Lives Saved Tool (LiST) Analysis for Global Nutrition Report Independent Expert Group

Pakistan, Bangladesh, and Ethiopia

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1. Overview and Objective

Recent analyses of global child survival underscore the urgent need to accelerate progress in preventing newborn and child deaths in South Asia and Africa south of the Sahara (SSA), which together account for four out of five deaths of children under age 5 globally (1). Among all deaths in this age group, 45 percent, or approximately 3 million deaths a year, are attributable to undernutrition (2, 3). Some critical nutritional disorders impacting mortality include small for gestational age (SGA) births, moderate and severe stunting, moderate and severe wasting, micronutrient deficiencies, and suboptimal breastfeeding practices (4). Some 10 percent of deaths and disability-adjusted life-years (DALYs) in children younger than 5 years are attributable to micronutrient deficiencies, with nearly all this burden due to deficiencies of vitamin A and zinc (5). Three-quarters of the world's stunted children live in South Asia or SSA. A major portion of these deaths are preventable, and reduction in child mortality at all levels is possible with scaling up of effective interventions (1).

As requested by the Independent Expert Group (IEG) for the Global Nutrition Report, we assessed the relationship of under-5 mortality and undernutrition in three high-burden countries of South Asia and SSA (Bangladesh, Ethiopia, and Pakistan) as well as the impact of select nutrition-sensitive and specific interventions. We evaluated potential impact of interventions on process indicators including SGA births, stunting, and wasting on the basis of recent information on intervention coverage available from the Countdown Report (2014) and the most recent demographic and health surveys of these countries. We estimated the numbers and proportions of neonatal and postneonatal child deaths that could be averted in each country by increasing the coverage of effective key nutrition-specific and sensitive interventions available in the Lived Saved Tool (LiST) on nutrition outcomes (SGA births, stunting, and wasting). These interventions were selected on the basis of the conceptual framework outlined in latest *Lancet* nutrition series (4). At present, the impact of these interventions on maternal mortality is limited and was not modeled as part of the analysis.

This report outlines the state of neonatal and child survival and determinants such as undernutrition in three countries—Bangladesh, Ethiopia, and Pakistan—and provides further empirical analysis that would be relevant to policymaking. The paper also suggests a template for evaluating evidence-based child survival and nutrition interventions that can make a difference and the current state of coverage.

2. Baseline Situation of Illustrative Countries (Bangladesh, Ethiopia, and Pakistan)

Demographics

Bangladesh and Pakistan are located in the northeastern and northwestern parts of South Asia subcontinent, respectively, and Ethiopia is situated in northern Africa. The land area of Bangladesh covers 147,570 square kilometers; Ethiopia, 1,100,000; and Pakistan, 796,096 (6–8). Basic demographic characteristics of Bangladesh, Ethiopia, and Pakistan are presented in Table 1. Among these countries Bangladesh is the most densely populated country, with 1,015 people per square kilometer (9), followed by Pakistan and Ethiopia with 231 (10) and 67 (11), respectively. Ethiopia is one of the least urbanized countries in the world; only 16 percent of the population live in urban areas (11). The majority of the population live in the highland areas. Pakistan is now the sixth most populous country in the world (10). The current population growth rate is 2 percent. According to estimates, Pakistan will become the fifth most populous country in 2050 at its current rate of population growth (10).

According to the country ranking presented by the Human Development Report (year 2012) Bangladesh and Pakistan ranked 146th and Ethiopia ranked 173th among nations (12). The Human Poverty Index (HPI) is a multidimensional measure of poverty for developing countries; it takes into account social exclusion; lack of economic opportunities; and deprivations in survival, livelihood, and knowledge.

Table 1 Demographic characteristics

	Bangladesh[a]	**Ethiopia[b]**	**Pakistan[c]**
Population (million)	154[d] (2012)	91.7[d] (2012)	184.5 (2012)
Growth rate (percent)	1.4 (2011)	2.6 (2007)	2.0 (2012)
Density (population/km^2)	1,015 (2011)	67.1 (2007)	231 (2012)
Percent urban	27 (2011)	16.1 (2007)	36 (2012)

Human Development Indicators rank[e]	146 (2012)	173 (2012)	146 (2012)

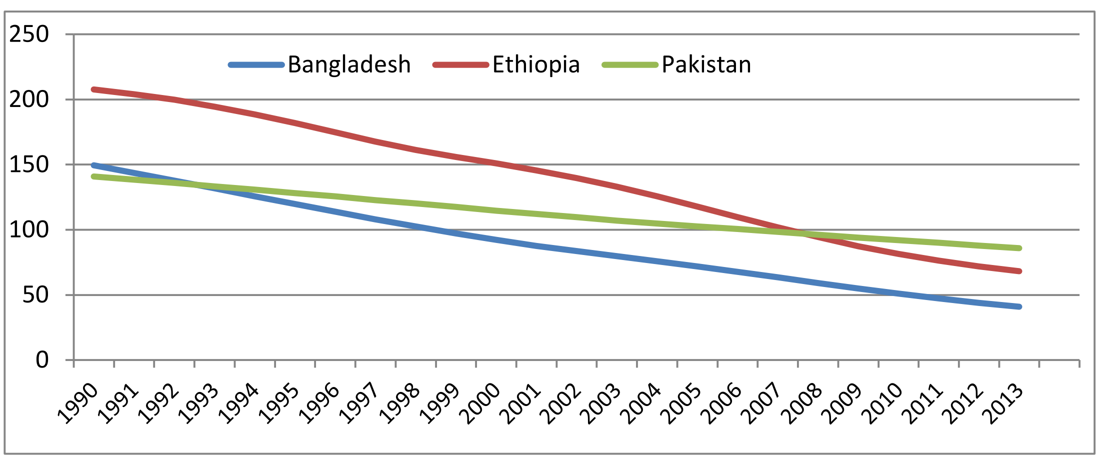
Sources:

(a) Bangladesh Bureau of Statistics (2012b).
(b) CSA (2010).
(c) Pakistan population census organization.
(d) Countdown to 2015 progress report (2013).
(e) UNDP Human development index report (2014).

Levels and Trends in Child Mortality

We reviewed mortality data from latest United Nations Inter-agency Group for Child Mortality Estimation (UN IGME), Countdown, and Demographic and Health Survey (DHS) reports. The country-level trends are encouraging. Bangladesh and Ethiopia reduced their under-5 mortality rates 73 percent and 67 percent, respectively, from 1990 to 2013 (Figure 1). The annual rate of reduction in under-5 mortality is highest in Bangladesh (5.7 percent) followed by Ethiopia (5.0 percent), which enables these countries to reach Millennium Development Goal (MDG 4) targets (Table 2). Pakistan, in contrast, has lagged behind, with the annual rate of reduction in under-5 mortality averaging 2.2 percent (Table 2, Figure 1). Pakistan is now rated as having the 26th highest mortality rate, with 89 under-5 deaths per 1,000 live births. From 1990 to 2013 Pakistan managed to reduce under-5 deaths. The proportion of neonatal deaths among under-5 child deaths is highest in Bangladesh (60 percent). Also in Pakistan 50 percent of these deaths occurred in neonatal period. This has clear implications for policies and priorities related to newborn health and survival. It has relevance to maternal undernutrition as well, as a large proportion of newborn and young infant deaths are related to SGA births (among both term and preterm infants).

Figure 1 Mortality trends 1990–2013



Source: IGME (2013).

Table 2 Mortality statistics

	Bangladesh	Ethiopia	Pakistan
Under-5 mortality ranking (2012)[a]	60	40	26

Neonatal mortality rate (2011–2012)	32[b]	37[c]	55[d]
Under-5 mortality rate (2011–2012)	53[b]	88[c]	89[d]
Neonatal deaths: % of all under-5 deaths[e] (2012)	60%	43%	50%
Annual rate of reduction in child mortality with uncertainty interval[a] (1990–2013)	5.7 (5.4–6.0)	5.0 (3.9–6.3)	2.2 (1.5–2.9)

Sources:

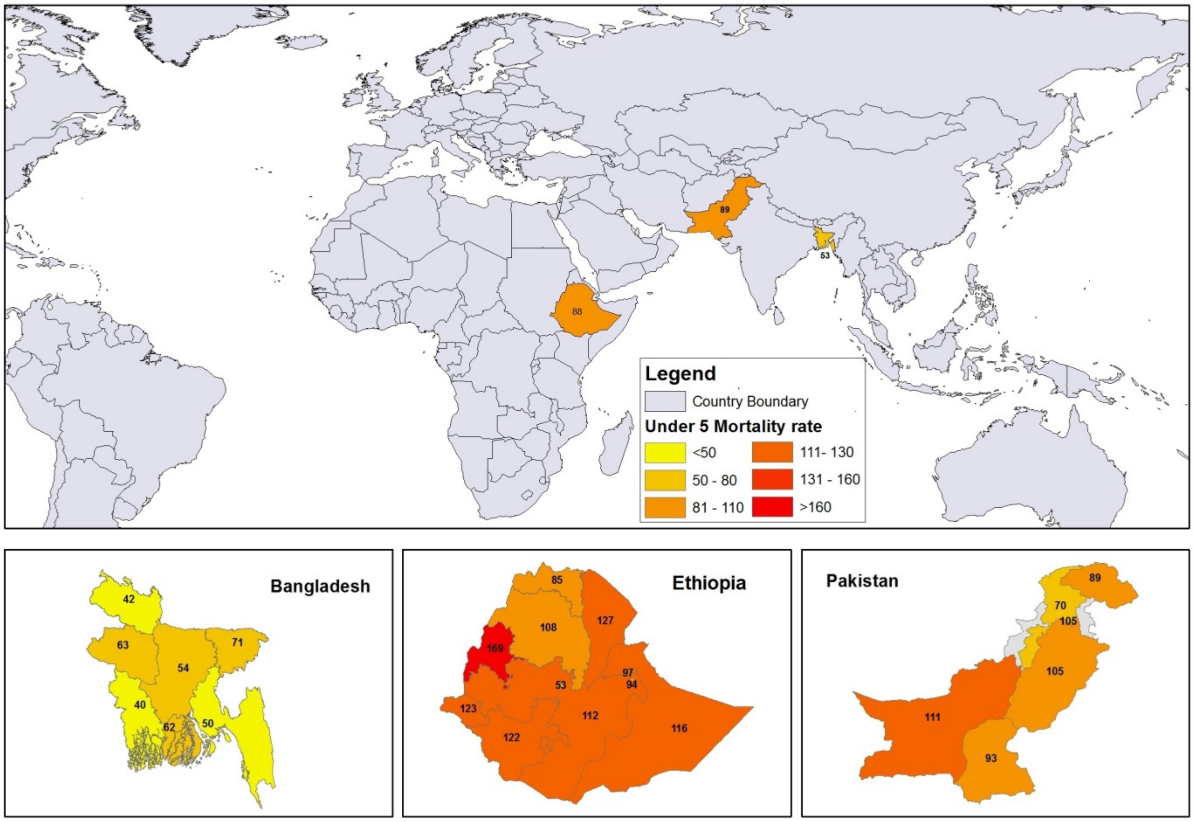
(a) Mortality rates and number of deaths, IGME (2013).
(b) Bangladesh demographic and health survey 2011–2012.
(c) Ethiopia demographic and health survey 2011–2012.
(d) Pakistan demographic and health survey 2012–2013.
(e) Countdown to 2015: Progress report 2013.

These mortality trends demonstrate that it is possible to sharply lower child mortality, even from high initial rates, when concerted action, sound strategies, adequate resources, and strong political will are consistently applied in support of child and maternal survival.

Regional Differentials of Mortality

All three countries show wide disparities in under-5 deaths across the region. In Bangladesh the under-5 mortality rate ranges from 40 to 71 per 1,000 live births by seven divisions. Khulna has the lowest while Sylhet has the highest mortality rates. In Ethiopia under-5 mortality rates range from a low of 53 per 1,000 live births in Addis Ababa to a high of 169 per 1,000 live births in Benishangul-Gumuz. In Pakistan the child mortality rate ranges from 111 in Balochistan to 70 in Khyber Pakhtunkhwa (Figure 2).

Figure 2 Under-5 mortality rate: Global position of Bangladesh, Ethiopia, and Pakistan and regional variation within country

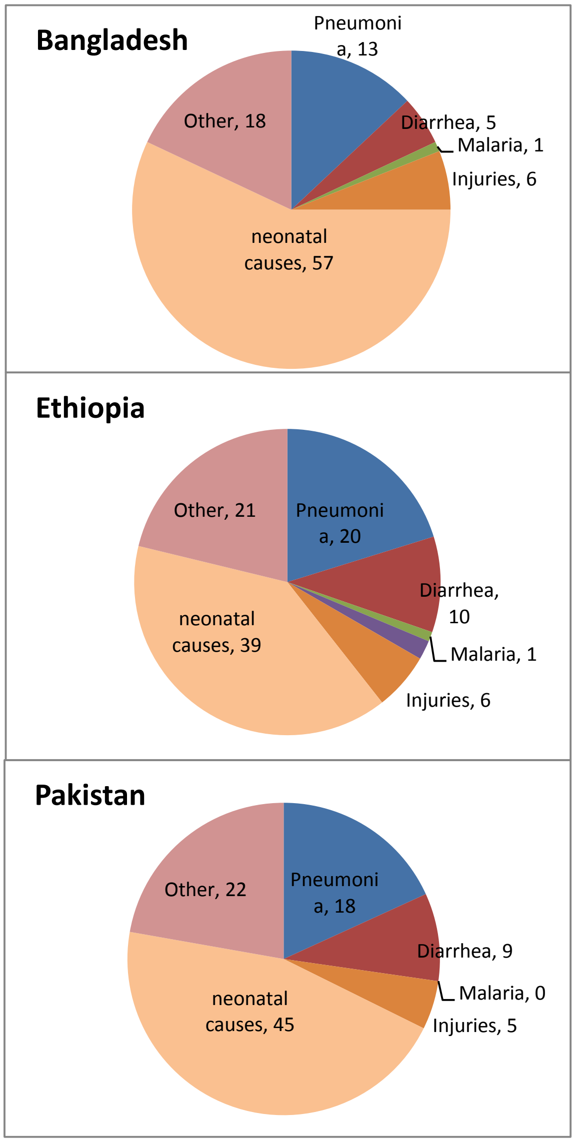


Source: DHS surveys 2011–2013.

Leading Causes of Child Mortality

Major causes of child mortality are important to guide global health efforts to improve child survival (2,13). In all three countries, neonatal complications are responsible for a majority of under-5 deaths (Figure 3). Globally Bangladesh now has the highest (60 percent) proportion of under-5 deaths in the neonatal period. Pakistan ranks sixth in its share of neonatal compared with under-5 child deaths (Table 2). This suggests that greater attention and investment are required to address all neonatal causes of death, and particularly preterm birth complications and intrapartum (delivery-related) complications, which make up a large share of these deaths.

Figure 3 Major causes of child mortality



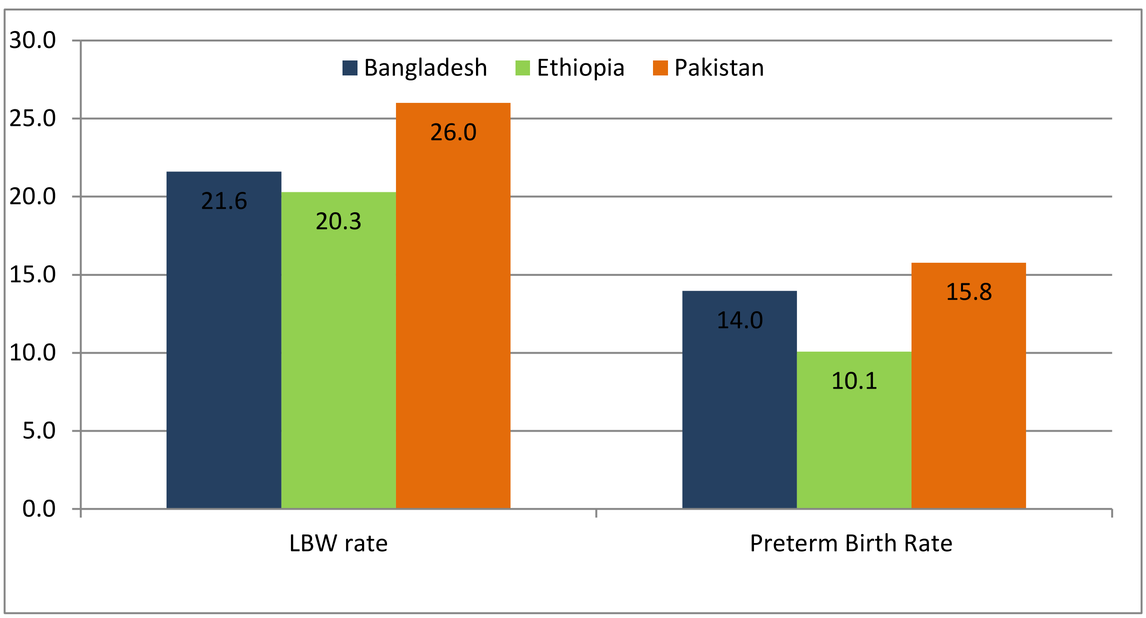
Source: WHO/CHERG (2013).

Apart from neonatal complications, leading infectious diseases including pneumonia and diarrhea together are the greatest causes of under-5 mortality in these countries. Much overlap exists among the determinants of childhood pneumonia and diarrhea. Risk factors that are common to both conditions include undernutrition, suboptimal breastfeeding, poor hygiene, and zinc deficiency (14). A clean home environment, including access to safe water and adequate sanitation, helps to prevent both pneumonia and diarrhea.

Undernutrition

Undernutrition is an underlying cause of child death (15). Almost half of all under-5 deaths are attributable to undernutrition. This puts children at greater risk of death from common infections, increases the frequency and severity of illnesses, and delays recovery. The interaction between undernutrition and infection can create a potentially lethal cycle of worsening illness and deteriorating nutritional status. In addition to increasing mortality risk, poor nutrition in the first 1,000 days of a child's life can lead to stunted growth, which is irreversible and is associated with impaired cognitive ability and reduced school and work performance. (16). The important undernutrition disorders that are strongly associated with newborn and under-5 deaths include low birth weight, SGA, stunting, and wasting (4). Among these three countries is small variation in low birth weight and preterm prevalence (Figure 4a).

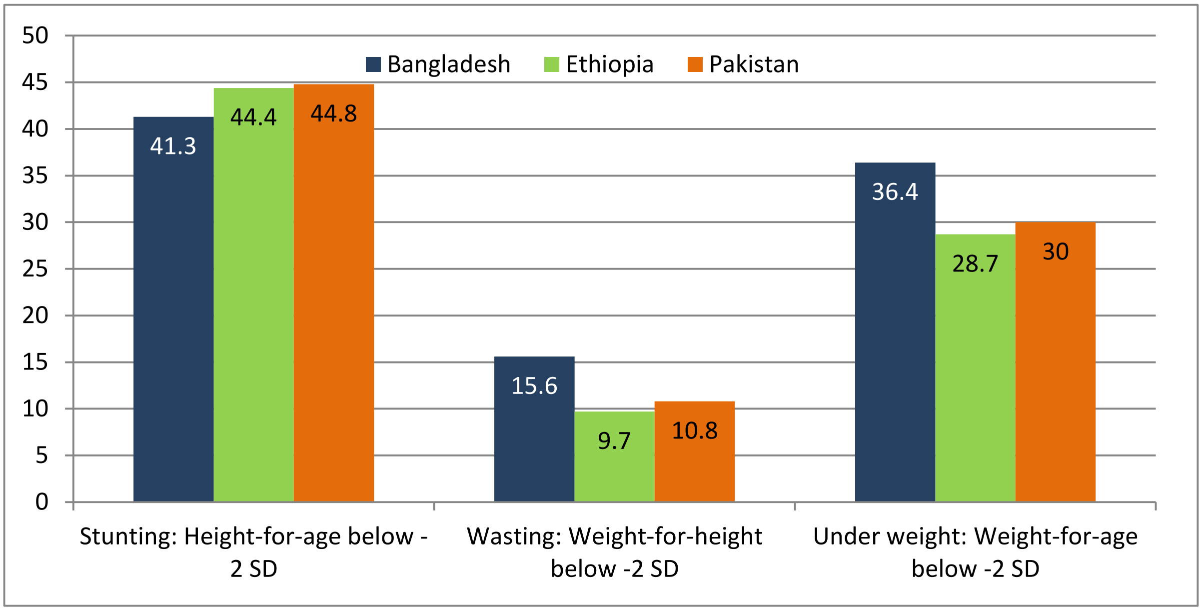
Figure 4a Prevalence of low birth weight and preterm births



Sources and Notes: LBW (low birth weight): Data sources and methods referenced in web appendix 3, Lee AC, Katz J, Blencowe H et al. 2012. Pre-term: Born too soon: the global action report on preterm birth. World Health Organization, Geneva.

Despite variations in child mortality rates, similar patterns are observed for stunting prevalence. Bangladesh has slightly higher wasting and underweight prevalence (Figure 4b). This leads to the conclusion that although some differences are seen in under-5 mortality rates, the situation with respect to undernutrition is broadly comparable in all three countries. This highlights the need to develop strategies and programs by implementing effective nutrition interventions to improve nutrition status and prevent mortality.

Figure 4b Prevalence of stunting, wasting, and underweight



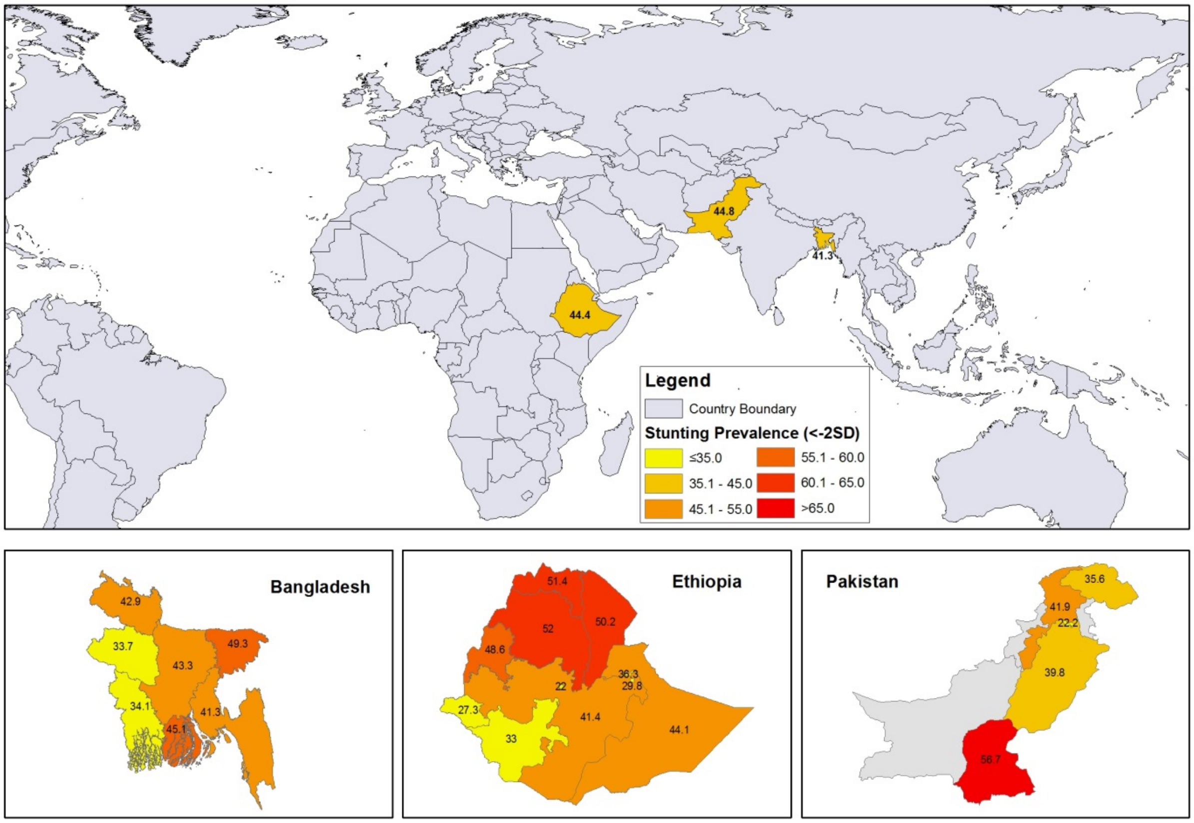
Sources:

(a) Bangladesh demographic and health survey 2011–2012.
(b) Ethiopia demographic and health survey 2011–2012.
(c) Pakistan demographic and health survey2012–2013.

Note: SD = standard deviation.

Variations are visible in the prevalence of stunting across regions among the countries. Figure 5 shows that the regions of Tigray and Afar in Ethiopia and the province of Sindh in Pakistan have more than 50 percent of under-5 children are stunted. In Bangladesh, except Khulna and Rajshahi divisions, the range of stunting is between 41 and 49 percent. The lowest prevalence of stunting was observed in the Addis Ababa and Gambela regions of Ethiopia, with 22 percent and 27 percent, respectively.

Figure 5 Prevalence of stunting: global position of Bangladesh, Ethiopia, and Pakistan and regional variation within country



3. Overview of Interventions Chosen for Modeling

We reviewed interventions that affect neonatal and child mortality and undernutrition-related outcomes. We selected interventions for modeling based on the conceptual framework presented in latest *Lancet* nutrition series (4) and with updated effect sizes from the recent Every Newborn series (17). The details of selection method and effect estimates are provided in the same paper. Here we provide a brief overview of the interventions that we modeled in context to effect the estimates provided in LiST.

Birth Spacing and Optimizing Birth Intervals

The interval between the birth of one child and the birth of the next with the same mother has important implications for child survival and health. Short birth spacing raises the risks of prematurity and of low birth weight in low- and lower-middle-income countries. Maintaining a birth spacing of at least 2 years would cut mortality among infants (less than 1 year old) by 10 percent, and would cut mortality among children ages 1–4 by 21 percent. Access to contraceptives and family planning services thus has significant potential to improve child survival through increasing birth spacing.

Folic Acid Supplementation

Folic acid supplementation has direct impact on neonatal congenital anomalies and deaths through reduction in neural tube defects. Preconceptual folic acid supplementation reduces 72 percent of risk of developing neural tube defects (RR: 0·28, 95%CI: 0·15–0·52) and reduces risk of recurrence (RR: 0·32, 95%CI: 0·17–0·60) (18).

Balanced Energy Supplementation

Balanced protein energy supplementation given to food-insecure women during pregnancy impacts neonatal mortality through reduction in incidence of SGA (RR, 0·68; 95%CI, 0·56–0·84) (19, 20) and has indirect impact on postneonatal diarrhea mortality through reduction in prevalence of stunting by reducing incidence of SGA.

Multiple Micronutrient Supplementation

Multiple-micronutrient supplementation during pregnancy is associated with an 11–13 percent reduction in low birth weight and SGA births, having comparable effects on rates of anemia and iron deficiency anemia as traditional iron folate supplements have (21).

Breastfeeding Promotion

Breastfeeding promotion includes several activities to increase the probability that a woman will breastfeed and continue to breastfeed. The World Health Organization (WHO) recommends exclusive breastfeeding of infants till 6 months of age to achieve optimum growth (22). A review by Imdad et al. (23) evaluated the impact of education promotion interventions on the rates of breastfeeding in developing countries and concluded that educational and counseling interventions increased exclusive breastfeeding by 43 percent at day 1, by 30 percent till 1 month, and by 90 percent from 1 to 6 months. Breastfeeding, in addition to its other benefits, confers vital protection against diarrhea and pneumonia-related mortality. Available evidence suggests that, in the context of developing countries, children who are not breastfed at all could be at substantially greater risk of diarrhea- and pneumonia-related mortality than children who are either exclusively or even partially breastfed (24).

Complementary Feeding for Food-Secure and Food-Insecure Populations

Complementary feeding for infants refers to the timely introduction of safe and nutritionally rich foods in addition to breastfeeding, that is, clean and nutritionally rich additional foods introduced at about 6 months of age and typically provided from 6 to 24 months of age (25). Adequate complementary feeding practices have substantial potential for reducing child mortality through reduction in prevalence of stunting. Complementary food provision in combination with nutrition education had a significant impact on improving height-for-age Z scores (SMD 0·15; 95%CI: 0·03, 0·27), and reducing underweight by 65 percent (RR 0·35; 95%CI: 0·16, 0·77). While these interventions had significant impact on reducing the prevalence of respiratory illnesses by 33 percent (RR 0·67; 95%CI: 0·53, 0·86), no impact was observed on diarrhea and febrile episodes (26, 27).

Vitamin A Supplementation

Vitamin A supplementation given to chlildren ages 6–59 months twice yearly has a direct impact of 30 percent reduction in mortality related to diarrheal illness (RR 0.70; 95%CI 0.58–0.86) (28).

Zinc Supplementation

Preventive zinc supplementation in populations at risk of zinc deficiency reduces the risk of morbidity from childhood diarrhea and acute lower respiratory infections and also increases linear growth and weight gain among infants and young children (29,30). A recent review by Yakoob et al. (31) evaluated 18 studies from developing countries and showed that preventive zinc supplementation reduced the incidence of diarrhea and pneumonia by 13 percent and 15 percent, respectively, with no impact on mortality.

Water Sanitation and Hygiene Interventions

Lack of access to safe drinking water, the practice of open defecation, and poor hygiene habits are significant threats to the survival and health of children. Proper hygiene including hand washing was already identified in the 19th century as an important factor in public health.

Improved water source: *Improved water source* is defined by the Joint Monitoring Program for Water Supply and Sanitation as access of households to safe drinking water sources like home connections, covered wells, bore wells, and so forth. This has a direct impact of 17 percent reduction on diarrhea-related mortality in children aged 1–59 months (32).

Water connection at home: Households supplied through piped water at home or in the yard are assumed to be safe and have adequate supply. This reduces 69 percent diarrhea-related mortality in children 1–59 months of age (32,33).

Improved sanitation: Open defecation puts entire communities at greater risk of diarrheal and other diseases, which exact a toll of deaths among children. Open defecation also raises the risk of infestation with intestinal worms. Recurrent diarrhea and intestinal infestations delay child growth and development in the form of stunting. The definition provided by the Joint Monitoring Program for Water Supply and Sanitation includes covered latrines and indoor sanitation facilities. Improved sanitation facilities proved to reduce diarrhea-related mortality 36 percent (32).

Hand washing with soap: Appropriate hand-washing practices are defined as washing hands with soap, ash, or other materials with adequate water after defecation and before preparing meals. Recent evidence suggests that adequate hand washing could reduce diarrhea morbidity 48 percent (RR: 0·52, 95%CI: 0·37–0·76) (32).

Hygienic disposal of stools: Hygienic disposal of children's stools is defined as appropriate containment by either using latrines or stools thrown in latrines or buried. The effect of safe disposal of excreta was also associated with a 36 percent reduction in diarrhea morbidity (32).

Zinc for Treatment of Diarrhea

Current WHO guidelines on the management and treatment of diarrhea in children strongly recommend continued feeding alongside administration of oral rehydration solutions, plus zinc therapy. The impact of therapeutic zinc supplementation for the management of diarrhea was evaluated by Walker et al. (34). Thirteen studies from developing countries concluded that zinc supplementation reduced all-cause mortality by 46 percent (95%CI: 12 percent, 68 percent) and diarrhea-related hospitalization by 23 percent (95%CI: 15 percent, 31 percent), while impacts were nonsignificant on diarrhea-specific mortality and diarrhea prevalence.

Feeding for Moderately and Severely Wasted Children

Therapeutic feeding for moderate and severe acute malnutrition can provide a recovery rate 78 percent and 80 percent among moderately and severely wasted children, respectively (35–37).

4. LiST Methods for Intervention Modeling

LiST is a modeling tool based on the original *Lancet* Child Survival (2003) and Neonatal Survival series (2005) and is built into a demographic software package (Spectrum™). The model has been substantially improved and modified since it was first developed. LiST databases include most recent national mortality and cause-of-death data for mothers, newborns, and children based on definitions and estimates from the Child Health Epidemiology Group with WHO based on International Classification of Diseases guidelines. The baseline coverage data for each country are based on the most recent data and estimates available from country-specific DHSs or Multiple Indicator Cluster Surveys (MICSs). If coverage data are not available for any intervention, estimates were made on known coverage of other interventions as described in the LiST manual.

LiST models standard sequential introduction of interventions to avoid double counting of impact and estimate reduction in deaths from one or more causes or prevalence of risk factor by increasing coverage of interventions. Based on the coverage change and the effectiveness of a given intervention, the number of deaths prevented is then calculated.

We modeled potential impact of interventions in three high-burden countdown countries—Pakistan, Ethiopia, and Bangladesh—using three approaches: The first and second scenarios include scale-up of nutrition-specific interventions using different base years 2011 and 2013 with a common set of interventions (Table 3). The third scenario comprises prior nutrition and two related nutrition-sensitive interventions—birth spacing; and water, sanitation, and hygiene interventions listed in Table 3—to allow comparison of relative benefit of nutrition interventions versus others. These interventions will scale up from their most recent coverage to 90 percent from 2013 to 2025. Effect estimates used for the modeling are presented in the Appendix in Tables A5a to A5c.

Table 3 List of modeled interventions for addressing maternal and child undernutrition

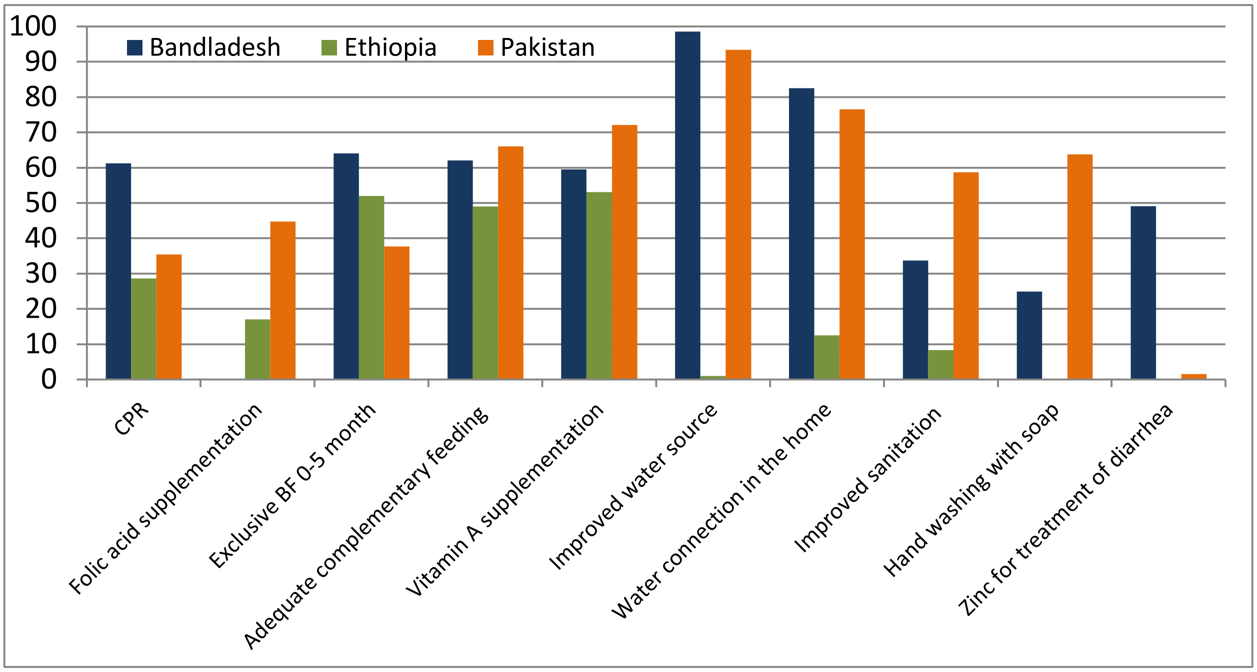
Time period	Interventions model for first scenario (focusing on nutrition-specific interventions—both sensitive and specific interventions modeled in LiST)	Expanded interventions model for second scenario
PRECONCEPTION		1. Birth spacing and optimizing birth intervals
	1. Folic acid supplementation/fortification	2. Folic acid supplementation/fortification

Time period	Interventions model for first scenario (focusing on nutrition-specific interventions—both sensitive and specific interventions modeled in LiST)	Expanded interventions model for second scenario
PREGNANCY	2. Balanced energy supplementation 3. Multiple micronutrient supplementation	3. Balanced energy supplementation 4. Multiple micronutrient supplementation
BREASTFEEDING	4. Promotion of breastfeeding (including early initiation)	5. Promotion of breastfeeding (including early initiation)
PREVENTIVE	5. Complementary feeding for food-secure and food-insecure population 6. Vitamin A supplementation 7. Zinc supplementation	6. Complementary feeding for food-secure and food-insecure population 7. Vitamin A supplementation 8. Zinc supplementation 9. Water, sanitation, and hygiene interventions
CURATIVE	8. Zinc for treatment of diarrhea 9. Feeding for moderately wasted children 10. Therapeutic feeding—for severe wasting	10. Zinc for treatment of diarrhea 11. Feeding for moderately wasted children 12. Therapeutic feeding—for severe wasting

5. Coverage of Modeled Interventions by Country

Baseline coverage of balanced protein energy, multiple micronutrient supplementation, zinc supplementation, and therapeutic feeding for moderate and severe malnutrition was not available for all three countries. Therefore these intervention coverage estimates were set to zero at baseline.

Figure 6 Baseline coverage of modeled interventions



Sources:

(a) Bangladesh demographic and health survey 2011–2012.
(b) Ethiopia demographic and health survey 2011–2012.
(c) Pakistan demographic and health survey2012–2013.

Notes: BF = breastfeeding; CPR = contraceptive prevalence rate.

Figure 6 shows variations in current coverage of selected interventions by country. For a majority of the interventions, Bangladesh has the highest and Ethiopia has the lowest coverage levels, except for sanitation and hand-washing practices. Coverage of these two interventions is relatively higher in Pakistan. This variation is highest in water, sanitation, and hygiene (WASH) interventions. Ethiopia has very low coverage levels for WASH interventions.

6. Results

Impact of Scaling Up of Interventions on Mortality

Our modeling suggests that by scaling up of nutrition interventions at the 90 percent target level in Bangladesh can prevent 58,000 (41 percent) and 50,000 (39 percent) of under-5 deaths from base years 2011 and 2013, respectively. The comparable estimates for Ethiopia are 59,000 (32 percent) and 55,000 (31 percent), respectively; and for Pakistan, 158,000 and 162,000 (37 percent), respectively. Adding birth spacing and WASH interventions along with nutrition interventions can prevent 54,000 (42 percent), 65,000 (37 percent), and 162,000 (42 percent) child deaths in Bangladesh, Ethiopia, and Pakistan, respectively (Appendix Table A1). The number of deaths averted is higher in Ethiopia by adding WASH interventions because of the low baseline coverage level of these interventions. Figures 7a and 7b provide the number and percent of deaths prevented in the neonatal and 1–59 months age groups.

Figure 7a Number of deaths averted by scenarios

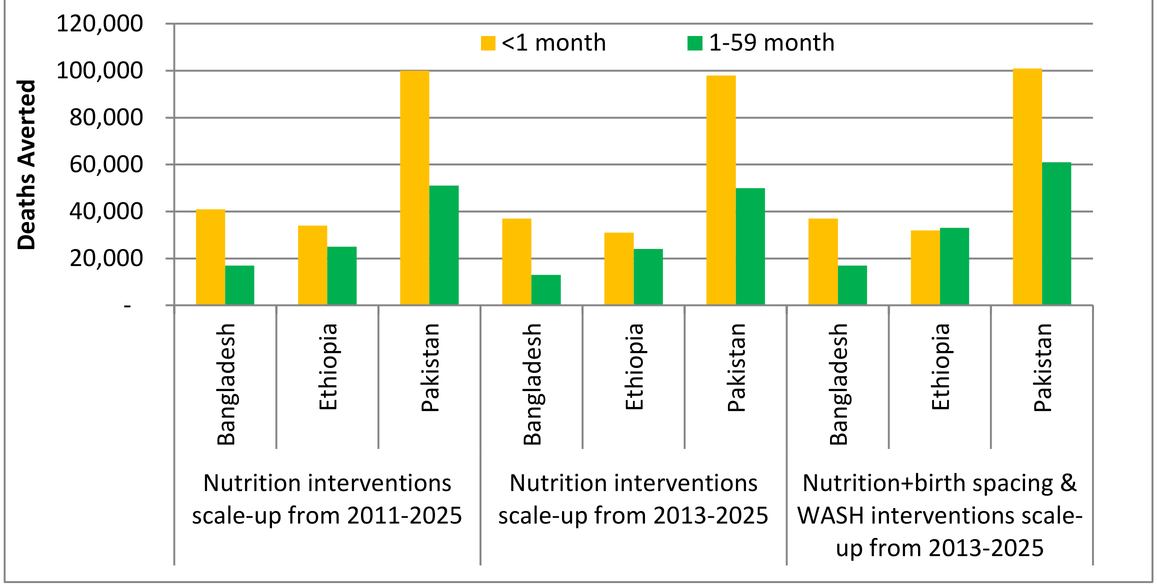
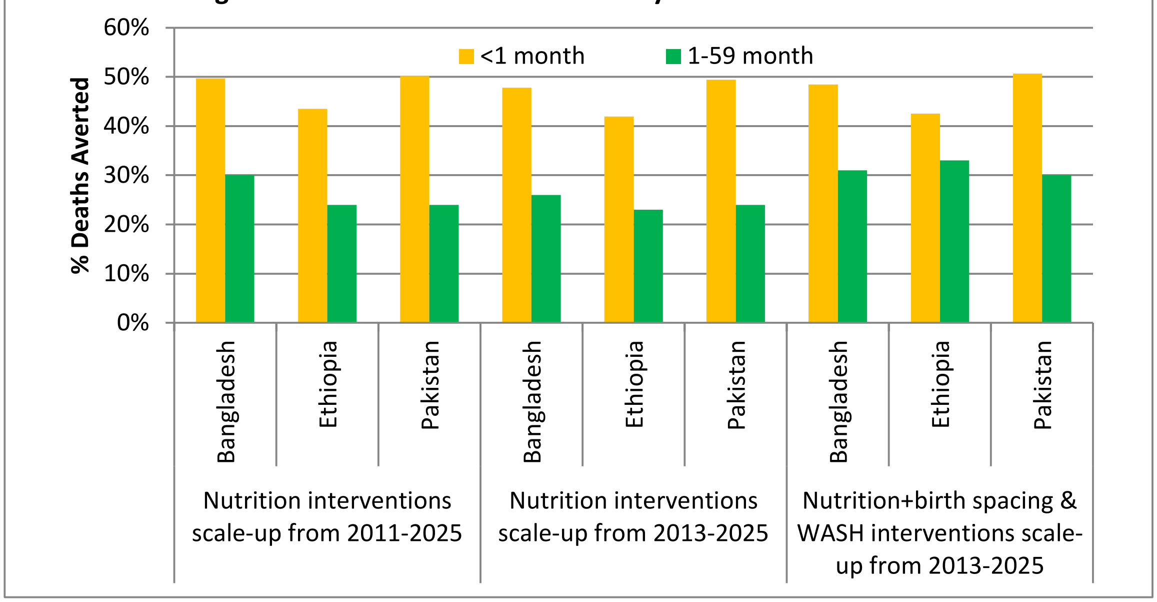


Figure 7b Percent of deaths averted by scenarios



The impact of scaling up of individual interventions by all three strategies is presented in Figures 8a, 8b, and 8c. Breastfeeding promotion and therapeutic feeding for severe acute malnutrition proved to have the highest impact when applied with or without WASH and birth spacing interventions in all three countries.

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Figure 8a Deaths averted by scale up nutrition intervention (2011-2025)

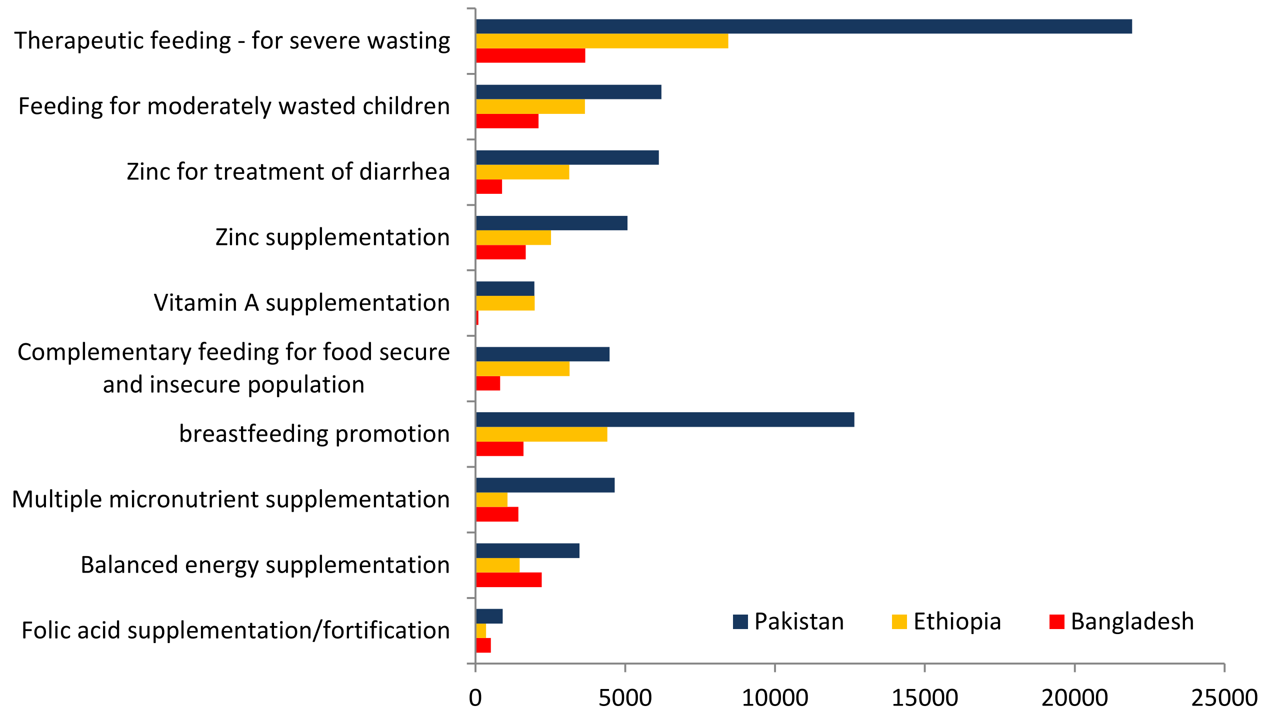


Figure 8b Deaths averted by scale up nutrition intervention (2013-2025)

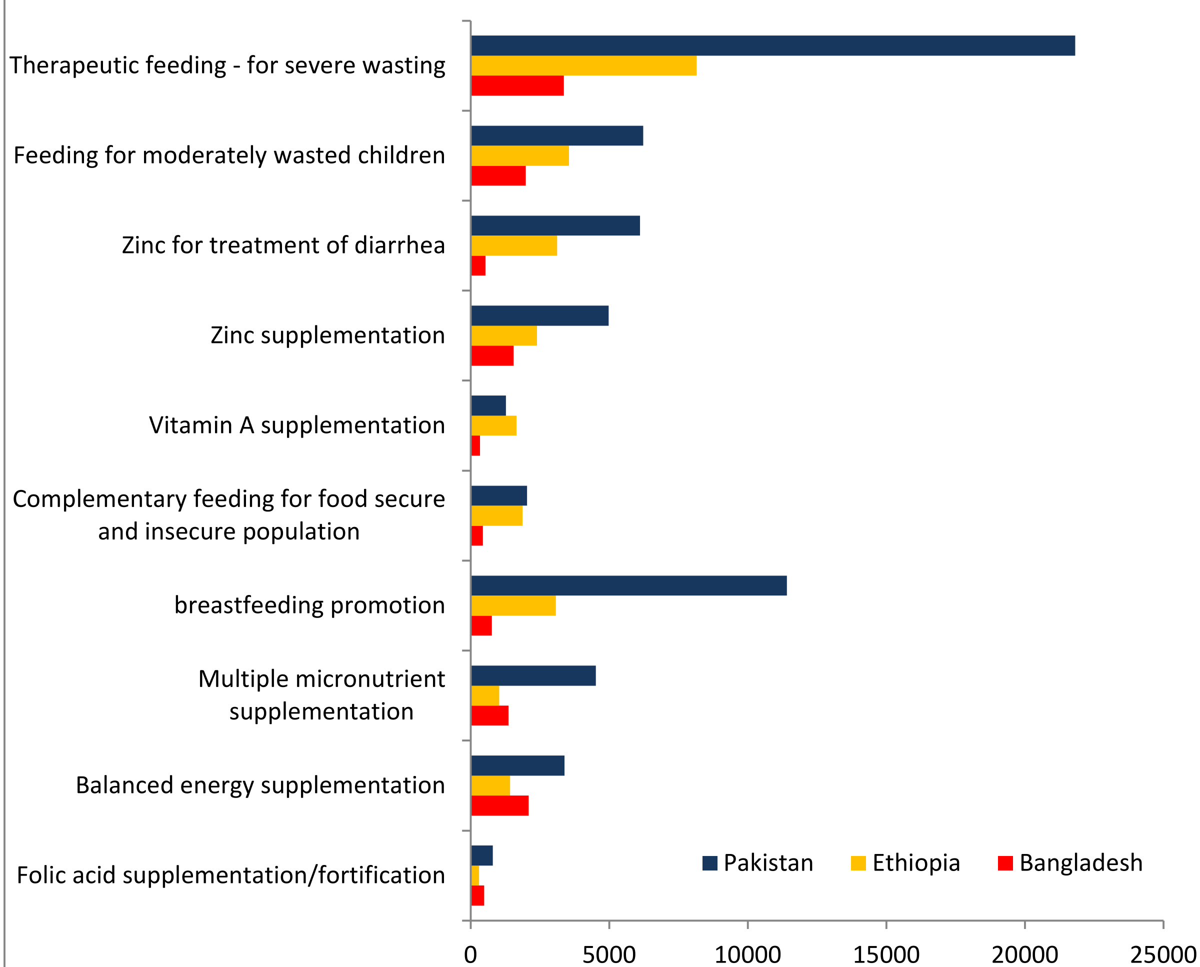
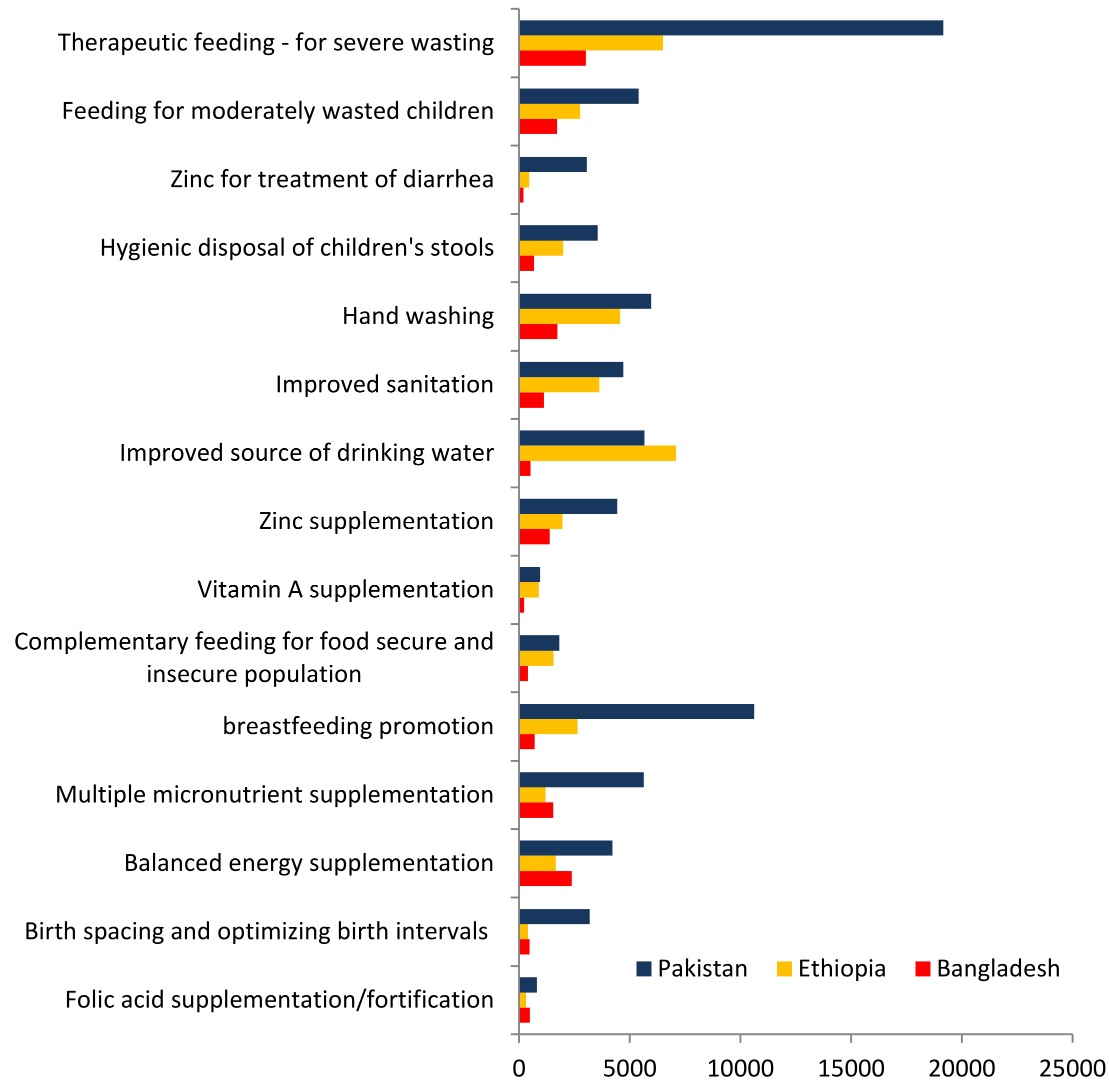


Figure 8c Deaths averted by scale up nutrition, birth spacing, and WASH intervention (2013-2025)



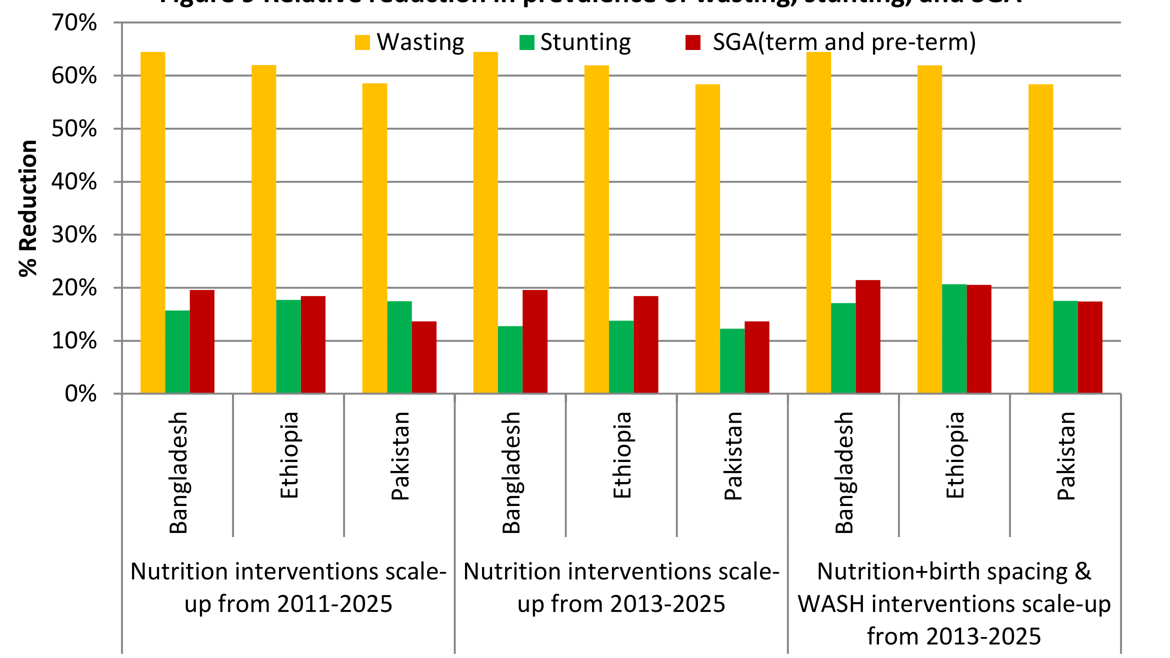
Impact of Scaling Up of Interventions on Undernutrition Parameters

By scaling up nutrition interventions, the model provides an 16 percent, 18 percent, and 17 percent reduction during 2011–2025 and 13 percent, 14 percent, and 12 percent reduction during 2013–2025 in the prevalence of stunting. This could increase to 17 percent, 21 percent, and 17 percent during 2013–2015 by adding WASH interventions in Bangladesh, Ethiopia, and Pakistan, respectively (Appendix Table A2)

Impact on reduction in prevalence of wasting is almost the same in three scenarios. We estimated 64 percent, 62 percent, and 59 percent reduction in Bangladesh, Ethiopia, and Pakistan, respectively (Appendix Table A3).

Incidence of SGA in Bangladesh, Ethiopia and Pakistan also reduced by 20 percent, 18 percent, and 14 percent, respectively, when relevant interventions were scaled up from either 2011 or 2013. This proportion increased to 21 percent, 21 percent, and 17 percent in Bangladesh, Ethiopia, and Pakistan, respectively, by including birth spacing and WASH with nutrition interventions (Figure 9). Impact on preterm and term SGA was similar (Appendix Table A4).

Figure 9 Relative reduction in prevalence of wasting, stunting, and SGA



7. Interpretation

These modeling estimates confirm the findings of the benefits of the core set of nutrition-specific interventions highlighted in the recent *Lancet* series. Some gains seem to have been made in coverage estimates for several interventions in the three countries evaluated (Bangladesh, Pakistan, and Ethiopia).

Since the last evaluation in 2012 (based on 2011 coverage data) the baseline has changed in coverage of interventions and hence the relatively small incremental gain in mortality reduction for current estimates in 2014. The addition of two nutrition-sensitive interventions to the mix of interventions (namely, birth spacing and WASH interventions) have some impact on reducing stunting and SGA rates, but the overall impact is also marginal because of the relatively small effects of these interventions on stunting, wasting, and SGA births in the current models. Future studies and observational data may provide more robust estimates of the effect size of these interventions on nutrition outcomes as opposed to mortality, where the effects seem to be largely mediated through mortality reduction.

Appendix

Table A1 Deaths averted and percent of deaths averted by scenarios across countries

		<1 month	1–59 months
Nutrition interventions scale-up 2011–2025	Bangladesh	41,000 (50%)	17,000 (30%)
	Ethiopia	34,000 (43%)	25,000 (24%)
	Pakistan	100,000 (50%)	51,000 (24%)
Nutrition interventions scale-up 2013–2025	Bangladesh	37,000 (48%)	13,000 (26%)
	Ethiopia	31,000 (42%)	24,000 (23%)
	Pakistan	98,000 (49%)	50,000 (24%)
Nutrition + birth spacing & WASH interventions scale-up 2013–2025	Bangladesh	37,000 (48%)	17,000 (31%)
	Ethiopia	32,000 (43%)	33,000 (33%)
	Pakistan	101,000 (51%)	61,000 (30%)

Note: WASH = water, sanitation, and hygiene.

Table A2 Reduction in prevalence of stunting

		Moderate			Severe			Overall		
		Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)
Scenario 1: scale up 10 nutrition interventions 2011–2025	Bangladesh	26.9	22.7	15.8%	15.9	13.4	15.6%	42.8	36.1	15.7%
	Ethiopia	23.8	19.6	17.7%	20.1	16.5	17.8%	43.9	36.1	17.7%
	Pakistan	22.0	18.1	17.5%	21.8	18.0	17.5%	43.7	36.1	17.5%
Scenario 2: scale up 10 nutrition interventions 2013–2025	Bangladesh	26.9	23.5	12.8%	15.9	13.9	12.8%	42.8	37.4	12.8%
	Ethiopia	23.8	20.6	13.8%	20.2	17.4	13.8%	44.0	37.9	13.8%
	Pakistan	22.0	19.3	12.3%	21.8	19.1	12.3%	43.8	38.4	12.3%
Scenario 3: scale up 10 nutrition interventions + WASH and birth spacing 2013–2025	Bangladesh	26.9	22.3	17.2%	15.9	13.2	17.0%	42.8	35.5	17.1%
	Ethiopia	23.8	18.9	20.6%	20.2	16.0	20.7%	44.0	34.9	20.7%
	Pakistan	22.0	18.1	17.5%	21.8	18.0	17.5%	43.8	36.1	17.5%

Note: WASH = water, sanitation, and hygiene.

Table A3 Reduction in prevalence of wasting

		Moderate			Severe			Overall		
		Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)
Scenario 1: scale up 10 nutrition interventions 2011–2025	Bangladesh	14.4	5.4	62.7%	2.9	0.8	73.1%	17.3	6.2	64.5%
	Ethiopia	7.2	2.9	59.4%	2.9	0.9	68.3%	10.0	3.8	62.0%
	Pakistan	9.0	4.1	54.9%	5.9	2.1	64.2%	14.9	6.2	58.6%
Scenario 2: scale up 10 nutrition interventions 2013–2025	Bangladesh	14.4	5.4	62.7%	2.9	0.8	73.2%	17.3	6.2	64.5%
	Ethiopia	7.1	2.9	59.4%	2.9	0.9	68.2%	10.0	3.8	61.9%
	Pakistan	9.0	4.1	54.8%	5.8	2.1	64.0%	14.8	6.2	58.4%
Scenario 3: scale up 10 nutrition interventions + WASH and birth spacing 2013–2025	Bangladesh	14.4	5.4	62.7%	2.9	0.8	73.2%	17.3	6.2	64.5%
	Ethiopia	7.1	2.9	59.4%	2.9	0.9	68.2%	10.0	3.8	61.9%
	Pakistan	9.0	4.1	54.8%	5.8	2.1	64.0%	14.8	6.2	58.4%

Table A4 Reduction in prevalence of small for gestational age (SGA) births

		Preterm SGA			Term SGA			SGA		
		Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)	Baseline	2025	Relative change (%)
Scenario 1: scale up 10 nutrition interventions 2011–2025	Bangladesh	3.1	2.5	19.6%	36.5	29.4	19.5%	39.6	31.9	19.5%
	Ethiopia	1.6	1.3	18.4%	30.5	24.8	18.4%	32.1	26.2	18.4%
	Pakistan	3.5	3.0	13.7%	43.5	37.5	13.7%	47.0	40.6	13.7%
Scenario 2: scale up 10 nutrition interventions 2013–2025	Bangladesh	3.1	2.5	19.6%	36.5	29.4	19.5%	39.6	31.9	19.5%
	Ethiopia	1.6	1.3	18.4%	30.5	24.8	18.4%	32.1	26.2	18.4%
	Pakistan	3.5	3.0	13.7%	43.5	37.5	13.7%	47.0	40.6	13.7%
Scenario 3: scale up 10 nutrition interventions + WASH and birth spacing 2013–2025	Bangladesh	3.1	2.3	25.5%	36.5	28.8	21.1%	39.6	31.1	21.4%
	Ethiopia	1.6	1.2	25.2%	30.5	24.3	20.3%	32.1	25.5	20.5%
	Pakistan	3.5	2.7	24.6%	43.5	36.2	16.8%	47.0	38.8	17.4%

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Table 5a Interventions and estimates of effects

Interventions	Impact on	Estimate	Age period	Population
Folic acid fortification	Neonatal congenital mortality	0.35	Periconceptual	Women of reproductive age
Multiple micronutrient supplementation	Small for gestational age	0.09	Pregnancy	All pregnant women
Balanced energy supplementation	Small for gestational age	0.31	Pregnancy	Pregnant women living on less than $1 a day
Iron folate supplementation	Small for gestational age	0.05	Pregnancy	All pregnant women
Vitamin A supplementation	Diarrhea mortality	0.47	6–59 months	Percent of children 6–59 months who are vitamin A deficient
Zinc supplementation	Diarrhea mortality	0.50	12–59 months	Percent of children 12–59 months who are zinc deficient
Zinc supplementation	Pneumonia mortality	0.51	12–59 months	Percent of children 12–59 months who are zinc deficient
Zinc for diarrhea treatment	Diarrhea mortality	0.23	1–59 month	All children
Improved water source	Diarrhea mortality	0.17	1–59 months	All children
Water connection in the home	Diarrhea mortality	0.69	1–59 months	All children
Improved sanitation—utilization of latrines or toilets	Diarrhea mortality	0.36	1–59 months	All children
Hand washing with soap	Diarrhea mortality	0.48	1–59 months	All children
Hygienic disposal of children's stools	Diarrhea mortality	0.20	1–59 months	All children
Zinc supplementation	Diarrhea incidence	0.65	12–59 months	Percent of children 12–59 months who are zinc deficient
Vitamin A supplementation	Diarrhea incidence	0.62	6–59 months	Percent of children 6–59 months who are vitamin A deficient
Zinc supplementation	Pneumonia incidence	0.52	12–59 months	Percent of children 12–59 months who are zinc deficient
Therapeutic feeding—for severe acute malnutrition	Other mortality, 1–59 months	0.78	6–59 months	Children 6–59 months who are severely wasted

Table 5b Breastfeeding, complementary and therapeutic feeding, estimates modeled

		Odds ratio for age period					
Intervention	**Impact on**	**<1 month**	**1–5 months**	**6–11 months**	**12–23 months**	**24–59 months**	**Population**
Therapeutic feeding—for severe wasting	Wasting	N/A	N/A	0.78	0.78	0.78	Children 6–59 months who are severely wasted
Feeding for moderately wasted children	Wasting	N/A	N/A	0.80	0.80	0.80	Children 6–59 months who are moderately wasted
Complementary feeding—food secure with promotion of use of complementary feeding	Stunting	N/A	N/A	1	1	N/A	Mothers of children 6–23 months living on more than $1 a day
Complementary feeding—food secure without promotion of complementary feeding	Stunting	N/A	N/A	1.43	1.43	N/A	Mothers of children 6–23 months living on more than $1 a day
Complementary feeding—food insecure with promotion of complementary feeding and supplementation	Stunting	N/A	N/A	1.6	1.6	N/A	Mothers of children 6–23 months living on less than $1 a day
Complementary feeding—food insecure with neither promotion nor supplementation	Stunting	N/A	N/A	2.39	2.39	N/A	Mothers of children 6–23 months living on less than $1 a day
Children supplemented with zinc	Stunting	N/A	N/A	N/A	1	1	All children 12–59 months
Children not supplemented with zinc	Stunting	N/A	N/A	N/A	1.11	1.11	All children 12–59 months
Promotion of breastfeeding	Age appropriate breastfeeding behavior	2.3	4.6	1.60	1	1	Mothers of children 0–11 months

Table 5c Impact of birth spacing on small for gestational age

		RR for birth			
Intervention	**Impact on**	**Preterm SGA**	**Preterm AGA**	**Term SGA**	**Population**
Birth Intervals—first birth	SGA	N/A	N/A	N/A	
Birth Intervals—<24 months	SGA	2.04	1.07	1.25	Women of reproductive age with one or more births
Birth Intervals—>=24 months	SGA	1	1	1	

Note: AGA=Appropriate for Gestational Age; RR= Risk Ratio; SGA=Small for Gestational Age.

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