DALYs were estimated at \$93.4 million USD, by multiplying the total averted DALYs with GDP per capita (1,235 USD) of Bangladesh (presented together with benefits from neonatal deaths reduction in table 3).

### Neonatal deaths reduction and benefits

A literature review of the effect of health facility delivery on neonatal mortality found that 32.9 neonates per 1,000 live births die when delivered at home and only 9.9 neonates per 1,000 live births die in facility delivery (Appendix 1: Tura et al. 2013). It means that neonatal deaths could be reduced by 70% if deliveries took place in the facilities in comparison with home delivery. Applying the rate of neonatal deaths reduction in the target population, we found that 34,467 deaths could be averted. Considering the average age of death of a neonate is 4 weeks and the average life expectancy is 70.4 years, the total DALYs averted were estimated to \$2,4 million USD. The total benefits due to DALYs averted are estimated to be \$1,2 billion USD.

### All deaths averted and total benefits

Bringing the target population of approximately 1.5 million pregnant women into facility delivery services with SBA would require a total investment of \$115.2 million USD. From such an investment, \$2.6 million DALYs from pregnant women and their neonates could be averted. Neonatal deaths reduction constituted 97.2% of all DALYs averted. As a consequence of total reduction in deaths and

DALYs of pregnant women and neonates averted, \$1.33 billion USD could be saved from the economy of Bangladesh.

**Table 3. Costs and benefits of facility delivery with skilled birth attendants**

Costs per service (USD)	Number of target population	Total intervention costs (USD)	Maternal deaths		Neonatal deaths		Total benefits (USD)	Benefit-Cost Ratio
			Cases averted	DALYs averted	Cases averted	DALYs averted		
77.0	1,496,984	115,200,178	3,260	132,373	37,727	2,556,203	1,326,395,101	11.5 (7.7; 4.0)*

\* Values within parenthesis present benefit-cost ration at 5% and 10% discounting rates respectively. We need new tables for discounted costs and benefits at 5% and 10% (not just their BCRs).

### Return on investment

Applying 3% discounting rate on total benefits and costs, the benefit-cost ratio was 11.1, which means that 1 USD investment on facility delivery with skilled birth attendants would result in a return of 11.1 USD from saving life and DALYs of mothers and neonates. The return on investment decreases to 7.41 USD and 3.84 USD if 5% and 10% discounting rates are applied, respectively.

## Trained birth attendants

We assumed that unattended deliveries in remote rural areas and rural hard-to-reach areas are targeted with the service from trained (traditional) birth attendants (TBA) in the community and 20% of total unattended deliveries (374,246 pregnancies) belong to these areas. Due to lack of data on Bangladesh, we employed findings from studies in Pakistan, which showed that services of trained birth attendants reduced both maternal and neonatal mortality (Appendix 1: Jokhio et al. 2005). However, the costs of similar interventions were found in cost analyses of Maternal, Neonatal and Child Health (MANOSHI) intervention, undertaken in Dhaka, Bangladesh (Islam et al. 2010; Sarker et al. 2010), which was used for estimating the total costs of covering the target population. We assumed that trained traditional birth attendants were corresponding to trained community health workers and are addressed as trained birth attendants (TBA) throughout the report.

### Costs of intervention

The cost of intervention of MANOSHI programme included costs of training community health workers (CHW) and costs of providing the services (Appendix 1: Islam et al. 2010; Sarker et al. 2010). The costs included normal delivery costs in a birthing hut located in a community and the time allocated by CHW for providing the services. The cost per service was estimated to \$18.7 USD at the price level of 2014. This means that a total of \$6,992,923 USD would be required for providing the services to 374,246 pregnant women per year.

### Benefits of intervention

#### *Maternal deaths reduction and benefits*

The study found that maternal deaths were reduced from 360 to 268 per 100,000 live births, which means that 25.6% of deaths could be averted due to TBA intervention on MNH services. While applying the MMR of control group in the Bangladesh context (as we did in estimation of SBA, table 3), the total maternal deaths in target population would be 1,347 in total and a reduction in deaths by 25.6% would avert 344 death cases. By reducing these deaths, 13,979 DALYs could be averted. The economic benefits of such health outcomes were estimated at \$9.9 million USD (presented together with the benefits from neonatal deaths reduction in table 4).

#### *Neonatal deaths reduction and benefits*

The same study observed that 53 and 37 neonatal deaths per 1,000 live births could be averted due to TBA intervention, meaning that neonatal mortality could be reduced by 30.2%. Considering the current neonatal death rate of 53 per 1,000 live births in Bangladesh context (applying neonatal

mortality rate of control group, Jokhio et al. 2005), we found that 19,835 neonates would die without any additional intervention in the target population. However, intervention with TBA would save 8,988 death cases, which translate into 441,656 DALYs averted and economic benefit of \$85.9 million USD.

### *All deaths averted and total benefits*

TBA intervention would reduce a total number of 6,332 death cases and consequently 455,635 DALYs. By reducing these maternal and neonatal deaths and associated DALYs, would yield social benefits of \$227.4 million USD.

**Table 4. Estimated benefits and costs of MNH intervention by trained birth attendants**

Costs per service (USD)	Number of target population	Total intervention costs (USD)	Maternal deaths		Neonatal deaths		Total benefits (USD)	Benefit-Cost Ratio
			Case averted	DALYs averted	Case averted	DALYs averted		
18.7	374,246	6,992,923	344	13,979	5,988	441,656	227,424,422	32.5 (21.7; 11.2)*

\* Values within parenthesis present benefit-cost ratios at 5% and 10% discounting rates respectively.

### **Return on investment**

Applying 3% discounting rate on total benefits, we found a benefit-cost ratio of 32.5, which means that 1 USD investment on trained TBA would result in a return of 32.5 USD. When 5% and 10% discounting rates are applied, benefit-cost ratios reduce to 21.7 and 11.2, respectively.

# Neonatal homecare

## Costs of intervention

The cost of homecare per neonate was estimated to \$10.9 USD at the price level of 2014. The costs included costs of service providers (medical and non-medical personnel), actual and refresher trainings and household expenditure (consultation, medicine, transport) (Appendix 1: Lefevre et al. 2013). The total costs of intervention were estimated at \$8,123,927 USD for providing homecare to 748,492 targeted neonates.

## Benefits of intervention

A study in Bangladesh found that neonatal deaths were 31.2 per 1,000 live births among neonates who received homecare intervention. But for those without homecare intervention (control group), such deaths were 43.1 per live births (Appendix 1: LeFevre et al. 2013), which means that neonatal deaths were 28% less in intervention group. Considering this reduction rate, 8,907 neonatal deaths could be averted if homecare intervention were carried out in the target population (40% of neonates not born in a hospital facility). These reduced number of death cases would contribute to a total 636,169 DALYs averted. The estimated economic benefits would be \$326,876,700 USD per year.

**Table 5. Estimated benefits and costs of neonatal homecare intervention in the community**

Costs per service (USD)	Number of target population	Total deaths averted	Total DALYs averted	Total intervention costs (USD)	Total benefits (USD)	Benefit-Cost Ratio
10.9	748,492	8,907	636,169	8,123,927	326,876,700	40.2 (26.7; 13.8)*

\* Values within parenthesis present benefit-cost ratios at 5% and 10% discounting rates respectively.

## Return on investment

The total benefit-cost ratio (40.24) demonstrates that an investment of 1 USD on homecare would make 40.24 USD as a return on investment considering a 3% discounting rate. The benefit-cost ratios are reduced to 26.7 and 13.8 when 5% and 10% discounting rates are applied.

# Child immunization

## Rural Slums

### *Costs of intervention*

An incremental cost estimation of a highly effective intervention for improving immunization coverage among slum populations in Dhaka, Bangladesh, found that the average costs for vaccinating a child is 20.95 USD (Appendix 1: Hayford et. al. 2014). The costs included supervision (personnel and travel), clinical costs (personnel, facility cost), training costs, coordinating costs and supplies, communications and photocopying costs etc. Of the total costs per child, 73% was incurred for supervision, where research project staff with higher salaries than those in the public sector was involved. We, therefore, reduced the supervision costs by 50%, which reduced total costs per child to 18.0 USD at price level of 2014. For vaccinating additional 148,367 children (up to age 2) in urban slums in Bangladesh, a total of \$2.67 million USD would be needed.

### *Benefits of intervention*

The research initiative of highly effective immunization coverage in slum populations in Dhaka, Bangladesh showed that 43% of slum populations were covered by immunization in the baseline, which increased to 99% in the end line (Uddin et al. 2010). We have assumed a conservative estimation using the national immunization coverage rate of 84.7%, instead of 99% of the study finding (Uddin et al. 2010). An estimated 665,038 under-five children lived in slum areas in Bangladesh, of which 285,966 were fully immunized (43%) at the current coverage level. Implementation of the effective intervention would bring 277,321 additional children under immunization. Globally, 17% of deaths were related to vaccine preventable diseases<sup>2</sup>. Applying the death rate of vaccine preventable diseases along with 90% efficacy of the vaccine, we found that 1,710 deaths could be averted among under-five children in slums due to this highly effective intervention. Note that to reach these immunization levels (and resultant benefits) does not require total immunization of the under 5 population every year. Rather only one age cohort of children requires vaccination every year, since once immunized, coverage continues for many years. In this study we conservatively assume for costing purposes, **three** age cohorts are vaccinated every year – namely all children before they turn three years old. This leads to an additional 148,367 children vaccinated per year at a cost of 2.6m USD.

---

<sup>2</sup> [http://apps.who.int/immunization\\_monitoring/diseases/en/](http://apps.who.int/immunization_monitoring/diseases/en/) (accessed on 22/03/2016).



**Table 6. Benefits and costs of child immunization in urban slum populations**

Costs per child vaccinated (USD)	Number of additional children vaccinated per year	Total intervention costs (USD)	Total deaths averted	Total DALYs averted	Total benefits (USD)	Benefit-Cost Ratio
18.0	148,367	2,665,454	1,710	117,985	61,235,132	23.0 (15.3; 12.9)*

\* Values within parenthesis present benefit-cost ratio at 5% and 10% discounting rates respectively.

### Return on investment

The base estimation (3% discounting) of benefit-cost ratio of the intervention showed that 1 USD investment in intervention on child immunization would bring \$23.0 USD in return by reducing deaths and DALYs of under-five children in slums of Bangladesh. Application of 5% and 10% discounting rates would result in returns on investment of 15.3 USD and 12.9 USD, respectively.

### Rural hard-to-reach areas

#### Costs of intervention

In the absence of costs of intervention data in rural hard-to-reach areas in Bangladesh, we estimated the intervention costs from data in urban slums and a ratio of incremental costs comparing core and satellite setting (Appendix 1: Hayford et al. 2014; Bishai et al. 2010). We found that a highly effective intervention in urban setting (urban slums) cost \$24.5 USD per child vaccinated while adjusted for supervision costs (from research project staff to public sector staff) and from core vaccination setting to satellite setting at price level of 2014. The total cost for intervention on target population (263,782), children up to age of 2 years, was thus estimated to \$6.5 million USD.

**Table 7. Benefit and cost of child immunization in rural hard-to-reach areas**

Costs per child vaccinated (USD)	Number of additional children vaccinated per year	Total intervention costs (USD)	Total deaths averted	Total DALYs averted	Total benefits (USD)	Benefit-Cost Ratio
24.5	263,782	6,458,747	2,430	167,639	87,005,650	13.5 (7.7; 3.4)*

\* Values within parenthesis present benefit-cost ratios at 5% and 10% discounting rates respectively.

### *Benefits of intervention*

The intervention in rural hard-to-reach areas (low-lying land and hills) increased average vaccination coverage from 50.8% in baseline to 83.5% in the end line, which means an increase of 32.8%. Additionally, 263,782 children per year would be vaccinated in the entire country through the tested effective intervention. Applying the proportion of preventable deaths in rural hard-to-reach populations, we found that increasing immunization coverage to 83.5% with 90% efficacy of vaccine would avert 2,430 deaths among the under-five. These averted under-five deaths meant that 167,639 DALYs could be saved. Estimated total economic benefits would amount to \$87.0 million USD.

### *Return on investment*

Investment in child immunization in rural hard-to-reach areas shows that a return of 13.5 USD would be expected from each dollar invested at 3% discounting rate. Return on investment would be to 7.7 USD and 3.4 USD when 5% and 10% discounting rates are applied, respectively.

## DISCUSSION

Challenges and priorities in healthcare sector by the Government of Bangladesh and evidence from research initiatives mainly in Bangladesh and in some other low- and middle-income countries were used as the basis for analyzing the returns on investment in maternal and neonatal health and child immunization. Our estimation showed that for securing relevant health services to the target populations, the investment would provide economic benefits to the country of between 11.5 USD and 40.2 USD for each USD invested. The largest return (40.2 USD) was found from investment in homecare package for neonates and the lowest (11.5 USD) from facility-based delivery with SBA to pregnant women. Since the interventions targeted different population groups, the findings should be used more as complementary rather than competitive for priority setting.

Facility delivery with SBA was estimated to reduce deaths of pregnant women and neonates by 3,260 and 37,727 cases, respectively. Using TBA, we found that 344 of maternal deaths and 5,988 neonatal deaths could be averted. To the number of DALYs averted and also to return on investment, contribution of reduction in neonatal deaths were remarkably high due to higher rate of death cases averted among them in comparison with mothers and the larger number of years of lost life (YLL) saved. Providing homecare package through community on 40% of total neonates (currently unattended by any medically trained workers) would require 8.1 million USD, which were estimated to give total benefits of 326.9 million USD by saving the lives of 8,907 neonates. Intervention on

children for immunization in urban slums and in rural hard-to-reach cost 18.0 USD per child and 24.5 USD per child, respectively, and higher return was expected from the interventions in urban slums (23.0 USD) than rural hard-to-reach areas (13.5 USD). Total costs of 2.67 million USD in urban slums and 6.46 million USD in rural hard-to-reach areas would be required. The benefits would be manifolds in both settings, estimated at 61.2 million USD and 87.0 million USD, respectively.

A framework for estimating benefits of investing in maternal, newborn, and child health using data from South Asia and Africa found benefit-cost ratios for 'basic', 'expanded' and 'comprehensive' service package to be 24.0, 24.2 and 14.3 respectively (Foster and Bryant, 2013). Our estimated return on investment or benefit-cost ratio ranged between 11.5 and 32.5 depending on types of interventions, i.e., services provided by SBA or TBA respectively. A study of return on investment from childhood immunization in low- and middle- income countries found that 43.8 USD (uncertainty range, 26.7-66.7) would benefit from each USD invested when broader economic benefits (due to averted mortality and morbidity) were considered in the analysis (Ozawa et al. 2015). Among the ninety-four countries, countries in South and South-East Asia and Sub-Sahara Africa showed high return due to a large number of preventable cases in those areas. Similar to our study, Ozawa and colleagues found that the investment was worthy though the size of return was much larger in their study. Difference in return on investment could be explained by that our estimation covering a single country (Bangladesh) with country-specific data and the return on investment was mostly calculated on the basis of mortality cases averted, except for homecare for neonates.

The estimation had several challenges. For instance, data on target population, intervention effects and intervention costs were collected from different sources, though efforts had been made to keep them comparable. Costs of intervention data were used from public sources (SBA in facility), NGOs (TBA) and research initiatives (child immunization). However, for making the costs comparable, we adjusted for the supervision costs of research project staff since the salary of research staff members in some organizations are often higher than the salary of public and NGO staff members. In estimating the benefits, we considered the foregone economic loss in relation to premature deaths of pregnant women, neonates and children under 5 for immunization. However, we could not capture the economic loss in connection with years lost due to disability (YLD) because of the lack of relevant data. The return on investment was thus a conservative estimate.

The economic estimation showed incentives for investing in the health interventions with higher expected return than required investment. Bangladesh possesses extensive experience in health service deliveries through public, NGO, for-profit organizations and public-private partnership (PPP).

However, how these interventions, i.e., service deliveries should be organized for reaching the target populations is out of scope of this report. Level of intervention costs through public and NGO providers are generally comparable. For keeping the costs of service deliveries low even with for-profit private providers, market competition should be created while encouraging public-private partnership.

## REFERENCES

BDHS. 2015. National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. Bangladesh Demographic and Health Survey 2014: Key Indicators. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.

Bishai D, Johns B, Lefevre A, Nair D. 2010. *Cost effectiveness of measles eradication*, Johns Hopkins Bloomberg School of Public Health, USA.

Brouwere VD, Lerberghe WV (ed.). 2001. *Safe Motherhood Strategies: a Review of the Evidence*, Studies in Health Services Organization & Policy, 17.

Bredenkamp, C, Wagstaff, A, Buisman, L, Prencipe L. 2012. World Bank. 2014. Health Equity and financial protection datasets – South Asia, The World Bank. Washington D.C.

El Arifeen S, Christou A, Reichenbach L, Osman FA, Azad K, Islam KS, Ahmed F, Perry HB, Peters DH. 2013. Community-based approaches and partnerships: innovations in health-service delivery in Bangladesh, *Lancet Series - Bangladesh: Innovation for Universal Health Coverage*, [http://dx.doi.org/10.1016/S0140-6736\(13\)62149-2](http://dx.doi.org/10.1016/S0140-6736(13)62149-2).

Foster S, Bryant M. 2013. A Framework for Estimating Benefits of Investing in Maternal, Newborn, and Child Health, Department of International Health Boston University School of Public Health, Boston, USA.

GoB, 2011. Comprehensive Multi-Year Plan of the National Immunization Program of Bangladesh, 2011 – 2016.

GoB. 2015a. Ministry of Health and Family Welfare, Bangladesh, Partnership for Maternal, Newborn & Child Health, WHO, World Bank and Alliance for Health Policy and Systems Research. *Success Factors for Women's and Children's Health: Bangladesh*.

GoB. 2015b. Health Bulletin 2015. Ministry of Health and Family Welfare, Government of Bangladesh. Dhaka.

GoB. 2015c. Millennium Development Goals – Bangladesh Progress Report 2015. General Economics Division (GED), Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.

Hayforda K, Uddin MJ, Koehlmoos TP, Bishai DM. 2014. Cost and sustainability of a successful package of interventions to improve vaccination coverage for children in urban slums of Bangladesh, *Vaccine* 32: 2294–2299.

Hoque ME, Khan JAM, Hossain SSA, Gazi R, Rashid HA, Koehlmoos TP, Walker DG. A systematic review of economic evaluations of health and health-related interventions in Bangladesh, *Cost Effectiveness and Resource Allocation*, 9:12.

Jokhio AH, Winter HR, Cheng KK. 2005. An intervention involving traditional birth attendants and perinatal and maternal mortality in Pakistan. *N Engl J Med*, 352: 2091-9.

LeFevre AE, Shillcutt SD, Waters HR, Haider S, El Arifeen S, Mannan I, Seraji HR, Shah R, Darmstadt GL, Wall SN, Williams EK, Black RE, Santosham M, Baqui AH. 2013. Economic evaluation of neonatal care packages in a cluster-randomized controlled trial in Sylhet, Bangladesh, *Bull World Health Organ* 91:736–745.

Nugent R. 2015. Benefits and costs of non-communicable disease targets for the post-2015 development agenda, Perspective Paper, Copenhagen Consensus Centre.

Sarowar MG, Medin E, Gazi R, Koehlmoos TP, Rehnberg C, Saifi R, Bhuiya A, Khan J. 2010. Calculation of Costs of Pregnancy- and Puerperiumrelated Care: Experience from a Hospital in a Low-income Country. *J Health Popul Nutr* 28(3):264-272.

Tura G, Fantahun M, Worku A. 2013. The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. *BMC Pregnancy and Childbirth* 13:18.

Uddin MJ, Larson CP, Oliveras E, Khan AI, Quaiyum MA, Saha NC. 2010. Child immunization coverage in urban slums of Bangladesh: impact of an intervention package. *Health Policy and Planning* 25:50–60.

Uddin MJ, Saha NC, Islam Z, Khan IA, Shamsuzzaman, Quaiyum MA, Koehlmoos TP. 2012. Improving low coverage of child immunization in rural hard-to-reach areas of Bangladesh: Findings from a project using multiple interventions, *Vaccine* 30:168– 179.

United Nations. 2015. Transforming Our World: The 2030 Agenda for Sustainable Development, A/RES/70/1, The United Nations.

World Bank. 1993. World Development Report 1993: Investing in Health. New York: Oxford University Press. World Bank.

World Bank. 2015. Health Equity and Financial Protection Datasheets (72014), South Asia. The World Bank, Washington D.C.

## Appendix 1: Description of studies employed in the analyses

Author & Journal/source; Study title ; Study setting and country; Type of study; Objective; Methods; Data & sample size; Result

Bishai D, Johns B, Lefevre A, Nair D. 2010. Johns Hopkins Bloomberg School of Public Health, USA.; Cost effectiveness of measles eradication; Several developing countries were included in the analysis, i.e. Bangladesh, Brazil, Colombia, Ethiopia, Tajikistan and Uganda. ; Cost-effectiveness analysis; To estimate the cost-effectiveness of measles eradication programs ; "A dynamic age-tiered measles transmission model for 6 countries and a linear model that could be applied to every country in the world."; Data from 6 developing countries were used; In Bangladesh, scale up cost per child vaccination for core areas was 27.83 USD and for satellite areas was 37.93 USD.

Brouwere VD, Lerberghe WV (ed.). Studies in Health Services Organization & Policy, 2001(17). ; Safe Motherhood Strategies: a Review of the Evidence; Developing country context; Secondary source review; Secondary source review for estimating impact of skilled birth attendance (with facility) on safe motherhood.; Secondary source and data review; Data from several studies; 99.6%, 48.8%, 49.7% and 49.0% deaths were averted in connection to obstructed labor, eclampsia, puerperal and haemorrhage respectively due to primary and secondary prevention through skilled birth attendant with facility option.

Hayforda K, Uddin MJ, Koehlmoos TP, Bishai DM. Vaccine 2014; 32: 2294–2299.; Cost and sustainability of a successful package of interventions to improve vaccination coverage for children in urban slums of Bangladesh; Urban slum, Bangladesh; Cost-analysis; To estimate the incremental economic costs and explore satisfaction with a highly effective intervention for improving immunization coverage among slum populations in Dhaka, Bangladesh; Combination of activity-based costing (ABC) and an 'ingredients' approach were used. The analysis measured economic costs, which includes financial costs attributable to the intervention and opportunity costs.; Data from programme ; The average cost of per valid fully immunized children was estimated to 20.95 USD. The costs comprised of external management and supervision (73%), training (11%), coordination costs (1%), uncompensated staff time and clinic costs (2%), and communications, supplies and other costs (13%). Costs were associated with an estimated number of 874 children.

Islam Z, Khan JAM, Alam K, Sohni T, Sarker HS. 2010. Manoshi working paper; icddr, b and BRAC, Dhaka, Bangladesh.; Costs of MANOSHI Delivery Centres: Normal Delivery, ANC and PNC; Urban slum, Dhaka, Bangladesh; Cost analysis; "1. Estimate total cost of operating Manoshi delivery centres in Dhaka city slums 2. Estimate average cost of providing normal delivery care, antenatal care and postnatal care at Manoshi delivery centres."; A combination of bottom-up and top-down costing approach, provider perspective cost captured; Seven delivery centres of Kamrangirchar slum in Dhaka city; "The average cost per normal delivery conducted at the selected delivery centres was Tk. 1296 (USD 19) in 2008 and Tk. 1068 (USD 16) in 2009. The average cost of full ANC coverage was Tk. 141.23 (USD 2.07) and that of PNC coverage was Tk. 145.02 (USD 2.13). "



Jokhio AH, Winter HR, Cheng KK. *N Engl J Med*, 2005; 352: 2091-9. ; An intervention involving traditional birth attendants and perinatal and maternal mortality in Pakistan; Rural district in Pakistan; Intervention impact assessment from clinical trials; Impact of training traditional birth attendant on maternal mortality; Cluster-randomized control trial with intervention and control group; Intervention: 10,114; control: 9,443; Maternal death per 100,000 pregnancies: Intervention= 268, control=360; neonatal deaths per 1000 live births: intervention=340, control=439

LeFevre AE, Shillcutt SD, Waters HR, Haider S, El Arifeen S, Mannan I, Seraji HR, Shah R, Darmstadt GL, Wall SN, Williams EK, Black RE, Santosham M, Baqui AH. 2013. *Bull World Health Organ* 2013; 91:736–745. ; Economic evaluation of neonatal care packages in a cluster-randomized controlled trial in Sylhet, Bangladesh; Sylhet, Bangladesh; Economic evaluation using cluster randomized control trial; To evaluate and compare the cost-effectiveness of two strategies for neonatal care in Sylhet division, Bangladesh; The incremental cost-effectiveness analysis of each strategy was estimated. The levels of uncertainty in estimates were quantified through probabilistic sensitivity analysis.; The activities of the Project for Advancing the Health of Newborns and Mothers were implemented, among a population of about 500 000, in the Beanibazar, Zakiganj and Kanaighat subdistricts of Sylhet division. Live-births: 4 979, Neonatal deaths: 155, YLL: 881, YLD: 194, DALYs: 1 075; Programme, provider and user cost: 39 418 per 1,000 neonates.; 11.9 neonatal death averted (per 1,000 neonates) by homecare intervention with program cost 34958 USD (per 1,000 neonates)

Sarker BK, Ahmed S, Islam N, Khan JAM; *Cost Eff Resour Alloc.* 2013;11(1):28; Cost of behavior change communication channels of Manoshi -a maternal, neonatal and child health (MNCH) program in urban slums of Dhaka, Bangladesh; Urban slum, Dhaka, Bangladesh; Cost analysis; To estimate cost of BCC interventions for specific components of the Man oshi program in Bangladesh to a cost-per-exposure level; Micro-costing, provider perspective; Data on inputs and prices were collected from both primary and secondary sources. Primary data were obtained by interviewing BRAC staffs who were involved in implementing BCC tools an observation of BCC session. These sessions were undertaken in all five broad intervention areas of Manoshi, namely the Dhanmondi, Gulshan, Uttara, Mohammadpur and Jatrabari regions in Dhaka city.; Per exposure, the cost of face-to-face counseling was found to be 3.08 BDT during pregnancy detection, 3.11 BDT during pregnancy confirmation, 12.42 BDT during antenatal care, 18.96 BDT during delivery care and 22.65 BDT during post-natal care.

Sarwar MG, Medin E, Gazi R, Koehlmoos TP, Rehnberg C, Saifi R, Bhuiya A, Khan J. 2010. *J Health Popul Nutr* 28(3):264-272.; Calculation of Costs of Pregnancy- and Puerperiumrelated Care: Experience from a Hospital in a Low-income Country.; The inpatient obstetric and labour ward of Secondary level General Hospital run by public financing in Dhaka, the capital city of Bangladesh; Cost-analysis; The aim of this case study was to calculate the cost of pregnancy- and puerperium-related cases admitted to a secondary care hospital and to identify the practical challenges of carrying out this type of cost-calculation study in Bangladesh.; The study used a mixed method of 'micro-costing' and 'step-down cost allocation' for collecting information on different cost items.; 162 mothers were included, of which 146 mothers completed the care. ; Mean cost for c-section delivery: 89.98 USD and normal delivery: 43.63 USD

Tura G, Fantahun M, Worku A. *BMC Pregnancy and Childbirth* 2013: 13:18.; The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. ; The middle and low-income

countries; Meta analysis; Review was conducted with the aim of determining the pooled effect of health facility delivery on neonatal mortality; Meta analysis: Pooled effect size was determined in the form of relative risk in the random-effects model; 37 studies under systematic review; Neonatal death in health facility is 14,821 out of 150,4450 live births and susch mortality was 3,365 out of 102,355 live births

Uddin MJ, Larson CP, Oliveras E, Khan AI, Quaiyum MA, Saha NC. 2010. Health Policy and Planning 25:50–60.; Child immunization coverage in urban slums of Bangladesh: impact of an intervention package; Urban slum, Bangladesh; Impact assessment ; To assess the impact of an EPI (Expanded Programme on Immunization) intervention package, implemented within the existing servicedelivery system, to improve the child immunization coverage in urban slums of Dhaka, Bangladesh; ‘before and after’ assessment of selected immunization-coverage indicators; Baeline: 529; endline: 526; the proportion of fully immunized children of was 43% in baseline which was increased to 99% in endline

Uddin MJ, Saha NC, Islam Z, Khan IA, Shamsuzzaman, Quaiyum MA, Koehlmoos TP. Vaccine, 2012: 30:168– 179; Improving low coverage of child immunization in rural hard-to-reach areas of Bangladesh: Findings from a project using multiple interventions; Rural low-lying land (haor) and hills in Bangladesh; Impact assessment ; "to assess the impact of combined interventions to improve the child immunization coverage in rural hard-to-reach areas of Bangladesh."; Baseline and endline comparison; Haor: 720 in baseline, 721 in endline (group A; 720 in baseline and 720 in endline (group B) AND Hills: 720 in baseline, 722 in endline (group A), 720 in baseline, 721 in endline (group B) ; On average in haor and hills: Coverage in baseline=48% and endline 86% in group A and coverage in baseline 53.5% and endline 81% in group B. Final increase in all areas=32.75%



Bangladesh, like most nations, faces a large number of challenges. What should be the top priorities for policy makers, international donors, NGOs and businesses? With limited resources and time, it is crucial that focus is informed by what will do the most good for each taka spent. The Bangladesh Priorities project, a collaboration between Copenhagen Consensus and BRAC, works with stakeholders across Bangladesh to find, analyze, rank and disseminate the best solutions for the country. We engage Bangladeshis from all parts of society, through readers of newspapers, along with NGOs, decision makers, sector experts and businesses to propose the best solutions. We have commissioned some of the best economists from Bangladesh and the world to calculate the social, environmental and economic costs and benefits of these proposals. This research will help set priorities for the country through a nationwide conversation about what the smart - and not-so-smart - solutions are for Bangladesh's future.

# SMARTER SOLUTIONS FOR BANGLADESH

For more information visit [www.Bangladesh-Priorities.com](http://www.Bangladesh-Priorities.com)

## C O P E N H A G E N C O N S E N S U S C E N T E R

Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.