

SUPPORTING THE NATIONAL ACTION PLAN ON NUTRITION:

Estimating the Costs, Impact, and Cost- Effectiveness, and Economic Benefits of Expanding the Coverage of Direct Nutrition Interventions in Bangladesh

DISCUSSION PAPER

April 2018

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WORLD BANK GROUP
Health, Nutrition & Population



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Health, Nutrition and Population (HNP) Discussion Paper

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SUPPORTING THE NATIONAL ACTION PLAN ON NUTRITION: Estimating the Costs, Impact, and Cost-Effectiveness, and Economic Benefits of Expanding the Coverage of Direct Nutrition Interventions in Bangladesh

Abstract: This report presents an analysis of the costs, benefits, and cost-effectiveness of implementing a set of key nutrition interventions included in Bangladesh's second National Plan of Action on Nutrition (NPAN2). The total public investment needed to implement the interventions is estimated to be USD 536.9 million over 10 years (or about USD 53.7 million annually). This includes USD 152.8 million to maintain the current coverage of the intervention and an additional USD 384.8 million to expand their coverage gradually to reach 90% over 10 years. The analyses demonstrate that investing in nutrition in Bangladesh is very cost-effective and that the benefits it would generate greatly outweigh the initial investment costs. Expanding coverage of the interventions would, over 10 years, result in preventing almost 50,000 deaths and over 500,000 cases of stunting in children under five years of age and in averting over 860,000 DALYs. Those gains would translate into increases in economic productivity worth about USD 5.6 billion over the productive lives of the children who benefited from the interventions. The benefit-cost ratio would be 20.5, which means that every dollar invested in nutrition would bring in over 20 dollars in economic benefits. Averting one death would cost about USD 7,700; averting one DALY, about USD 447, and preventing once case of stunting, about USD 765. Geographic targeting in the short and medium term could lead to increased efficiency of investments.

Keywords: nutrition-specific interventions, cost-effectiveness, benefit-cost analysis, nutrition financing, Bangladesh.

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ABBREVIATIONS AND ACRONYMS

BDHS	Bangladesh Demographic Health Survey
BNNC	Bangladesh National Nutrition Council
BNNP	Bangladesh National Nutrition Policy
BSTI	Bangladesh Standards and Testing Institution
DFATD	Department of Foreign Affairs, Trade and Development (Canada)
CIDD	Control of Iodine Deficiency Disorders
CMSD	Central Medical Stores Depot
DALYs	disability-adjusted life years
DNIs	direct nutrition interventions
EPI	Expanded Programme on Immunization
EU	European Union
g	grams
GAIN	Global Alliance for Improved Nutrition
GDP	gross domestic product
GNI	gross national income
HNP	Health, Nutrition and Population
HPNSDP	Health, Population, Nutrition Sector Development Program
icddr,b	International Centre for Diarrheal Disease Research, Bangladesh
IHME	Institute for Health Metrics and Evaluation
IGME	Inter-agency Group for Child Mortality Estimation
IU	International Units
kg	kilograms
LiST	Lives Saved Tool
M&E	monitoring and evaluation
MICS	
mg	milligrams
µg	micrograms
mmol/l	millimols/liter
n.a.	not applicable
FSNSP	National Food Security Nutritional Surveillance Project
NGO	nongovernmental organization
NPAN	National Plan of Action on Nutrition
NPAN2	Second National Plan of Action for Nutrition
NVAC	National Vitamin A Campaign
PAF	population attributable fraction
RUTF	ready-to-use therapeutic food
SAM	severe acute malnutrition
SD	standard deviation
SUN	Scaling Up Nutrition
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
DFID	U.K. Department for International Development
USAID	U.S. Agency for International Development
VAT	value added tax
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

WHZ	weight-for-height Z-score
WFP	World Food Programme (UN)
WPP	World Population Prospects
YLD	years of life spent with disability (from a disease)
YLL	years of life lost (from a disease)

All dollar amounts are U.S. dollars unless noted otherwise.

GLOSSARY OF TECHNICAL TERMS

A **benefit-cost ratio** summarizes the overall value of a project or proposal. It is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. The benefit-cost ratio takes into account the amount of monetary gain realized by implementing a project versus the amount it costs to execute the project. The higher the ratio, the better the investment. A general rule is that if the benefit from a project is greater than its cost, the project is a good investment.

Capacity development for program delivery is a process that involves increasing in-country human capacity and systems to design, deliver, manage, and evaluate large-scale interventions (Horton et al. 2010). This includes developing skills by training public health personnel and community volunteers to improve the delivery of services. These efforts typically accompany program implementation or, when possible, precede program implementation. In this analysis 9% of total programmatic costs is allocated to capacity development for program delivery.

Cost-benefit analysis is an approach to economic analysis that weighs the cost of an intervention against its benefits. The approach involves assigning a monetary value to the benefits of an intervention and estimating the expected present value of the net benefits, known as the *net present value*. Net benefits are the difference between the cost and monetary value of benefits of the intervention. The net present value is defined mathematically as:

$$\text{Net present value} = \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_0$$

where C_t is net cash inflows, C_0 is the initial investment, the index t is the time period, and r is the discount rate. A positive net present value, when discounted at appropriate rates, indicates that the present value of cash inflows (benefits) exceeds the present value of cash outflows (cost of financing). Interventions with net present values that are at least as high as alternative interventions provide greater benefits than interventions with net present values equal to or lower than alternatives. The results of cost-benefit analysis can also be expressed in terms of the benefit-cost ratio.

Cost-effectiveness analysis is an approach to economic analysis that is intended to identify interventions that produce the desired results at the lowest cost. Cost-effectiveness analysis requires two components: the total cost of the intervention and an estimate of the intervention's impact, such as the number of lives saved. The cost-effectiveness ratio can be defined as:

$$\text{Cost-effectiveness ratio} = \frac{\text{total cost of implementing the intervention}}{\text{impact of the intervention on a specific outcome}}$$

The analysis involves comparing the cost-effectiveness ratios among alternative interventions with the same outcomes. The intervention with the lowest cost per benefit is considered to be the most cost-effective intervention among the alternatives.

A **DALY** is a **disability-adjusted life year**, which is equivalent to a year of healthy life lost due to a health condition. The DALY, developed in 1993 by the World Bank, combines the years of life lost from a disease (YLL) and the years of life spent with disability from the disease (YLD). DALYs

count the gains from both mortality (how many more years of life lost due to premature death are prevented) and morbidity (how many years or parts of years of life lost due to disability are prevented). An advantage of the DALY is that it is a metric that is recognized and understood by external audiences such as the World Health Organization (WHO) and the National Institutes of Health (NIH). It helps to gauge the contribution of individual diseases relative to the overall burden of disease by geographic region or health area. Combined with cost data, DALYs allow for estimating and comparing the cost-effectiveness of scaling up nutrition interventions in different countries.

A **discount rate** refers to a rate of interest used to determine the current value of future cash flows. The concept of the time value of money suggests that income earned in the present is worth more than the same amount of income earned in the future because of its earning potential. A higher discount rate reflects higher losses to potential benefits from alternative investments in capital. A higher discount rate may also reflect a greater risk premium of the intervention.

The **internal rate of return** is the discount rate that produces a net present value of cash flows equal to zero. An intervention has a non-negative net present value when the internal rate of return equals or exceeds the appropriate discount rate. Interventions yielding higher internal rates of return than alternatives tend to be considered more desirable than the alternatives.

The **Lives Saved Tool (LiST)** is an estimation tool that translates measured coverage changes into estimates of mortality reduction and cases of childhood stunting averted. LiST is used to project how increasing intervention coverage would impact child and maternal survival. It is part of an integrated set of tools that comprise the Spectrum policy modeling system.

Nutrition-sensitive interventions “address the underlying and basic determinants of maternal, fetal, and child nutrition and development, including food security; adequate caregiving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment, and incorporate specific nutrition goals and actions. Nutrition-sensitive programs can serve as delivery platforms for nutrition-specific interventions, potentially increasing their scale, coverage, and effectiveness. Examples include programs for agriculture and food security; SSNs [social safety nets]; early childhood development; maternal mental health; women’s empowerment; child protection; schooling; WASH [water, sanitation and hygiene]; and health and family planning services” (Bhutta et al. 2013).

Nutrition-specific interventions “have an immediate and direct impact on maternal, fetal, and child nutrition and development, including adequate food and nutrient intake, feeding, caregiving and parenting practices, and low burden of infectious diseases. Examples include adolescent, preconception, and maternal health and nutrition; maternal dietary or micronutrient supplementation; promotion of optimum breastfeeding; complementary feeding and responsive feeding practices and stimulation; dietary supplementation; diversification and micronutrient supplementation or fortification for children; treatment of SAM [severe acute malnutrition]; disease prevention and management; and nutrition in emergencies” (Bhutta et al. 2013).

Sensitivity analysis is a technique that evaluates the robustness of findings when key variables change. It helps to identify the variables with the greatest and least influence on the outcomes of the intervention, and it may involve adjusting the values of a variable to observe the impact of the variable on the outcome.

Stunting (chronic malnutrition) is low height-for-age, defined as more than 2 standard deviations below the mean of the sex-specific reference data. Stunting is the cumulative effect of long-term deficits in food intake, poor caring practices, and illness.

Unit Cost is the cost of all inputs divided per unit of output (person treated, group sensitized, report produced, and so on) in one given intervention.

Wasting (acute malnutrition) is low weight-for-height, defined as more than 2 standard deviations below the mean of the sex-specific reference data. Wasting is usually the result of a recent shock, such as lack of calories and nutrients or illness, and is strongly linked to mortality.

A **Z-score** is a metric describing deviations from a reference value (usually the mean of a distribution). It is calculated with the following formula:

$$Z\text{-score} = \frac{(\text{observed value}) - (\text{median reference value})}{\text{standard deviation of reference population}}$$

EXECUTIVE SUMMARY

In January 2016 the Government of Bangladesh requested technical assistance from the World Bank and the United Nations Children's Fund (UNICEF) to estimate the cost of implementing nutrition actions considered for the inclusion in the country's Second National Plan of Action for Nutrition (NPAN2) and to assist with the prioritization of scale up of the nutrition action over the coming 10 years.

This report presents the analysis conducted as part of the technical assistance. It consists of four parts. Part I presents background context and an overview of nutritional status of the population of Bangladesh, with a focus on pregnant women and children under age five. Part II describes the methodology employed, including details on the assumptions used to develop unit costs (cost per beneficiary) that will be used by the Government of Bangladesh as the basis for estimating the cost of the implementation of the NPAN2. Part III presents an analysis of the costs, benefits, and cost-effectiveness of a set of key nutrition-specific interventions included in the NPAN2. Part IV of the report summarizes the main conclusions, limitations, and policy implications. The goal of the analysis is to contribute to the building of an investment case for nutrition in Bangladesh and to inform prioritization within the NPAN2 by identifying which interventions are the most cost-effective (that is, which offer the lowest cost per death averted or case of stunting averted) and in which geographic regions investments in nutrition-specific action have the potential to achieve the greatest impact.

Country Context:

Bangladesh has seen marked improvement in the under-five mortality rate over the last two decades; the current rate of 46 deaths per 1,000 live births is below the 2015 Millennium Development Goal of 48 deaths per 1,000 live births. Even though under-five mortality is declining, however, the data suggest a concentration of mortality in the early years with infant mortality at 38 deaths per 1,000 live births. There are also significant regional variations in infant and child mortality. Under-five mortality ranges from 35 deaths per 1,000 live births in the Barisal Division to as many as 67 deaths per 1,000 live births in the Sylhet Division.

Undernutrition is one of the key factors increasing mortality risk in infants and young children. Worldwide, it is thought to underlay nearly 45% of all child deaths (Black et al. 2013). This is because malnourished children who develop common childhood illnesses such as pneumonia, diarrhea, sepsis, or other conditions have lower survival rates and slower recovery times. In Bangladesh, 36%, 14%, and 33% of children under five years of age are stunted, wasted, or underweight, respectively. Stunting rates have shown improvements over the past 10 years with a decline from 51% in 2004 to 36% in 2014, but commensurate progress has not been achieved with regard to wasting. Geographically, stunting prevalence across the seven divisions in Bangladesh varies greatly—ranging from 31.1% in Rajshahi to 49.6% in Sylhet. Micronutrient deficiencies are also pervasive in Bangladesh. The most recent data estimates available reveal an anemia prevalence of 10.7% among preschool- age children, and 7.1% among nonpregnant and nonlactating women (icddr,b 2013). Only slightly more than half of households consume adequately iodized salt, leaving many households unprotected from iodine deficiency disorders (icddr,b 2013). About 62% of mothers reported that their child (age 6–59 months) received vitamin A supplementation in the past six months (BDHS 2014).¹ This is a slight increase from 60%

¹ It is possible that the 2014 Bangladesh Demographic and Health Survey (BDHS) underestimates the coverage of vitamin supplementation chiefly because of recall bias. The data from the National Nutrition Service (that is, from the 2015 WHO's Expanded Programme on Immunization (EPI) coverage survey) indicate a higher coverage.

reported in 2011; nevertheless, it indicates a significant supplementation coverage gap. The rate of exclusive breastfeeding in Bangladesh has declined from 64% in 2011 to 55% in 2014. The Bangladesh Demographic and Health Survey (BDHS 2014) showed that 65% of infants age 6–8 months were introduced to complementary food. However, only 23% of children age 6–23 months are given the minimum acceptable diet—that is, minimum meal frequency (a proxy for energy intake) with minimum dietary diversity (foods from at least four food groups) in addition to continued breastfeeding.

Nutrition has been embedded in some of Bangladesh's key development policy and planning documents. The Bangladesh National Nutrition Council (BNNC) led the development of the first National Plan of Action on Nutrition (NPAN) in 1997. Under the Health, Population, and Nutrition Sector Development Programme 2011–2016 (HPNSDP) of the Sixth Five Year Plan, the Ministry of Health and Family Welfare had taken the approach of mainstreaming nutrition through existing health services. The National Nutrition Policy, adopted in 2015, reflects a strong multisectoral approach, involving appropriate line ministries to specifically target action areas within their purview. It also lays out clear objectives and strategies based on updated evidence for improving the nutrition status of all populations, particularly children, adolescent girls, pregnant women, and lactating mothers. To operationalize the Policy, the government has undertaken the development of the second National Plan of Action for Nutrition (NPAN2) for 2016–2025. Under the leadership of the BNNC and the Ministry of Health and Family Welfare, the plan's development has brought together all relevant sectors and includes contributions from all the stakeholder ministries, nongovernmental organizations (NGOs), development partners, and other stakeholders such as academic institutions and the private sector.

Methods

The analysis in this report focuses on the nutrition-specific interventions based on the package identified in the 2013 *Lancet* series on Maternal and Child Malnutrition, with some modifications (such as salt iodization and deworming). Most of these interventions are included in the country's direct nutrition intervention package, and their expansion is planned under the Second National Plan of Action for Nutrition (NPAN2). Definition, scope, costed delivery platforms, target populations, and areas of impact for each intervention are described in Table ES.1

Table ES1: Description, Target Population, Delivery Platforms, and Areas of Impact of Direct Nutrition Interventions

Intervention	Description/Dosage	Target population	Costed delivery platform ^a	Expected Area of Impact
Iron and folic acid supplementation during pregnancy	Supplementation of 200 mg ferrous fumarate plus 400µg folic acid in one daily tablet during pregnancy	Pregnant women	Health facilities during antenatal and postnatal visits	Maternal anemia; maternal and child mortality
Calcium supplementation during pregnancy	Calcium supplementation of twice daily 500 g of calcium carbonate for 140 days during pregnancy	Pregnant women	Health facilities during antenatal visits	Maternal mortality
Promotion of optimum infant and young child feeding	Promotion of early initiation of breastfeeding; exclusive breastfeeding for 6 months; timely introduction of complementary food; age-appropriate quantity, frequency, and quality of complementary food; continued breastfeeding through two years of age; feeding during illness; and essential hygiene actions at key moments	Infants and children from conception up to two years old; mothers during pregnancy and lactation	Individual sessions mainstreamed through primary health care; group counselling sessions delivered through health sector	Child mortality and morbidity; stunting
Vitamin A supplementation for children	Twice yearly provision of vitamin A capsules to children 6–59 months through a National Vitamin A Campaign	Infants and children 6–59 months	National Vitamin A campaign	Child mortality and morbidity; stunting
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	For each episode of diarrhea, 10–14 day course of oral zinc (20g per day) with oral rehydration solution	All infants and children age 0–59 months experiencing acute diarrhea	Facility-based treatment	Child morbidity
Deworming of children	1 tablet of albendazole treatment given twice per year through the EPI outreach program	Children age 24–59 months	Semiannual distribution at EPI outreach centers	Child morbidity; child anemia
Provision of micronutrient powders to infants and young children	1 sachet daily of micronutrient powder containing 12.5 mg elemental iron, 300 µg retinol, including 0.16 mg folic acid and 30 mg vitamin C and 5 mg elemental zinc	Infants and young children age 6–23 months	Community-based outreach conducted by family welfare assistants	Child anemia

Intervention	Description/Dosage	Target population	Costed delivery platform ^a	Expected Area of Impact
Treatment of severe acute malnutrition	Treatment using therapeutic foods (RUTF), folate supplementation, and one course of wide-spectrum antibiotic, according to the national protocol	Children age 6–59 months diagnosed with severe acute malnutrition (WHZ <–3 SD)	Outpatient treatment	Child morbidity and mortality; wasting
Management of moderate acute malnutrition	Provision of fortified supplemental foods (wheat-soy blend) for approximately 75 days; 200 g per child per day.	Children age 6–59 months diagnosed with moderate acute malnutrition (–2 SD < WHZ <–3 SD)	Outpatient treatment	Child morbidity and mortality; wasting
Salt iodization	The current salt law mandates that 100% of salt must be iodized at a level of 45–50 parts per million (or 90 mg potassium iodate (KIO3) fortificant per 1 kg of salt)	General population, 100%	Open market	Child cognitive development; general population morbidity
Fortification of edible oil with vitamin A	Bangladesh mandates the fortification of all edible oil with vitamin A at a level of 20,000 IU vitamin A per kg	General population, 100%	Open market	Maternal morbidity; child mortality and morbidity; stunting
Rice fortification	Rice is fortified with vitamins A, B1, B2, and folic acid; and minerals zinc and iron	General population, 100%	Distributed through social safety net programs (Vulnerable Group Development and Vulnerable Group Feeding)	Maternal anemia; maternal mortality and morbidity; child mortality; anemia in women of reproductive age
Public provision of complementary food	Provision of SuperCereal Plus to children age 6–23 months (daily ration of 32.7 g/day for children 6–11 months and 63.4 g/day for children 12–23 months)	Children age 6–23 months living below the poverty line (food insecure)	Distributed through standalone social safety net programs (such as Vulnerable Group Development and Vulnerable Group Feeding) using NGO support	Child mortality and morbidity; stunting

Note: a For interventions that currently are not implemented at scale, the delivery platforms presented in this report are necessary to estimate potential program costs and should be considered only as programmatic examples. These platforms do not constitute recommendations, and dedicated stakeholder consultations are needed to weigh options and identify appropriate delivery platforms. EPI = Expanded Programme on Immunization; g = grams; IU = international units; kg = kilograms; mg = milligrams; µg = micrograms; NGO = nongovernmental organization; RUTF = ready-to-use therapeutic food; SD = standard deviations; WHZ = weight-for-height Z-score.

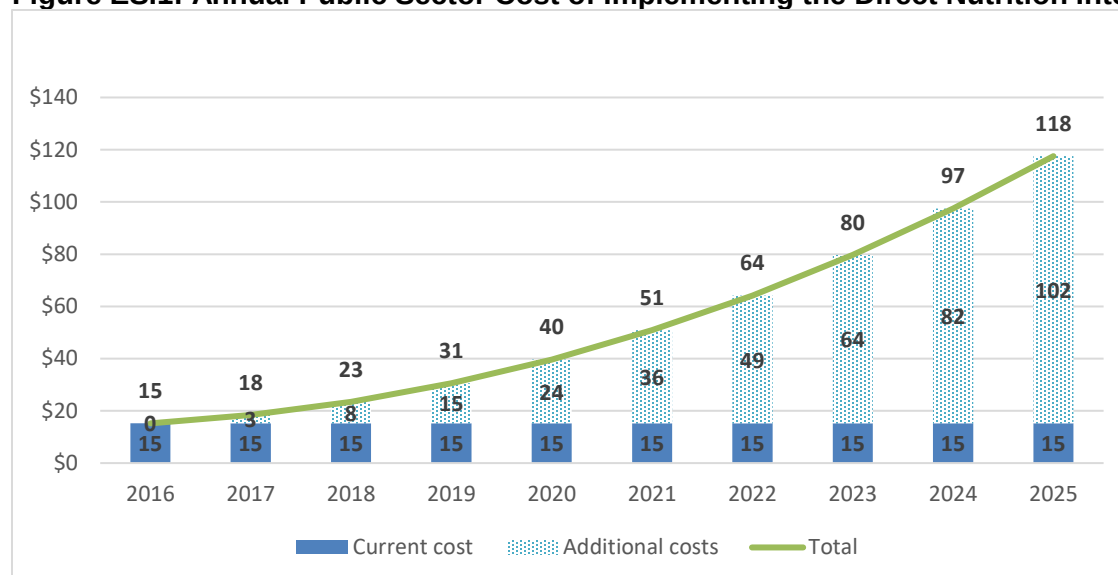
The costs estimated in this report focus on the costs borne by the public sector—the government—as well as other organizations (NGOs, UN family organizations) involved in the provision of nutrition services and are reported in financial terms. They do not capture the full social resource requirements, such as the opportunity costs of the time committed by beneficiaries accessing the services.

Following the proposed timeframe of the NPAN2, we estimated the cost of expanding the coverage of the direct nutrition interventions in Bangladesh over the next 10 years. At the time of writing, the NPAN2 does not include a detailed results framework with annual intervention-specific target. Therefore, we have assumed a linear scale-up of each intervention in 2025 from the current coverage to 90% in 2025.

Results:

The total public investment needed to implement the direct nutrition interventions in Bangladesh is estimated to be USD 536.9 million over 10 years (or about USD 53.7 million annually). This includes USD 152.8 million to maintain the current coverage of the intervention and an additional USD 384.8 million to expand their coverage gradually to reach 90% in year 10. Human resources account for about 41% of total costs; consumables—mostly nutrition supplements and therapeutic and supplemental food—account for 24% of the total costs; program management, including supervision and M&E, account for 25%, equipment and other inputs account for about 7%, and transport for about 3% of the total cost.

Figure ES.1: Annual Public Sector Cost of Implementing the Direct Nutrition Interventions



In addition to public investment, expanding the coverage of fortification of rice with iron and folic acid, fortification of edible oil with vitamin A, and iodization of salt would entail costs that would be passed by producers on to the consumers. These include the cost of fortificant and initial capital investment. Expanding the coverage of fortification of rice and edible oil, and iodization of salt would require an additional USD 2.5 billion over 10 years resulting from increases in price of those products. In absolute terms, the costs to consumers seem high, because those three interventions target the entire population of Bangladesh (compared to other interventions, which target more specific groups, such as children under 5 years of age or pregnant women). However, the relative price increases that may occur due to the expansion of fortification programs are

modest – 5% increase in the price of 1kg of rice and significantly less than that for edible oil and salt.

Expanding the coverage of the key direct nutrition interventions in Bangladesh from the current baseline coverage levels to 90% over the next 10 years would result in preventing almost 50,000 deaths and over 500,000 cases of stunting in children under five and averting over 860,000 DALYs. Preventing one death would cost about USD 7,700; preventing once case of stunting, about USD 765; and averting one DALY, about USD 447. Based on WHO cost-effectiveness thresholds (WHO 2014a), the expansion of the full package of direct nutrition interventions can be considered very cost-effective.

The analyses included two types of prioritization: based on the cost-effectiveness of specific interventions and based on geographic regions. The WHO has set standard willingness-to-pay thresholds for determining the cost-effectiveness of health programs and interventions that are based on DALYs (WHO 2014a). Specifically, interventions and programs with a cost per DALY lower than the gross national income (GNI) per capita are considered to be very cost-effective. Interventions and programs with a cost per DALY between one and three times GNI per capita are considered to be cost-effective. Interventions and programs whose cost per DALY exceeds three times per capita GNI are considered not to be cost-effective. As noted above, the cost per DALY averted is about USD 447—much lower than the Bangladesh GNI per capita of USD 1,211. Therefore, based on the WHO thresholds, the expansion of the full package of direct nutrition interventions can be considered very cost-effective.

The greatest number of deaths, cases of stunting, and DALYS would be averted in Dhaka and Chittagong. This is not surprising, given that these are the two most populous divisions (33% and 20% of the total population, respectively, live in those two divisions). Conversely, the lowest number of deaths and cases of stunting would be prevented in Barisal—the division with the smallest population (6% of the total population). The cost per death averted, case of stunting averted, and DALY averted would be the lowest in Sylhet, Chittagong, and Dhaka Divisions. The differences in the cost per DALY averted between regions are substantial. For example, compared to Sylhet, the cost per DALY averted in Barisal is about 20% higher and in Rangpur it is about 21% higher.

Economic Benefits

The estimated economic benefits of investing in the direct nutrition intervention are substantial: USD 5.6 billion in increased economic productivity over the productive lives of the beneficiaries. The estimated benefit-cost ratio is 20.5, which means that every dollar invested in nutrition would bring in over 20 dollars in economic benefits. Even under conservative assumptions regarding future economic growth, the economic benefits exceeded the cost more than six times.

Limitations

This report has a number of important limitations. First, it sought to estimate the cost of expanding the direct nutrition interventions through the public health sector. However, it should be noted that currently public health services are reaching only a minority of the population in Bangladesh. According to the 2010 Household Income and Expenditure Survey (HIES) 79% of Bangladeshis access health care through non-public providers: 40.2% at the pharmacy/dispensary, 24.6% at a private doctor's office, and 14.3% at a private practice of a government doctor (BBS, 2010). At the same time, however, about 68.1% of pregnant women receive ante-natal services through the public sector (at a satellite clinic, a union family welfare facility, or a thana/upazila health center).

Second, the analysis focuses on the cost of delivering direct nutrition services using delivery modalities currently in place or ones that have the potential to be delivered at scale (for example, moderate acute malnutrition screening and management, outpatient severe acute malnutrition treatment, and the public provision of complementary food). Although this analysis compares effectiveness and cost-effectiveness of different interventions, due to data limitations, it does not address different service modalities options for delivering a specific intervention.

Third, the economic benefits presented above, based largely on mortality, morbidity, and cognitive deficits avoided in children under age five, do not include benefits from reductions in anemia and micronutrient deficiency resulting from the fortification of staples in the general population. Therefore, it is likely that the benefits are, in fact, underestimated.

Finally, even though this report focuses almost exclusively on nutrition-specific interventions, the causes of malnutrition are multisectoral, so any longer-term approach to improving nutrition outcomes must also include nutrition-sensitive interventions. An important next step will be to extend the cost-effectiveness analysis to nutrition-sensitive interventions implemented outside of the health sector. More robust data on nutrition-sensitive interventions are needed to do so.

Conclusions

The total public investment needed to implement the interventions is estimated to be USD 536.9 million over 10 years (or about USD 53.7 million annually). This includes USD 152.8 million to maintain the current coverage of the intervention and an additional USD 384.8 million to expand intervention coverage.

Not only is this set of interventions considered very cost-effective according to WHO cost-effectiveness criteria, but this public investment would result in very substantial benefits. Over 10 years, this coverage expansion would prevent over 50,000 deaths and 500,000 cases of stunting in children under 5 years of age, and avert over 860,000 DALYs. It would also add about 5.6 billion to the country's economy. This means that one dollar invested in the scale up of direct nutrition interventions in Bangladesh would result in about 20 dollars of economic returns.

Currently, no reliable data on nutrition expenditure in Bangladesh exist. This report provides a very perfunctory estimate of the current expenditure on direct-nutrition intervention of about USD 15 million. The estimate is derived simply by multiplying the estimated unit cost for each intervention by the number of individuals currently covered by the intervention. It is limited to the interventions included in the analysis, and does not include any cost related to the management of the national nutrition programs not captured in the unit cost (see the section on unit cost and appendix A). While perfunctory, and included for illustration purposes only, this estimate is roughly consistent with the estimate of current budget allocations for direct nutrition interventions in Bangladesh produced by others (SUN Movement Secretariat; the Results for Development Institute). Taken together, these estimates suggest that the current annual expenditure on nutrition direct interventions in Bangladesh is likely somewhere between USD 15 million and USD 60 million.

Considering the additional public resources required to scale up direct nutrition intervention (USD 384.8 million) in the context of expected growth in the health sector budget reveals that nutrition would have to account for about a third of the expected growth in the health sector budget.² Such

²The current per capita public expenditure on health in Bangladesh is about USD 8.6. Based on recent projections, total health expenditure is expected to grow annually by 3.6% over the next two decades (roughly 31 cents per year). The average annual per capita cost of expanding the coverage of direct nutrition

prioritization of direct nutrition investments may be challenging and, mobilizing additional financing may need to be explored. This could include reallocation of existing resources, or increases in development assistance for nutrition in Bangladesh.

intervention is estimated to be about 12 cents per person per year. This means that expanding the coverage of the direct nutrition interventions would require that over 38% of the expected increases in public health expenditure be directed toward nutrition.

PART I – BACKGROUND

OBJECTIVES AND STUDY RATIONALE

In January 2016 the Government of Bangladesh requested technical assistance from the World Bank and the United Nations Children's Fund (UNICEF) to estimate the cost of implementing nutrition actions considered for the inclusion in the country's Second National Plan of Action for Nutrition (NPAN2) and to assist with the prioritization of scale up of the nutrition action over the coming 10 years.

This report presents the analysis conducted as part of the technical assistance. It consists of four parts. Part I presents background context and an overview of nutritional status of the population of Bangladesh, with a focus on pregnant women and children under age five. Part II describes the methodology employed, including details on the assumptions used to develop unit cost (cost per beneficiary) that will be used by the Government of Bangladesh as the basis estimating the cost of the implementation of the NPAN2. Part III presents an analysis of the costs, benefits, and cost-effectiveness of a set of key nutrition-specific interventions included in the NPAN2. Part IV of the report summarizes the main conclusions, limitations, and policy implications. The goal of the analysis is to contribute to the building of an investment case for nutrition in Bangladesh and to inform prioritization within the NPAN2 by identifying which interventions are the most cost-effective (that is, which offer the lowest cost per death averted or case of stunting averted) and in which geographic regions investments in nutrition-specific action has the potential to have the greatest impacts.

COUNTRY CONTEXT

Bangladesh is the most densely populated country in the world (excluding city-states such as Singapore, Bahrain, and the Vatican). According to the United Nations Development Programme (UNDP) World Population Prospects (WPP) data, the population of Bangladesh in 2016 was about 160 million, with a population density of 1,070 people per square kilometer. Bangladesh is now experiencing a demographic transition because its population growth rate is declining and smaller population increases are expected in the coming decades. The country has seen steady annual economic growth of 6% over the past five years, with an increase of 6.5% in fiscal year 2014/15 (BDHS 2014). Economic growth is dominated by the manufacturing and construction sectors, with these sectors seeing expansion to 20% and 7%, respectively, of national GDP. Agriculture is the second largest sector, accounting for 16% of GDP. In 2014, the gross national income (GNI) per capita in Bangladesh rose to USD 1,314, putting Bangladesh in the category of a lower-middle-income country.

The Ministry of Health and Family Welfare is currently implementing the Health, Population, Nutrition Sector Development Program (HPNSDP) to improve access to and quality of key health services. About 3.5% of GDP is spent on health, with a total per capita annual health expenditure of USD 31 (2014 data; World Development Indicators 2015). Out-of-pocket expenditure is high and accounts for 63% of total health expenditure. Government expenditure accounts for about 35% of total health expenditure and, over the past several years, has seen considerable declines (Islam 2015). The low level of public spending on health and the high out-of-pocket expenditure limits the fiscal space for Bangladesh's plan to achieve universal health coverage by 2032. To reach this goal, the government will need to improve policies that address health care financing and increase human resources for health (Islam 2015).

HEALTH AND NUTRITION STATUS

Health Status

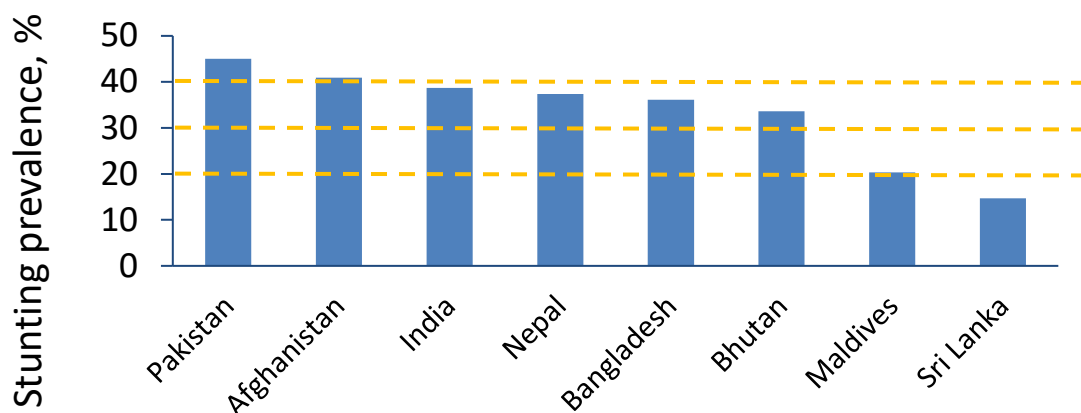
Bangladesh has seen marked improvement in the under-five mortality rate over the last two decades; the current rate of 46 deaths per 1,000 live births is below the 2015 Millennium Development Goal of 48 deaths per 1,000 live births. Even though under-five mortality is declining, however, the data suggest a concentration of mortality in the early years with infant mortality at 38 deaths per 1,000 live births. There are also significant regional variations in infant and child mortality. Under-five mortality ranges from 35 deaths per 1,000 live births in the Barisal Division to as many as 67 deaths per 1,000 live births in the Sylhet Division.

Nutrition Status

Undernutrition is one of the key factors increasing mortality risk in infants and young children. Worldwide, it is thought to underlay nearly 45% of all child deaths (Black et al. 2013). This is because malnourished children who develop common childhood illnesses such as pneumonia, diarrhea, sepsis, or other conditions have lower survival rates and slower recovery times.

Over the past 15 years, stunting in South Asia has decreased significantly but continues to be the highest among all regions worldwide (WHO, UNICEF, and World Bank 2015). Stunting in children varies within the South Asia region, with Bangladesh stunting ranked as high based on the WHO thresholds (see Figure 1). When comparing stunting to GDP within the region, countries such as Sri Lanka and Maldives demonstrate that lower stunting prevalence can be achieved with lower GDP growth rates (Figure 2).

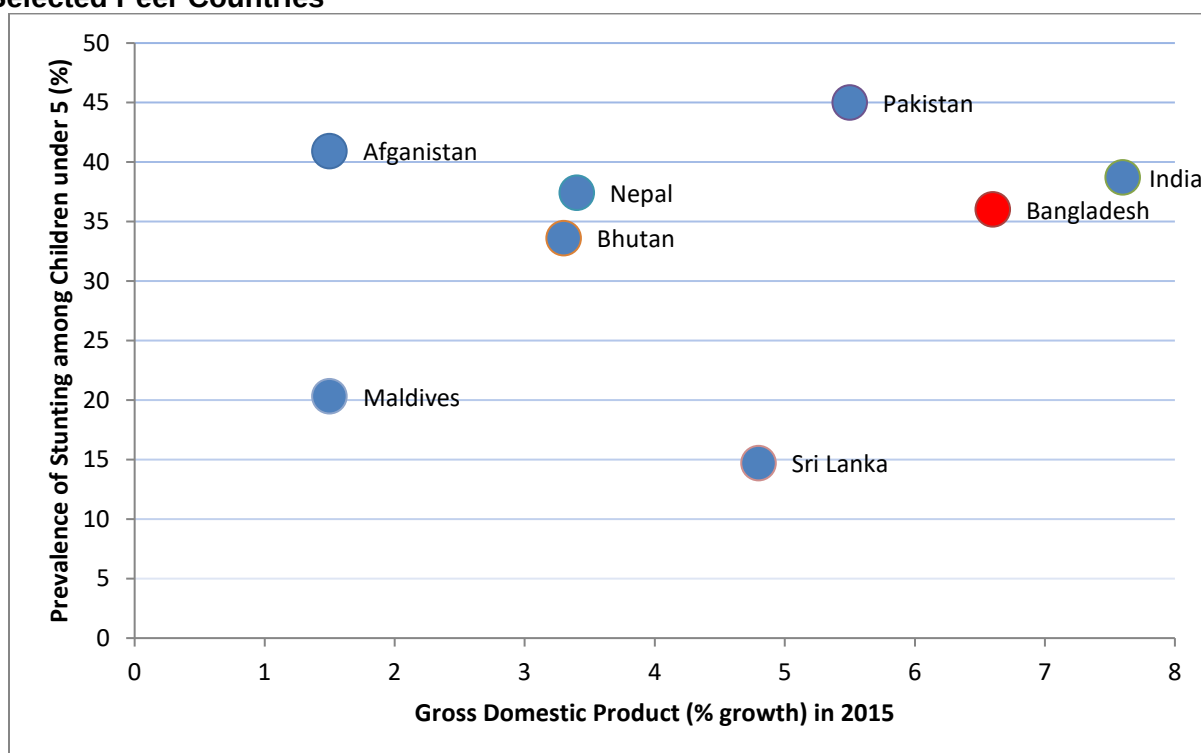
Figure 1: Child Stunting by Country, South Asia Region



Source: WHO, UNICEF, and World Bank 2015.

Note: Yellow dotted lines indicate WHO cutoffs for medium (20%), high (30%), and very high (40%) stunting prevalence.

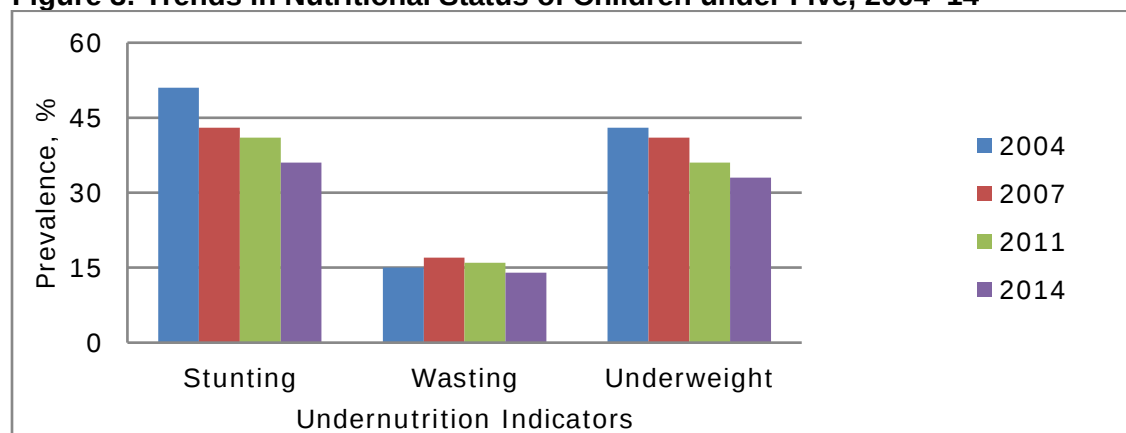
Figure 2: Prevalence of Stunting in Children under Five and GDP in Bangladesh and Selected Peer Countries



Sources: UNICEF, WHO, and World Bank 2016; World Bank 2016.

In Bangladesh, 36%, 14%, and 33% of children under five years of age are stunted, wasted, or underweight, respectively. Stunting prevalence has shown improvements over the past 10 years with a decline from 51% in 2004 to 36% in stunting in 2014, but commensurate progress has not been achieved with regard to wasting (Figure 3).

Figure 3: Trends in Nutritional Status of Children under Five, 2004–14

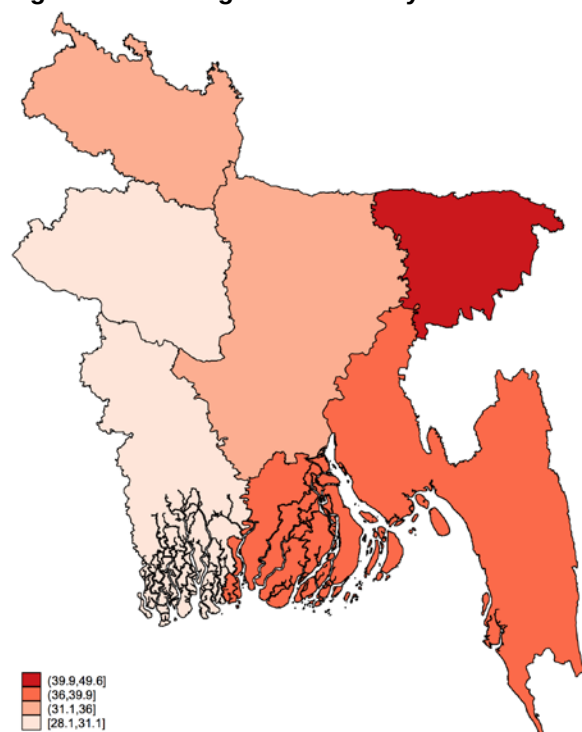


Source: BDHS 2004, 2007, 2011, and 2014.

Note: Stunting, wasting and underweight are calculated as more than 2 standard deviations below the median values for height-for-age, weight-for-height, and weight-for-age, respectively.

Geographically, stunting prevalence across the seven divisions in Bangladesh varies greatly—ranging from 31.1% in Rajshahi to 49.6% in Sylhet (see Figure 4).

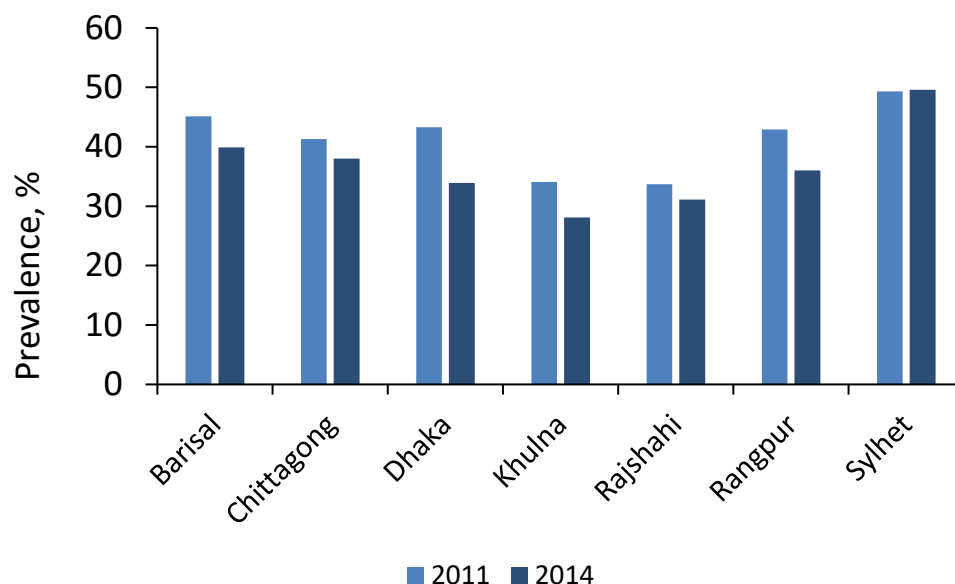
Figure 4: Stunting Prevalence by Division



Source: BDHS 2014.

Figure 5 shows the changes in stunting prevalence from 2011 to 2014 for each division. A very slight increase in stunting prevalence has been seen in Sylhet, while Dhaka and Rangpur have seen relatively large reductions in stunting.

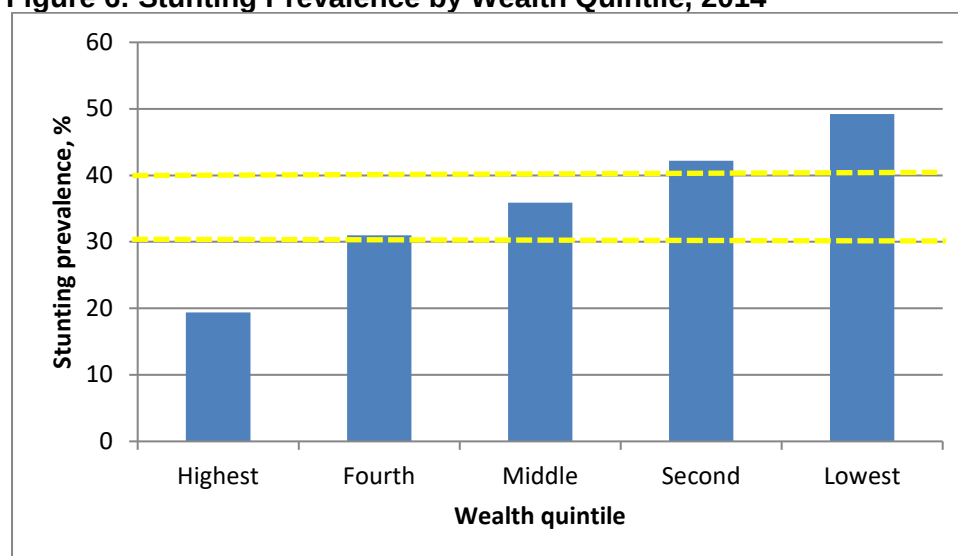
Figure 5: Geographic Disparities in Child Stunting in Bangladesh, 2011–14



Source: BDHS 2011 and 2014.

Stunting prevalence is linked with wealth at the household level with the highest stunting prevalence observed in children from the poorest households and progressively lower prevalence in household in higher wealth quintiles (see Figure 6). In addition to a lack of household resources required to achieve optimum nutrition, this also reflects disparities in access to health care services, and preventative interventions for improving the nutrition status of children in the poorest communities. Finally, in 2014 stunting prevalence was slightly higher among boys than among girls (36.7% and 35.4%, respectively; BDHS 2014).

Figure 6: Stunting Prevalence by Wealth Quintile, 2014



Source: BDHS 2014.

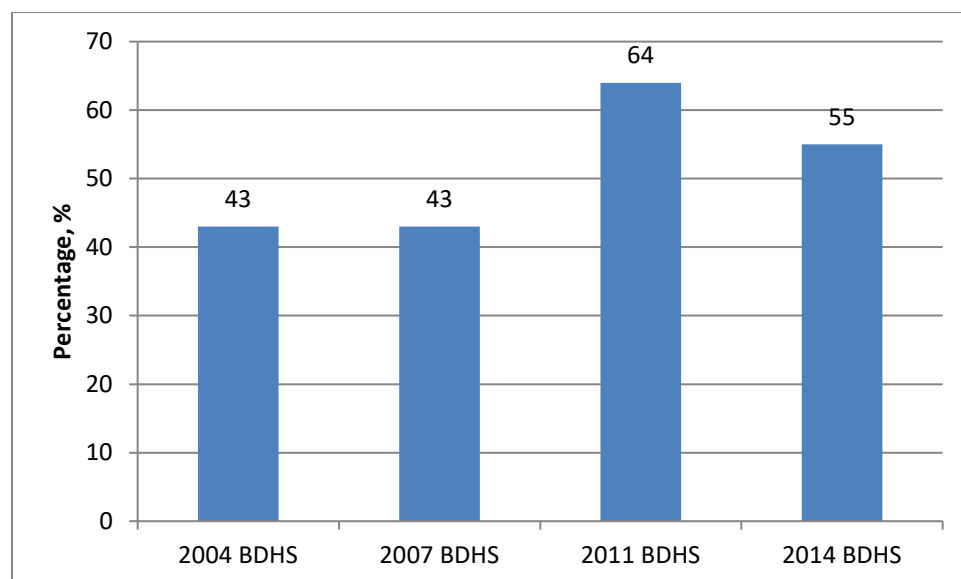
Note: Yellow dotted line at 30% indicates “high stunting prevalence” and at 40% indicates “very high stunting prevalence.”

Micronutrient deficiencies, known as “hidden hunger”, are pervasive in Bangladesh. The most recent estimates available reveal an anemia prevalence of 10.7% among preschool- age children and 7.1% among nonpregnant and nonlactating women (icddr,b 2013). Only slightly more than half of households consume adequately iodized salt, leaving many unprotected from iodine deficiency disorders (icddr,b 2013). About 62% of mothers reported that their child (age 6–59 months) received vitamin A supplementation in the past six months, with similar supplementation rates among boy and girls (61.7% and 62.5%, respectively; BDHS 2014).³ This is a slight increase from 60% reported in 2011; nevertheless, it indicates a significant supplementation coverage gap.

The rate of exclusive breastfeeding in Bangladesh has recently declined from 64% in 2011 to 55% in 2014 (see Figure 7). The Bangladesh Demographic and Health Survey (BDHS 2014) showed that 65% of infants age 6–8 months were introduced to complementary food. However, only 23% of children age 6–23 months (22.7% of boys and 23% of girls) are given the minimum acceptable diet—that is, minimum meal frequency (a proxy for energy intake) with minimum dietary diversity (foods from at least four food groups) in addition to continued breastfeeding.

³ It is possible that the 2014 Bangladesh Demographic and Health Survey (BDHS) underestimates the coverage of vitamin supplementation chiefly because of recall bias. The data from the National Nutrition Service (that is, from the 2015 WHO's Expanded Programme on Immunization (EPI) coverage survey) indicate a higher coverage.

Figure 7: Trends in Exclusive Breastfeeding Practices among Mothers of Children 0–5 Months, 2004–14



Source: BDHS 2014.

One of the underlying reasons for poor nutrition outcomes is the inadequate availability and accessibility of food, also known as *food insecurity*. Research suggests that, at the household level, food is mostly available from markets, barter systems, and subsistence farming, and that the quantity of food available should be enough to meet the levels of demand in most areas of the country (Save the Children 2015). Affordability of food as a consequence of low crop outputs, poverty, and hikes in food prices remains a key challenge. Much of the agricultural sector is made up of cropped land given to rice production, which leads many households to buy imported foods instead of domestically producing pulses, oilseed, or fruits, thus reducing dietary diversity. Mechanisms for providing social protection to households unable to afford food in the short term and improving local crop production in the longer term could vastly improve the diversity of diets, translating into reduced stunting in children. Some social protection and crop production mechanisms are in place already, and food shortages are becoming less common in Bangladesh (Gillespie et al. 2016). However, this has not resulted in significant gains in minimum dietary diversity. The juncture of nutrition-sensitive interventions to improve food security and nutrition-specific interventions to improve dietary quality and diversity is critical for further reducing malnutrition in Bangladesh.

NATIONAL EFFORTS TO ADDRESS MALNUTRITION IN BANGLADESH

Nutrition has been embedded in some of Bangladesh's key development policy and planning documents. The National Planning Commission defines the country's development strategy every five years through the preparation of five-year plans. The Seventh Five Year Plan FY2016–FY2020 was launched in December 2015 with “Accelerating Growth, Empowering Citizens” as its central theme. There are four key sectors in the plan that directly and indirectly impact on food security and nutrition: (1) agriculture; (2) environment and climate change; (3) health, nutrition and population development strategy; and (4) social protection.

Over the years, the Government of Bangladesh has also elaborated several important policy documents specifically related to nutrition and developed institutions to coordinate and implement nutrition actions. The Bangladesh National Nutrition Council (BNNC) led the development of the first National Plan of Action on Nutrition (NPAN) in 1997. Under the Health, Population, and Nutrition Sector Development Programme 2011–2016 (HPNSDP) of the Sixth Five Year Plan, the Ministry of Health and Family Welfare has taken the approach of mainstreaming nutrition through existing health services.

Bangladesh became one of the first countries to join the national Scaling Up Nutrition movement in 2012. Revisions to the existing National Food Policy Plan of Action (2008–2015) and the Country Implementation Plan (2010–2015) are currently underway. A national nutrition communication and advocacy strategy has been drafted, and a consortium of five development partners—Canada's Department of Foreign Affairs, Trade and Development (DFATD), the U.K. Department for International Development (DFID), the European Union (EU), the U.S. Agency for International Development (USAID), and the World Bank—have jointly developed the Common Narrative on Undernutrition to support advocacy efforts (SUN 2015).

It has been recognized that the Sixth Five Year Plan failed to sufficiently consider the multisectorality of nutrition. Consequently, the 2015 Bangladesh National Nutrition Policy reflects a strong multisectoral approach, involving appropriate line ministries to specifically target action areas within their purview. It also lays out clear objectives and strategies based on updated evidence for improving the nutrition status of all populations, particularly children, adolescent girls, pregnant women, and lactating mothers. The policy falls in line with relevant national policies in areas such as health, food, agriculture, environment, and education. As such, institutionalization of the National Nutrition Policy 2015 will require coordination from the BNNC on monitoring and accountability to ensure a multisectoral and multistakeholder approach to addressing both nutrition-specific and nutrition-sensitive programming.

Based on the commitment of the Government of Bangladesh and the BNNC, and on recent global experience and a greatly expanded evidence base, the government has undertaken the development of the NPAN2 for 2016–2025. Under the leadership of the BNNC and the Ministry of Health and Family Welfare, the plan's development has brought together all relevant sectors and includes contributions from all the stakeholder ministries, nongovernmental organizations (NGOs), development partners, and other stakeholders such as academic institutions and the private sector.

This report seeks to inform the development of the NPAN2 by estimating the costs of expanding the coverage of a set of high-impact nutrition interventions referred to in the key policy documents as *direct nutrition interventions* (see Part II for detailed descriptions). In addition to estimating these costs, it also aims to inform the prioritization of interventions within the NPAN2 by identifying the most cost-effective interventions and the most cost-effective geographic expansion scenarios.

PART II – METHODOLOGY

ESTIMATING UNIT COST OF DIRECT NUTRITION INTERVENTIONS IN BANGLADESH

The analysis focuses on 13 interventions based on the package identified in the 2013 *Lancet* series on Maternal and Child Malnutrition. Many of these interventions are included in the country's direct nutrition intervention package, and their expansion is planned under the Second National Plan of Action for Nutrition (NPAN2). Definition, scope, costed delivery platforms, and target populations for each intervention are described in Table 1.

Table 1: Description, Target Population, and Delivery Platforms of Direct Nutrition Interventions

Intervention	Description/Dosage	Target population	Costed delivery platform ^a	Expected Area of Impact
Iron and folic acid supplementation during pregnancy	Supplementation of 200 mg ferrous fumarate plus 400µg folic acid in one daily tablet during pregnancy	Pregnant women	Health facilities during antenatal and postnatal visits	Maternal anemia; maternal and child mortality
Calcium supplementation during pregnancy	Calcium supplementation of twice daily 500 g of calcium carbonate for 140 days during pregnancy	Pregnant women	Health facilities during antenatal visits	Maternal mortality
Promotion of optimum infant and young child feeding	Promotion of early initiation of breastfeeding; exclusive breastfeeding for 6 months; timely introduction of complementary food; age-appropriate quantity, frequency, and quality of complementary food; continued breastfeeding through two years of age; feeding during illness; and essential hygiene actions at key moments	Infants and children from conception up to two years old; mothers during pregnancy and lactation	Individual sessions mainstreamed through primary health care; group counselling sessions delivered through health sector	Child mortality and morbidity; stunting
Vitamin A supplementation for children	Twice yearly provision of vitamin A capsules to children 6–59 months through a National Vitamin A Campaign	Infants and children 6–59 months	National Vitamin A campaign	Child mortality and morbidity; stunting
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	For each episode of diarrhea, 10–14 day course of oral zinc (20g per day) with oral rehydration solution	All infants and children age 0–59 months experiencing acute diarrhea	Facility-based treatment	Child morbidity
Deworming of children	1 tablet of albendazole treatment given twice per year through the EPI outreach program	Children age 24–59 months	Semiannual distribution at EPI outreach centers	Child morbidity; child anemia
Provision of micronutrient powders to infants and young children	1 sachet daily of micronutrient powder containing 12.5 mg elemental iron, 300 µg retinol, including 0.16 mg folic acid and 30 mg vitamin C and 5 mg elemental zinc	Infants and young children age 6–23 months	Community-based outreach conducted by family welfare assistants	Child anemia

Intervention	Description/Dosage	Target population	Costed delivery platform ^a	Expected Area of Impact
Treatment of severe acute malnutrition	Treatment using therapeutic foods (RUTF), folate supplementation, and one course of wide-spectrum antibiotic, according to the national protocol	Children age 6–59 months diagnosed with severe acute malnutrition (WHZ <–3 SD)	Outpatient treatment	Child morbidity and mortality; wasting
Management of moderate acute malnutrition	Provision of fortified supplemental foods (wheat-soy blend) for approximately 75 days; 200 g per child per day.	Children age 6–59 months diagnosed with moderate acute malnutrition (–2 SD < WHZ <–3 SD)	Outpatient treatment	Child morbidity and mortality; wasting
Salt iodization	The current salt law mandates that 100% of salt must be iodized at a level of 45–50 parts per million (or 90 mg potassium iodate (KIO3) fortificant per 1 kg of salt)	General population, 100%	Open market	Child cognitive development; general population morbidity
Fortification of edible oil with vitamin A	Bangladesh mandates the fortification of all edible oil with vitamin A at a level of 20,000 IU vitamin A per kg	General population, 100%	Open market	Maternal morbidity; child mortality and morbidity; stunting
Rice fortification	Rice is fortified with vitamins A, B1, B2, and folic acid; and minerals zinc and iron	General population, 100%	Distributed through social safety net programs (Vulnerable Group Development and Vulnerable Group Feeding)	Maternal anemia; maternal mortality and morbidity; child mortality; anemia in women of reproductive age
Public provision of complementary food	Provision of SuperCereal Plus to children age 6–23 months (daily ration of 32.7 g/day for children 6–11 months and 63.4 g/day for children 12–23 months)	Children age 6–23 months living below the poverty line (food insecure)	Distributed through standalone social safety net programs (such as Vulnerable Group Development and Vulnerable Group Feeding) using NGO support	Child mortality and morbidity; stunting

Note: a For interventions that currently are not implemented at scale, the delivery platforms presented in this report are necessary to estimate potential program costs and should be considered only as programmatic examples. These platforms do not constitute recommendations, and dedicated stakeholder consultations are needed to weigh options and identify appropriate delivery platforms. EPI = Expanded Programme on Immunization; g = grams; IU = international units; kg = kilograms; mg = milligrams; µg = micrograms; NGO = nongovernmental organization; RUTF = ready-to-use therapeutic food; SD = standard deviations; WHZ = weight-for-height Z-score.

We have used two primary approaches to estimate the unit cost (cost per beneficiary) of the interventions: (1) the *program experience costing approach* and (2) *ingredients-based costing approach*. The program experience approach, employed in the *Scaling Up Nutrition* report (Horton et al. 2010), uses budgets or expenditure from real-life programs. Unit costs are approximated by dividing the total annual expenditure by the number of beneficiaries served in a given year. This approach generates unit cost data that capture all aspects of service delivery—including the costs of commodities, transportation and storage, personnel, training, supervision, monitoring and evaluation (M&E), relevant overhead, wastage, and so on for each intervention. In the ingredients-based approach, unit costs are estimated based on assumptions regarding the elements that should make up a specific intervention. This approach identifies the key components of an intervention (for example, the time of nursing staff, drugs, medical equipment, overhead costs), their unit prices, and quantities needed. Per beneficiary, the cost is calculated by multiplying the price and quantity needed of each component and then summing those across all components. Costs estimated using the ingredients-based approach are less realistic than those estimated using the program-experience approach because they do not take into account any inefficiencies or departures from the ideal service delivery model.

In this report, the program experience approach was used for programs where the budgets or expenditure reports for specific interventions were available and the costs for a given intervention could be isolated from the overall budget or report. For interventions where budgets were not available or for interventions which were part of larger integrated programs (for example, iron and folic acid supplementation during pregnancy), we used the ingredients-based approach. Table 2 provides a summary of the costing method used to estimate the unit cost for each intervention.

Table 2: Description, Target Population, and Delivery Platforms of Direct Nutrition Interventions

High-impact intervention	Current government practice	Costing method
Iron and folic acid supplementation during pregnancy	In place	Ingredients-based
Calcium supplementation during pregnancy	Not in place	Ingredients-based
Promotion of optimum infant and young child feeding	In place	Ingredients-based
Vitamin A supplementation for children	In place	Program experience ^a
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	In place	Ingredients-based
Deworming of children	In place	Ingredients-based
Provision of micronutrient powders to infants and young children	In place, select geographic locations	Ingredients-based
Management of moderate acute malnutrition	In place	Program experience
Treatment of severe acute malnutrition according to the national protocol	In place, select geographic locations	Program experience
Salt iodization	In place	Program experience

High-impact intervention	Current government practice	Costing method
Fortification of edible oil with vitamin A	In place	Program experience
Rice fortification	In place, not at scale	Program experience
Public provision of complementary food	Not in place	Program experience

Note: The program experience method was supplemented with ingredients-based approach elements to calculate human resource costs because the costs of personnel were not included in the National Nutrition Services budgets.

The estimated costs were estimated from the public health sector perspective and include the costs that will be borne by the public sector—the government—as well as other organizations (NGOs, UN family organizations) involved in the provision of nutrition services. Other budgetary line items in the NPAN2 cover overhead costs (for example, capacity development, M&E, policy development, advocacy); these costs are *not* added to our estimates. Furthermore, the calculated costs are reported in financial terms. They do not capture the full social resource requirements, such as the opportunity costs of the time committed by beneficiaries accessing the services. Finally, all costs were estimated as incremental cost of providing nutrition services using the existing public health delivery system and do not include the cost of the existing or new health infrastructure (e.g. health facilities) or systems needed to deliver the interventions. Detailed assumptions and data used to calculate the unit cost of each intervention are presented in Appendix C.

OVERARCHING ASSUMPTIONS ABOUT THE DELIVERY AND SCALE UP OF INTERVENTIONS

A number of assumptions are consistent across all interventions. Our assumptions are based on information provided by CMSD on transport costs (see Appendix A) and from the Ministry of Health and Family Welfare on personnel salaries (see Appendix B). Furthermore, we assume that the current/proposed delivery platform is effective and can reach 90% of the target population for all interventions.

Following the proposed timeframe of the NPAN2, we estimated the cost of expanding the coverage of the direct nutrition interventions in Bangladesh over the next 10 years. At the time of writing, the NPAN2 does not include a detailed results framework with annual intervention-specific target. Therefore, we assumed a linear scale-up of each intervention in 2025 from the current coverage to 90%. Table 3 lists the most recent baseline coverage data available together with data sources and the assumed endline coverage. Baseline coverage estimates for each intervention by division are included in Appendix D.

Table 3: Baseline and Endline Coverage of the Direct Nutrition Interventions: Indicators Used and Data Sources

Intervention	Baseline percent coverage	Endline percent coverage	Indicator used	Data source
Iron and folic acid supplementation during pregnancy	27.0%	90.0%	Percent of pregnant women who took iron	FSNSP 2014

			and folic acid during pregnancy	
Calcium supplementation during pregnancy	0.0%	90.0%	— (assumed 0%)	n.a.
Promotion of optimum infant and young child feeding: breastfeeding promotion	61.0%	90.0%	Percent of pregnant women with 4 or 4+ visits	BDHS 2014
Promotion of optimum infant and young child feeding: complementary feeding education	24.7%	90.0%	Percent of pregnant women with 4 or 4+ visits	BDHS 2014
Vitamin A supplementation for children	62.1%	90.0%	Percent of children receiving vitamin A supplementation in 6 months preceding survey	BDHS 2014
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	38.1%	90.0%	Percent of children under 5 with diarrhea treated with oral rehydration solution and zinc	BDHS 2014
Deworming of children	58.0%	90.0%	Percent of children 24–59 months receiving deworming tablets in 6 months prior to survey	FSNSP 2014
Management of moderate acute malnutrition	0.0%	90.0%	— (assumed 0%)	n.a.
Treatment of severe acute malnutrition	0.0%	90.0%	— (assumed 0%)	n.a.
Salt iodization (total)	54.3%	90.0%	Percent of households consuming iodized salt (15+ PPM)	MICS 2014
Fortification of edible oil with vitamin A	—	—	—	—
Rice fortification	1.0%	90.0%	— (assumed 0%)	n.a.
Public provision of complementary food	0.0%	90.0%	— (assumed 0%)	n.a.

Note: — = not available; FSNSP = National Food Security Nutritional Surveillance Project; n.a. = not applicable; PPM = parts per million.

The scale-up costs were estimated by multiplying the unit cost by the assumed coverage and the target population. The calculation can be summarized by the following equation:

$$TC_{iy} = UC_i * C_{iy} * TP_{iy}$$

where:

TC_{iy} = is the total cost for i in year y

UC_i = the unit cost for intervention i

C_{iy} = the assumed coverage for intervention i in year y

TP_{iy} = target population for intervention i in year y

We have assumed that the unit costs will remain constant over time and that they will not vary as the intervention coverage expands.

Annual population estimates, which incorporate population growth, were obtained from the UNDP World Population Prospects and from the most recent Bangladesh Census Bureau population projections (BBS 2015). All cost estimates are presented as 2015 USD. Annual estimates have not been adjusted for inflation.

PART III – RESULTS

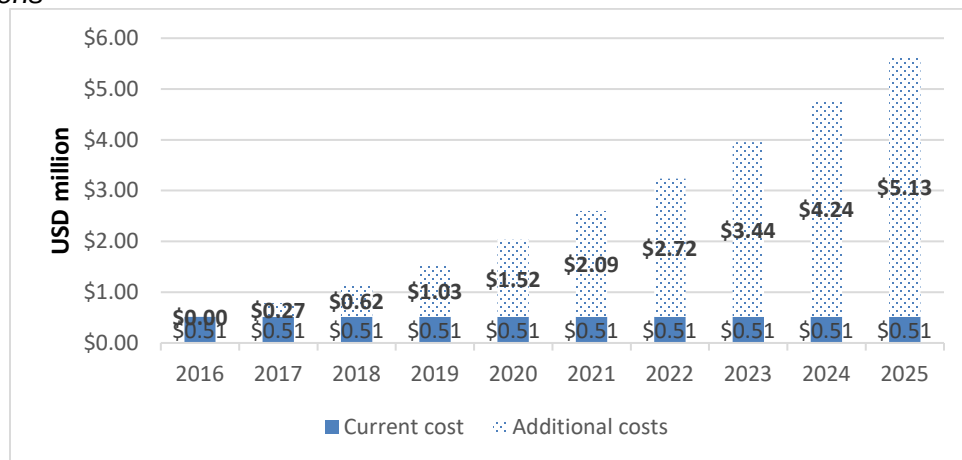
Part III presents the cost of maintaining the current coverage of the intervention as well as the additional cost of expanding the coverage during the 10-year period envisaged in the Second National Plan of Action for Nutrition (NPAN2).

COST BY INTERVENTION

Iron and Folic Acid Supplementation during Pregnancy

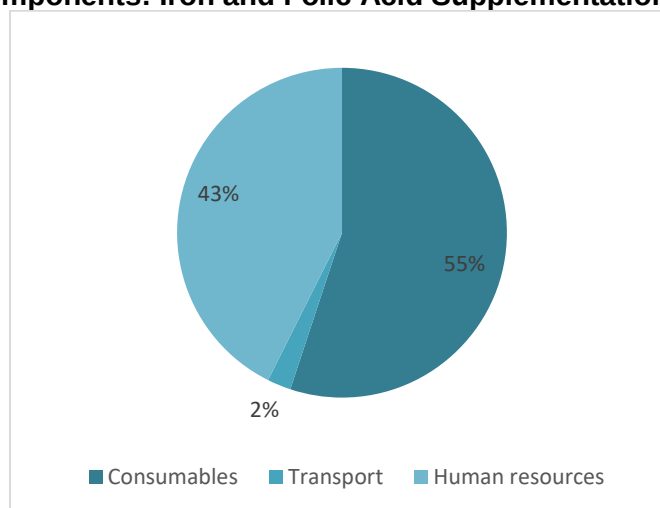
Applying estimated unit cost (USD 01.80 per beneficiary per year), we can estimate that maintaining the current coverage of iron and folic acid supplementation (27%) would cost about USD 0.5 million annually or about USD 5.1 million over the next decade (Figure 8). It needs to be emphasized that this is a rough approximation and should not be considered to be a rigorous estimate of the actual government expenditure. An additional USD 21 million would be needed to gradually expand the coverage so that 90% of pregnant women would be covered by 2025.

Figure 8: Annual Costs: Iron and Folic Acid Supplementation during Pregnancy
USD, millions



The cost of the supplement itself (200 milligrams of ferrous fumarate and 400 milligrams of folic acid) accounted for about 55% of the total cost (see Figure 9). Human resources (provider time) accounted for 43% of the costs. Transport cost (moving the supplement from a central warehouse in Dhaka to divisions and upazilas) accounted for the remaining 2%.

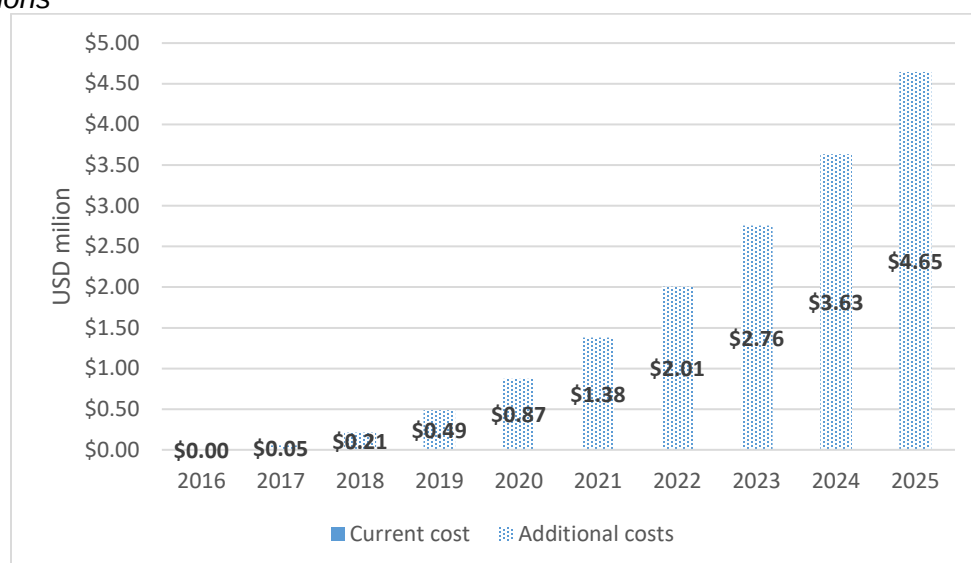
Figure 9: Cost Components: Iron and Folic Acid Supplementation during Pregnancy



Calcium Supplementation during Pregnancy

No data on the coverage of calcium supplementation in Bangladesh were available and it does not appear that significant numbers of women receive calcium on a routine basis as part of antenatal care. Therefore, we assumed that the current coverage of the intervention is 0. About USD 16 million will be required to expand the supplementation so that by 2025, 90% of pregnant women would receive calcium supplements (see Figure 10).

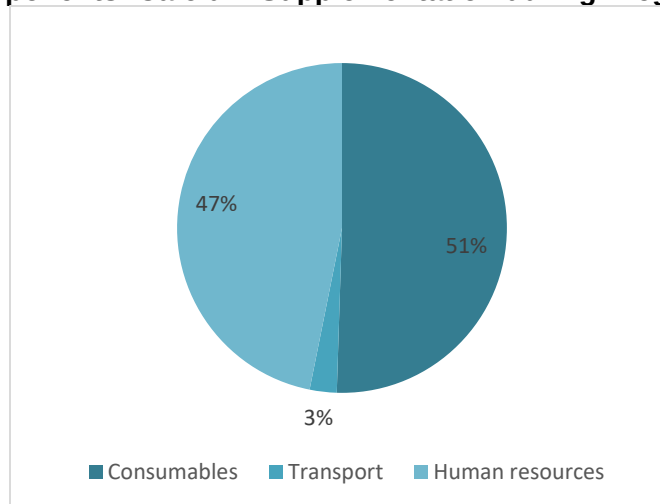
Figure 10: Annual Costs: Calcium Supplementation during Pregnancy
USD, millions



The cost of supplementing one woman during one pregnancy we estimated to be about USD 1.49. The cost of the supplement (calcium carbonate) accounted for about 51% of the total cost (see Figure 11). Human resources (provider time) accounted for 47% of the costs. Transport cost

(moving the supplement from a central warehouse in Dhaka to divisions and upazilas) accounted for the remaining 3%.

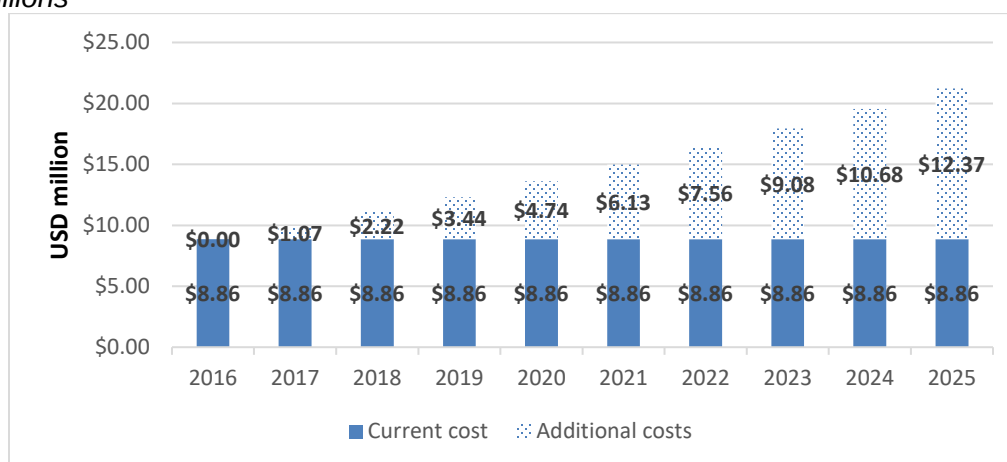
Figure 11: Cost Components: Calcium Supplementation during Pregnancy



Promotion of Optimum Infant and Young Child Feeding

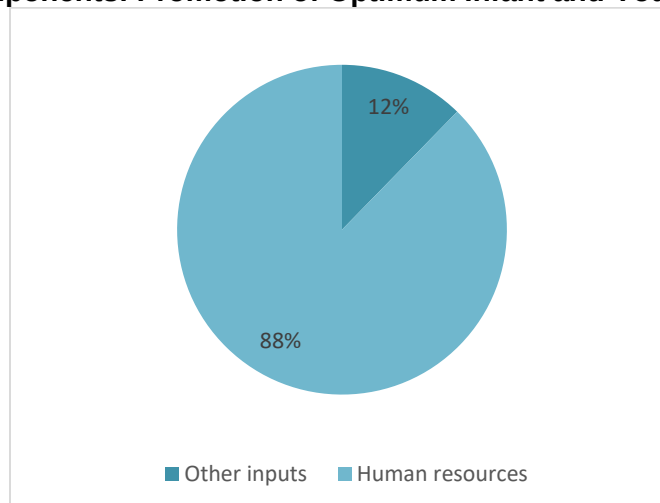
Figure 12 presents the estimated annual costs of maintaining the current level of coverage of infant and young child feeding counseling supplementation and of scaling it up gradually to 90%. Applying the estimated unit cost (USD 3.56 per beneficiary per year), we can estimate that maintaining the current coverage of infant and young child feeding (61% for breastfeeding counseling in pregnancy and in the first 6 months of a child's life and 24.7% for children older than 24 months) would cost about USD 8.9 million annually or about USD 88.6 over the next decade. It needs to be emphasized that this is a rough approximation and should not be considered a rigorous estimate of the actual government expenditure. An additional USD 57.3 million would be needed to gradually expand the infant and young child feeding coverage to 90% by 2025.

Figure 12: Annual Costs: Promotion of Optimum Infant and Young Child Feeding
USD, millions



Human resources (provider time) accounted for 88% of the cost (see Figure 13). Other inputs, including job aids for providers and growth monitoring equipment (height board, scales, growth monitoring cards) accounted for the remaining 12%.

Figure 13: Cost Components: Promotion of Optimum Infant and Young Child Feeding



Cost estimation for the promotion of optimum infant and young child feeding has several caveats. Reliable data of the coverage of the promotion of optimum infant and young child feeding currently does not exist. For breastfeeding counseling, the prevalence of exclusive breastfeeding for children age 0–5 months from the 2014 Bangladesh Demographic Health Survey (BDHS) was used as a very imperfect proxy of current coverage. Similarly, the percentage of women with at least four antenatal care visits from the 2014 National Food Security Nutritional Surveillance Project (FSNSP) was used as a proxy for the coverage of the breastfeeding promotion component of the infant and young child feeding. Given the challenges resulting from the lack of reliable data, the cost estimates for this intervention presented here, as well as impact estimates presented in the following sections, need to be interpreted with significant caution.

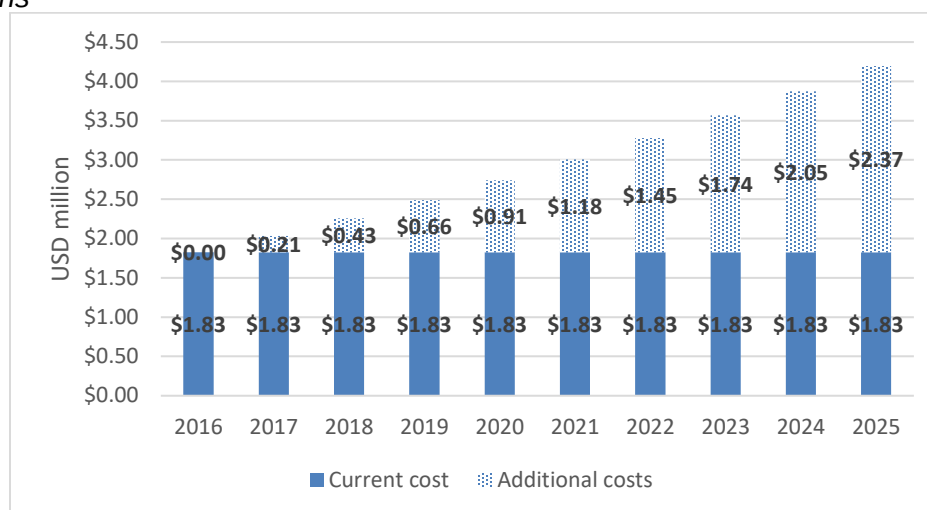
Vitamin A Supplementation for Children

Figure 14 presents the estimated 10-year cost of maintaining the current level of coverage of vitamin A supplementation and of scaling it up gradually to 90%. Applying the estimated unit cost (USD 0.35 per beneficiary per year), we can estimate that maintaining the current coverage of vitamin A supplementation (62.1%) would cost about USD 1.83 million annually or about 18.3 over the next decade.⁴ It needs to be emphasized that this is a rough cost estimate and should not be considered to be a rigorous estimate of the actual government expenditure on vitamin A supplementation. An additional USD 11 million would be needed to gradually expand the coverage so that 90% of children are reached by vitamin A supplementation campaigns by 2025.

Figure 14: Annual Costs: Vitamin A Supplementation for Children

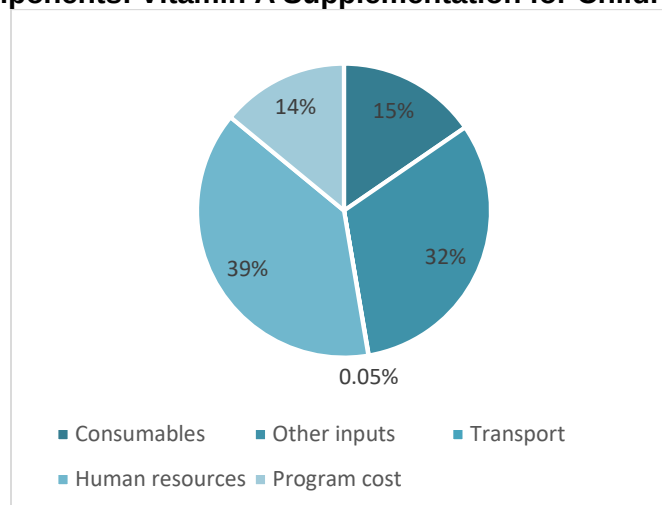
⁴ Because other key coverage indicators in this report come from the BDHS published in 2015, we are using the BDHS data for vitamin A coverage. However, as noted in the preceding section, there are concerns that the 2014 BDHS underestimates the coverage of vitamin A as a result of mothers' recall bias. The 2015 Expanded Programme on Immunization (EPI) coverage evaluation survey estimates that nationally about 79.6% of children age 6–11 months and 87.3% of children age 12–59 months received vitamin A capsules.

USD, millions



Human resources (health workers delivering the intervention) were the highest cost driver of this intervention (see Figure 15). About 39% of the estimated cost per beneficiary was attributable to human resources. Other program inputs—including patient registers, tally sheets, reporting sheets, field brochures, folders, flags and so forth—accounted for another 32% of the cost. Retinol capsules accounted for 15% of the total cost and program management (mostly supervision), accounted for another 14%. Transport cost (estimated only for retinol) accounted for only 0.05% of the total.

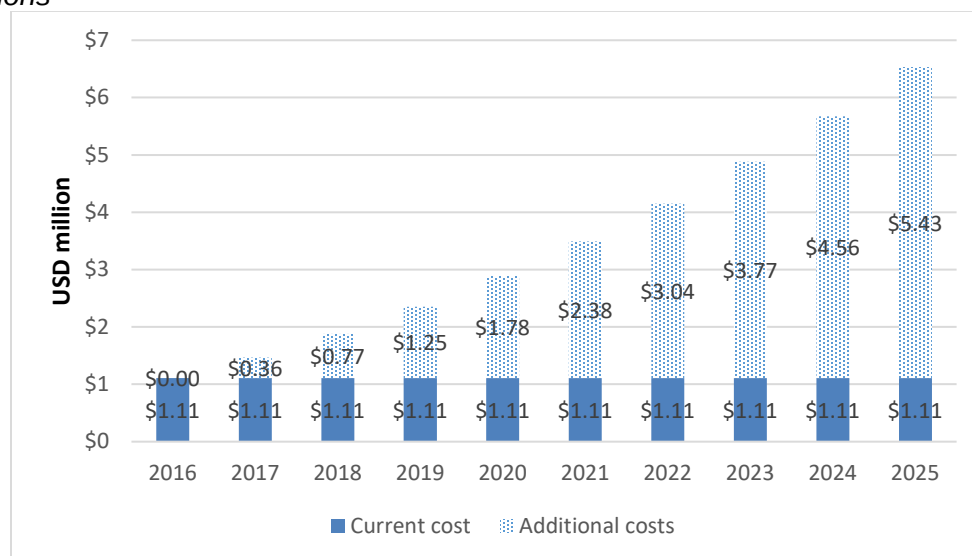
Figure 15: Cost Components: Vitamin A Supplementation for Children



Therapeutic Zinc and Oral Rehydration Solution for the Treatment of Diarrhea

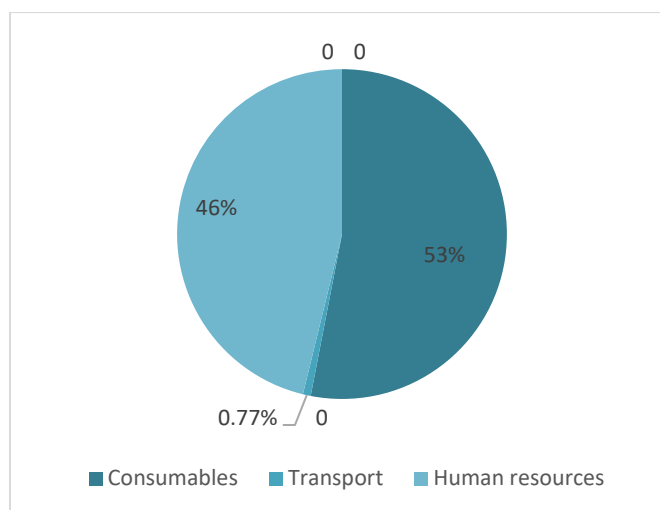
Applying estimated unit cost (USD 0.83 per beneficiary per year, given the assumption about diarrhea incidence described below), we can estimate that maintaining the current coverage of therapeutic zinc for the treatment of diarrhea (38.1%) would cost about USD 1.1 million annually or about USD 11.1 million over the next decade. An additional USD 23.3 million would be needed to gradually expand the coverage so that 90% of diarrhea cases in children under five could be treated by 2025 (see Figure 16).

Figure 16: Annual Costs: Therapeutic Zinc and Oral Rehydration Solution for the Treatment of Diarrhea
USD, millions



Consumables (Oral Rehydration Solution and zinc tables) account for about 53% of the total costs (see Figure 17). Human resources account for about 46% of the total costs and transportation cost for less than 1%.

Figure 17: Cost Components: Zinc and Oral Rehydration Solution for the Treatment of Diarrhea



The prevalence data used to calculate the scale-up cost of oral rehydration solution and therapeutic zinc supplementation was obtained from the 2014 BDHS. Because diarrhea prevalence and incidence vary significantly by season—with lower incidence and prevalence rates in the dry season and higher rates in the rainy season—there are concerns that, because the BDHS is conducted only in the dry season, these data may underestimate the average annual incidence and prevalence of diarrhea. Table 4 compares diarrhea prevalence (in the two weeks preceding data collection) from the 2014 BDHS and annual average diarrhea prevalence

calculated based on the 2013 FSNSP. FSNSP estimates are consistently and substantially higher than those from the DHS.

Table 4: Prevalence of Diarrhea in the Two Weeks Preceding Data Collection Based on BDHS 2014 and the FSNSP 2013

Division	BDHS (2014)	FSNSP (2013)
Barisal	6.5%	8%
Chittagong	6.7%	11%
Dhaka	6.5%	10%
Khulna	3.6%	8%
Rajshahi	4.3%	7%
Rangpur	2.7%	13%
Sylhet	6.1%	8%

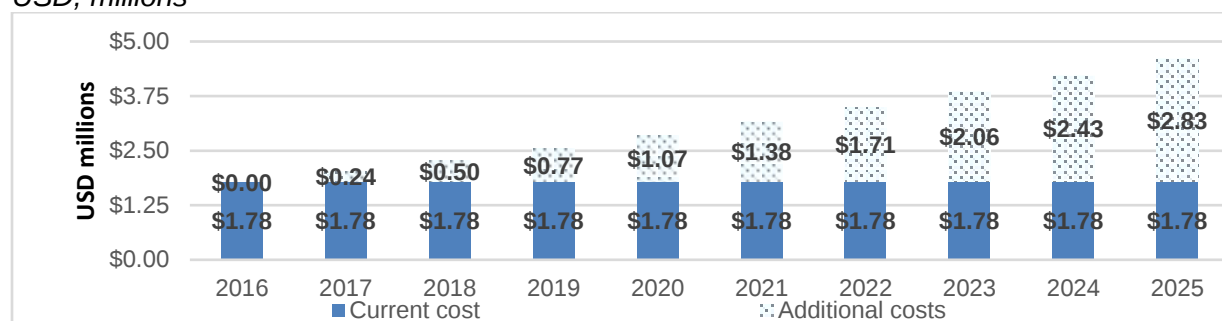
The cost estimates presented here are based on the BDHS because the survey is powered to produce nationally and regionally representative results. However, if the BDHS indeed underrepresents average annual diarrhea prevalence, which seems likely based on the comparison with the FSNP, the costs presented here are also underestimated.

Deworming of Children Age 24–59 Months

Figure 18 presents the estimated 10-year cost of maintaining the coverage of deworming at the current coverage level and of scaling it up gradually to 90%. Applying estimated unit cost (USD 0.38 per beneficiary per year), we can approximate that maintaining the current coverage of deworming (58%) would cost about USD 1.78 million annually or about USD 17.78 million over the next decade (note that, as mentioned above, annual estimates from 2016 through 20205 have not been adjusted for inflation). This is a very rough indicative estimate of the current spending, in particular because over the past two years deworming campaigns have been carried out only once a year in conjunction with immunization campaigns. Therefore, the service delivery modality costed here does not reflect current mode of delivery but rather the way delivery is envisioned under the NPAN2. An additional USD 13 million would be needed to gradually expand the coverage so that 90% of children are dewormed by 2025.

Figure 18: Annual Costs for Deworming of Children Age 24–58 Months

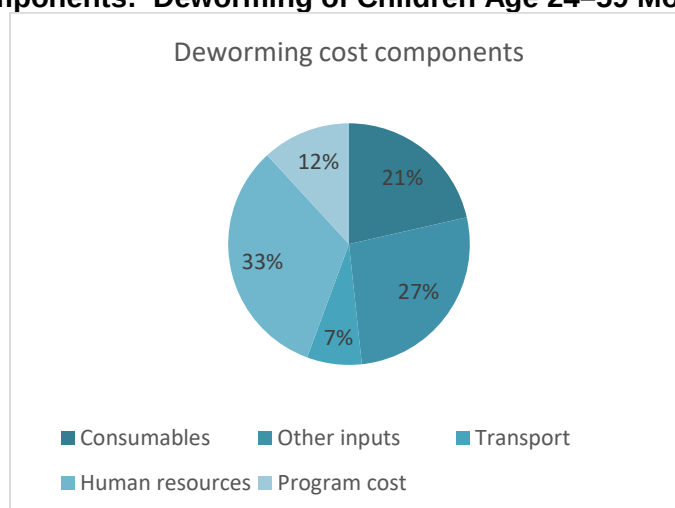
USD, millions



Human resources (health workers delivering the intervention) were the most significant cost driver of this intervention. About 33% of the estimated per-beneficiary cost was attributable to human resources (Figure 19). Albendazole tablets accounted for 21% of the total costs; program

management, mostly supervision costs, accounted for another 14%. Transport cost (estimated only for albendazole) accounted for about 7%.

Figure 19: Cost Components: Deworming of Children Age 24–59 Months

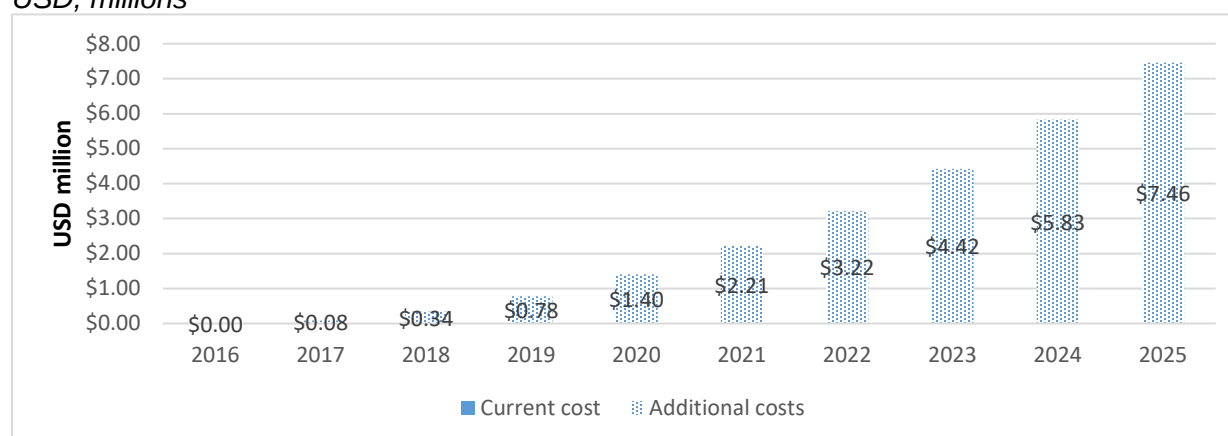


Management of Moderate Acute Malnutrition

Currently the coverage of the moderate acute malnutrition management program is minimal and was assumed to be zero. Expanding the coverage of this intervention so that, by 2025, 90% of children who suffer from moderate acute malnutrition could be treated would require about USD 26 million over the next decade (Figure 20). We assumed that the incidence of moderate acute malnutrition will remain constant over the next 10 years. If it declines, the program cost will also decline.

Figure 20: Annual Costs for the Management of Moderate Acute Malnutrition

USD, millions



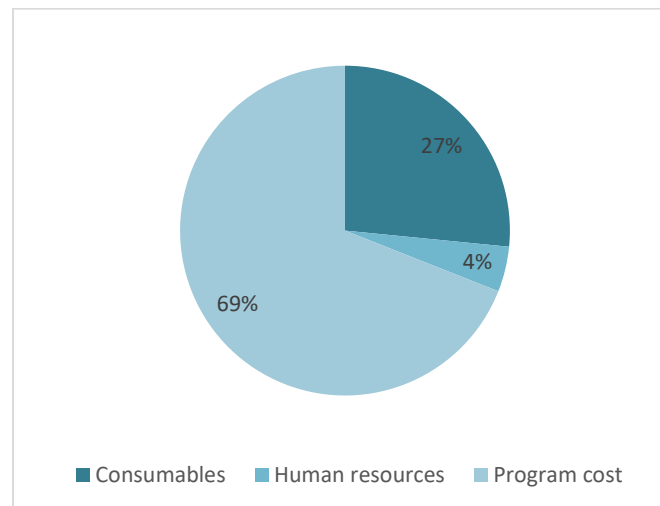
The cost of treating one case of moderate acute malnutrition was approximately USD 48. This included the cost of inputs (SuperCereal Plus and fortified edible oil). Unfortunately, the data collected could not be disaggregated of the total cost by cost component.

Treatment of Severe Acute Malnutrition According to the National Protocol

As noted in the previous section, currently severe acute malnutrition in Bangladesh is treated mostly in inpatient settings, even though a national protocol exists for outpatient treatment. In order to be consistent with the protocol and the expansion plans included in the NPAN2, the costs in this report were estimated for outpatient treatment. Unit cost estimates from Puett et al. (2010), inflated to 2015 values, were used to approximate the plausible costs of the future national-scale program. They are consistent in magnitude with the costs of outpatient programs in other countries (see, for example, Kakietek, Mehta, and Shekar 2016). However, these costs need to be interpreted with caution as a rough approximation.

The cost of treating one case of severe acute malnutrition was approximately USD 170. About 69% of that cost was for programmatic activities—mostly training and supervision (Figure 21; see also Puett et al. 2013). It needs to be noted that the intervention costed by Puett et al. was carried out by NGOs and, because it was a new program, it required significant investments in training, monitoring, and supervision. It is likely that those costs will decline in a large-scale national program implemented through the health system, where program management, training, and supervision can be streamlined with those of other interventions. Ready-to-use therapeutic foods accounted for about 27% of the costs and human resources (provider time) for about 4% of the total cost.

Figure 21: Cost Components: Treatment of Severe Acute Malnutrition According to the National Protocol



As noted above, the coverage of treatment of severe acute malnutrition is currently minimal and the baseline was assumed to be zero (Figure 22). An expansion of coverage to 90% by 2025 would require about USD 26 million over the next decade. This estimate is based on an assumption that the incidence of severe wasting will remain constant over the next 10 years. If it declines, the treatment cost will also decline.

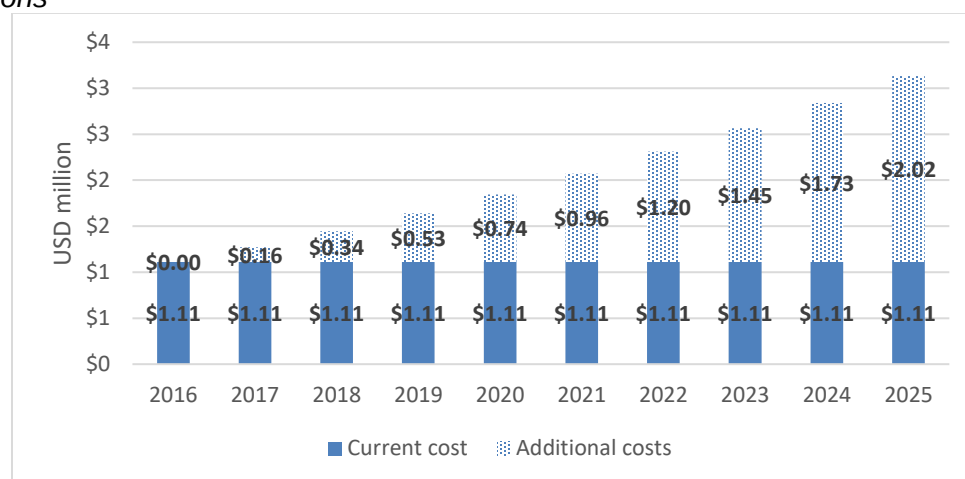
Figure 22: Annual Costs: Treatment of Severe Acute Malnutrition According to the National Protocol
USD, millions



Salt Iodization

Figure 23 presents the estimated 10-year public cost of maintaining the coverage of iodized salt at the current coverage level and of scaling it up gradually to 90%. Applying the estimated unit cost (USD 0.023 per consumer per year), we can estimate that maintaining the current coverage (54.3%) would cost about USD 1.1 million annually or about USD 11.1 million over the next decade). An additional USD 9.1 million would be needed to gradually expand the coverage so that 90% of the population in Bangladesh consumed iodized salt by 2025.

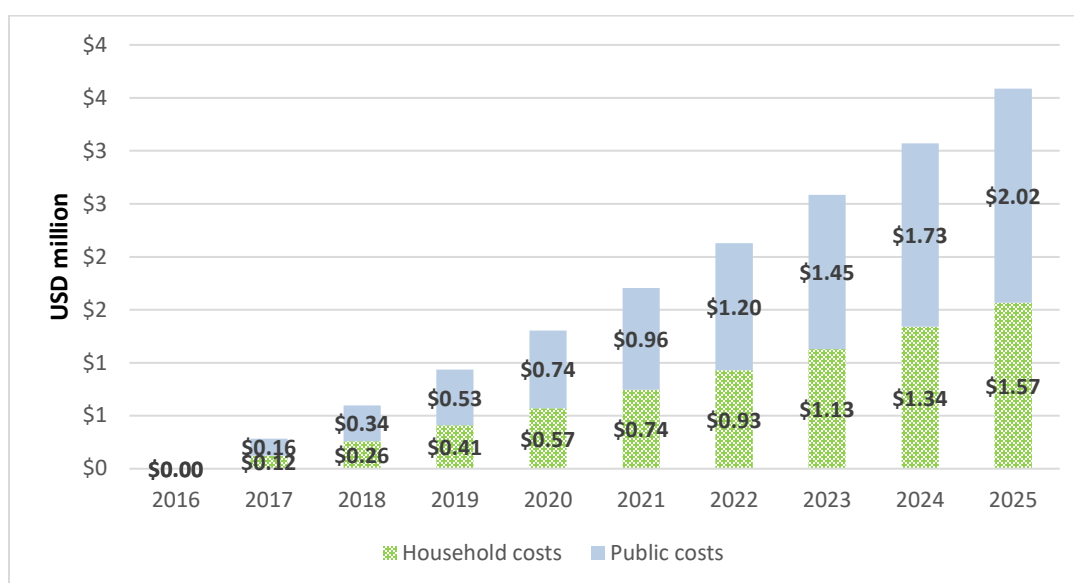
Figure 23: Annual Public Sector Costs: Salt Iodization
USD, millions



Similar to rice fortification, the cost of salt iodization consists of two main components: the program management cost (58% of the total costs) and the cost of the premix (42% of the total costs), which is assumed to be incurred by the producers and then passed on to the consumers. Program management costs include the waiving of the value added tax (VAT) and duty (about 26% of the total public costs), information and education campaigns (about 7%), human resources (about 4%), quality control and validation (about 6%), and other program management costs (62%).

Figure 24 presents the additional private and public costs needed to expand the coverage of iodized salt to 90% of the population. Over the next 10 years, in addition to the USD 9.12 million from the public sector, the expansion would require about USD 7.1 million incurred by the producers and passed on to the consumers.

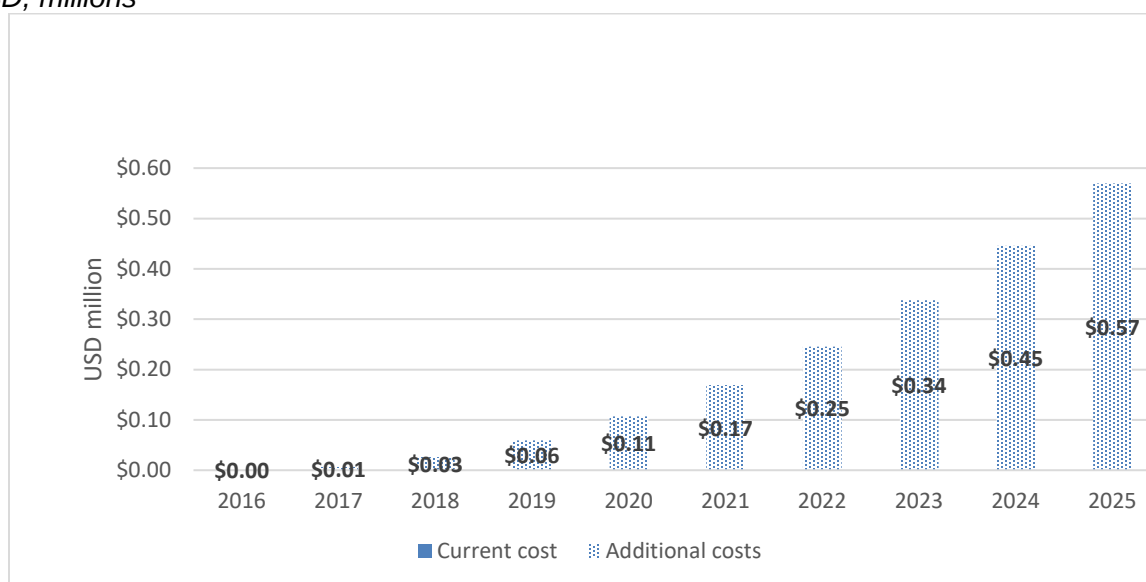
Figure 24: Annual Incremental Costs Covered by the Public Sector and by the Households: Salt Iodization
USD, millions



Fortification of Edible Oil with Vitamin A

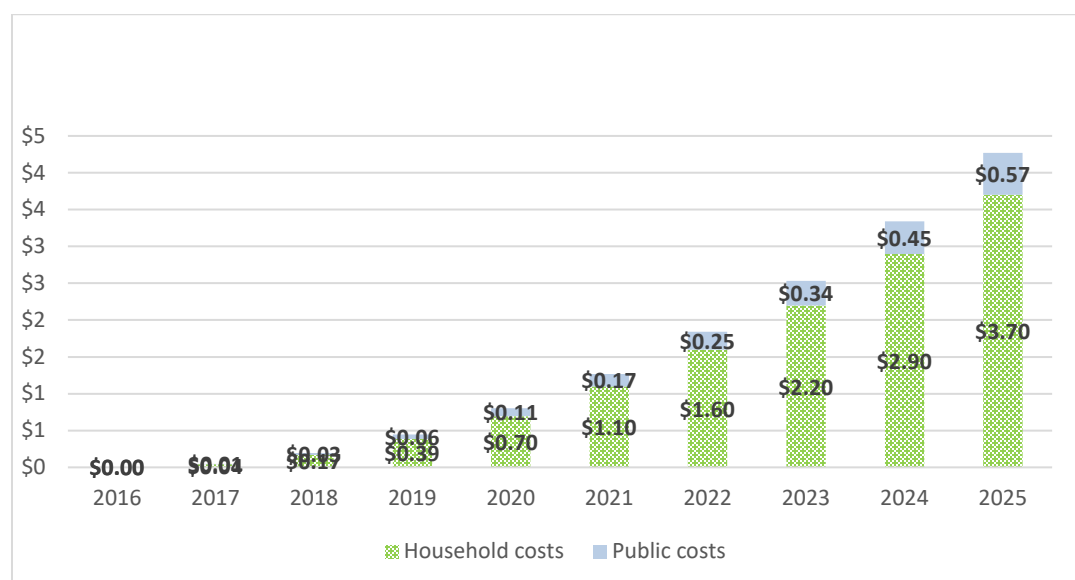
Figure 25 presents the estimated 10-year public cost of expanding the coverage of fortification of edible oil with vitamin A. No estimates regarding the percentage of the population consuming fortified oil in Bangladesh were available, but anecdotal evidence suggests that it is very low. Therefore, we assumed that the current coverage of this intervention is 0. Expanding the coverage of fortification so that it covers 90% of the population would, over 10 years, require about USD 2 million from public sources.

Figure 25: Annual Public Sector Costs: Fortification of Edible Oil
USD, millions



Like the two other fortification interventions, the cost of fortifying edible oil consists of two main components: program management cost (13% of the total cost) and the cost of premix, capital investment, and internal quality control (87% of the total costs), which is assumed to be incurred by the producers and then passed on to the consumers. In addition to the costs borne by the public sector, over the next 10 years about USD 12.8 million would be passed on to the consumers (about USD 0.26 per person per year; see Figure 26).

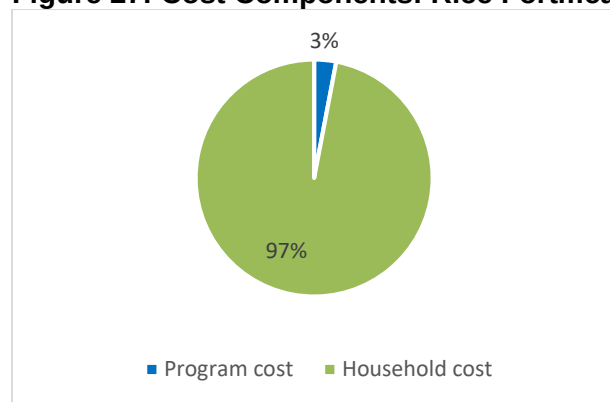
Figure 26: Annual Incremental Costs Covered by the Public Sector and by the Households: Fortification of Edible Oil



Rice Fortification

The annual per-person cost of rice fortification was estimated to be about USD 5.07. This cost consists of four main cost components: premix, premix duty and tax, quality control, and capital investment and recurrent cost. Premix cost accounted for about 70% of the total cost, capital investment and other recurrent costs for about 27% of the cost, quality control for about 2%, and premix duty and tax for about 1% (see Figure 27). The cost of quality control is borne by the government. We also assumed that the government would waive the premix duty and tax. This loss of government revenue would count as an additional (opportunity) cost to be borne by the government. In total, the public sector would bear about 3% of the cost (USD 0.15 per person per year). The costs of premix, capital investment, and recurrent costs were assumed to be incurred by the industry and then passed on to the consumer as increases in rice prices. Fortification would then translate into a 5% increase in the current retail price of 1 kilogram of rice.

Figure 27: Cost Components: Rice Fortification



WFP estimates that currently only about 1% of rice consumed in Bangladesh is fortified (personal communication). Over 10 years, the estimated public cost of rice fortification (the cost of quality control and waiving duties and tax on fortificant) would be about USD 74 million (see Figure 28).

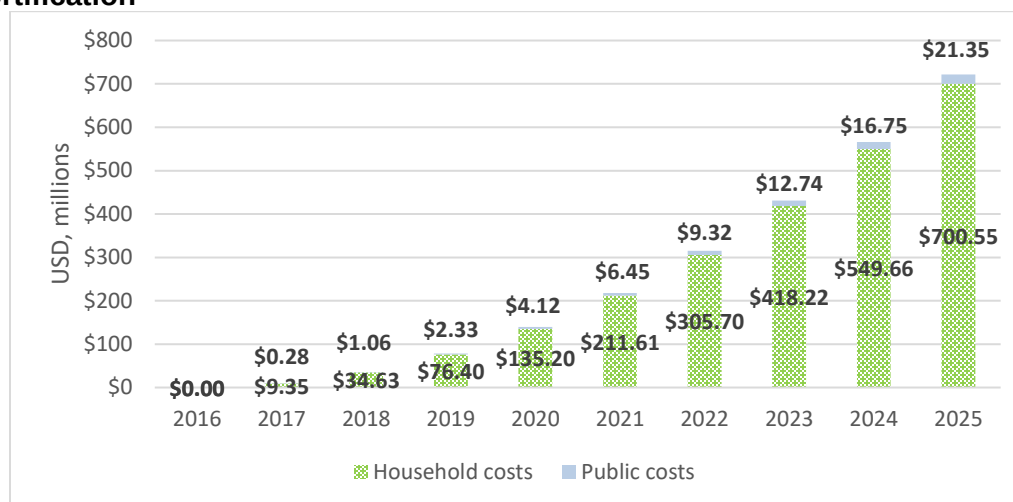
Figure 28: Annual Public Sector Costs: Rice Fortification

USD, millions



In addition to the costs borne by the public sector, over the next 10 years about USD 2.4 billion would be passed on to the consumers (about USD 5 per person per year; see Figure 29). This figure assumes no public subsidies for rice beyond the waiving of the fortificant tax and duty.

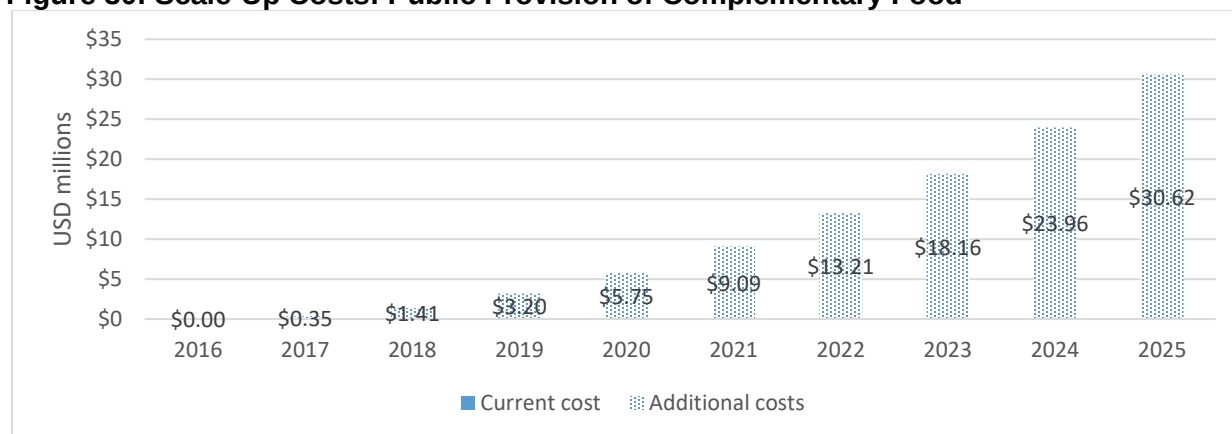
Figure 29: Annual Incremental Costs Covered by the Public Sector and by the Households: Rice Fortification



Public Provision of Complementary Food

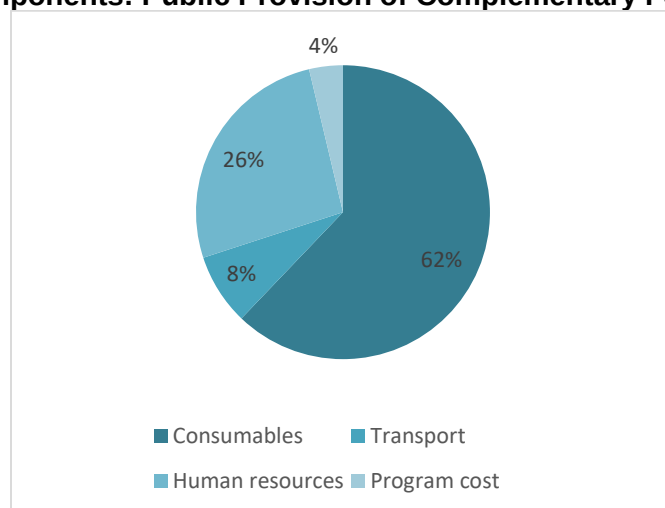
Currently, no large-scale public provision of complementary food exists in Bangladesh. Under the assumptions outlined above and in the preceding section, the introduction of such a program and an expansion of coverage to 90% by 2025 would require about USD 106 million over the next decade (Figure 30).

Figure 30: Scale-Up Costs: Public Provision of Complementary Food



Consumables—that is supplemental food—were the most significant cost driver of this intervention. About 62% of the estimated per-beneficiary cost was attributable to consumables (Figure 31). Human resources accounted for 26% of the total cost, transport accounted for about 8%, and program management for about 4%.

Figure 31: Cost Components: Public Provision of Complementary Food



TOTAL COSTS

The total private (household) and public costs of scaling up the direct nutrition interventions over the next 10 years is estimated to be about USD 3 billion. About USD 2.8 billion are incremental costs—that is, costs needed to expand the coverage from the current baseline level to 90%. Almost 86% of the total costs and over 82% of the incremental costs would be borne by the household (the costs of fortification of rice and edible oil and salt iodization are passed on to consumers; see Table 5).

Table 5: Total and Incremental Costs Borne by the Public Sector and by Households

Cost type	Incremental		Total	
	USD billions	Percent	USD billions	Percent
Public and private costs combined	USD 2,846.0	100.0%	USD 3,007.4	100.0%
Private costs	USD 2,461.2	86.5%	USD 2,470.6	82.1%
Public sector costs only	USD 384.8	13.5%	USD 536.9	17.9%

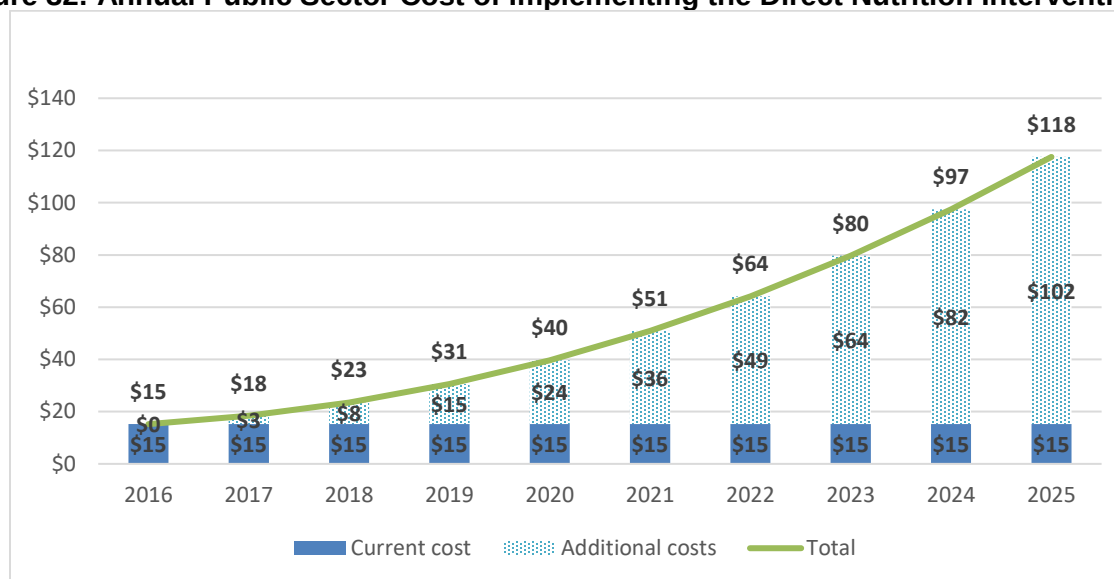
The focus of this report is to estimate the cost of implementing high-impact nutrition interventions in Bangladesh from the health system/public sector perspective. Therefore, in what follows, we present the total and incremental costs borne by the public sector. However, it needs to be noted that the household costs account for a very substantial portion of the implementation cost.

Table 6 presents the (public sector) costs by intervention. The total public-sector costs over 10 years would be about USD 536.9 million. About USD 384.8 million would be needed to expand the current coverage to reach 90% of the target group for each intervention by 2025.

Table 6: Total and Incremental Costs Borne by the Public Sector

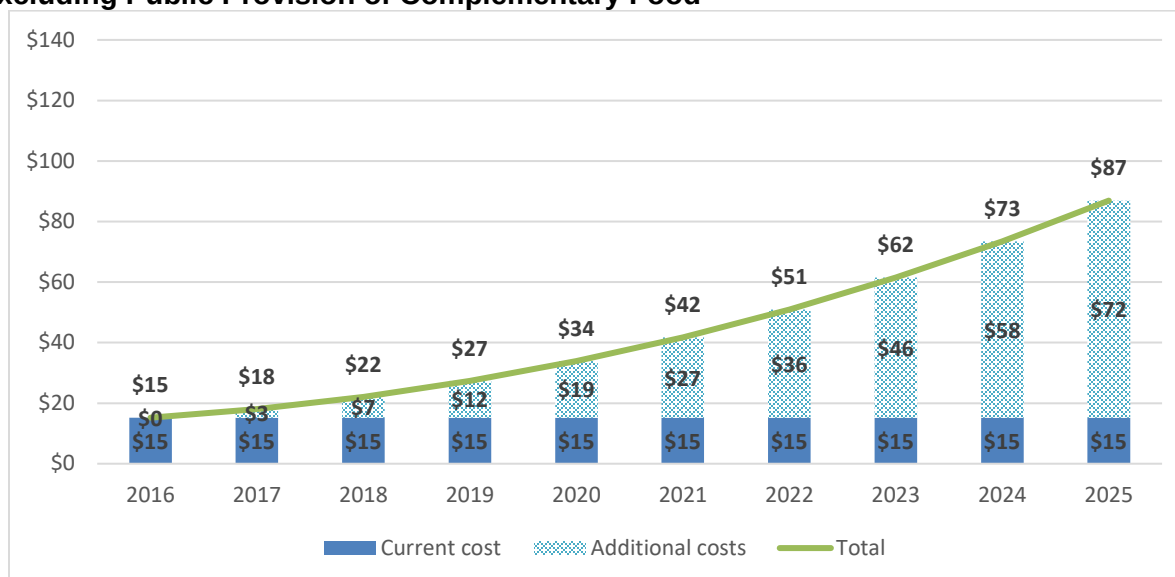
Intervention	Incremental		Total	
	USD millions	Percent	USD millions	Percent
Iron and folic acid supplementation during pregnancy	USD 21.1	5.5%	USD 26.2	4.9%
Breastfeeding counseling	USD 30.1	7.8%	USD 76.6	14.3%
Complementary feeding education	USD 27.2	7.1%	USD 69.4	12.9%
<i>Promotion of optimum infant and young child feeding (total cost)</i>	<i>57.3%</i>	<i>14.9%</i>	<i>USD 146.0</i>	<i>17.2%</i>
Vitamin A supplementation for children	USD 11.0	2.9%	USD 29.3	5.5%
Deworming of children age 24–59 months	USD 13.0	3.4%	USD 30.8	5.7%
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	USD 23.3	6.1%	USD 34.4	6.4%
Treatment of severe acute malnutrition	USD 26.1	6.8%	USD 26.1	4.9%
Public provision of complementary food	USD 105.7	27.5%	USD 105.7	19.7%
Rice fortification (public costs only)	USD 74.4	19.3%	USD 74.4	13.9%
Salt iodization (public costs only)	USD 9.1	2.4%	USD 20.2	3.8%
Calcium supplementation during pregnancy	USD 16.0	4.2%	USD 16.0	3.0%
Management of moderate acute malnutrition	USD 25.7	6.7%	USD 25.7	4.8%
Edible oil fortification (public costs only)	USD 2.0	0.5%	USD 2.0	0.4%
Total	USD 384.8		USD 536.9	

Figure 32: Annual Public Sector Cost of Implementing the Direct Nutrition Interventions



The cost of the public provision of complementary food for children age 6–24 months living under the poverty line—USD 105.7 million—accounts for about 20% of the total cost and over 27% of the incremental costs of scaling up direct nutrition interventions (Figure 32). The total cost of the remaining interventions is about USD 431 million; the incremental cost is USD 279 million. Public provision of complementary food is not currently implemented in Bangladesh on a large scale. Figure 33 shows annual public-sector costs of implementing all high-impact interventions excluding the public provision of complementary food.

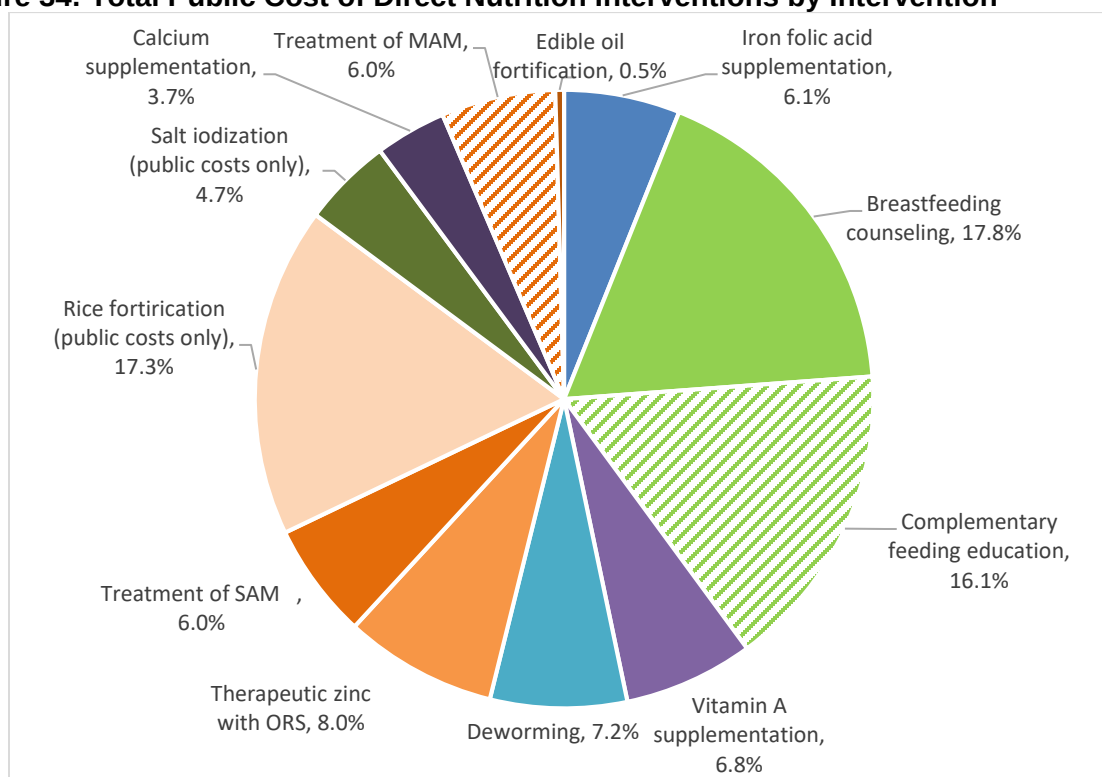
Figure 33: Annual Public-Sector Cost of Implementing High-Impact Interventions Excluding Public Provision of Complementary Food



When excluding the public provision of complementary food, promotion of optimum infant and young child feeding—including breastfeeding promotion and complementary feeding education—

accounts for the greatest percentage of the total cost (about 34%), the public cost of rice fortification accounts for about 17%; therapeutic zinc and oral rehydration solution for the treatment of diarrhea accounts for about 8% of the subtotal; vitamin A supplementation for children and deworming of children would each account for about 7% of the subtotal; treatment of severe acute malnutrition, iron and folic acid supplementation, and the management of moderate acute malnutrition would each account for about 6%; public sector costs of salt iodization for about 5%; and calcium supplementation during pregnancy for the remaining 4% of the subtotal (see Figure 34).

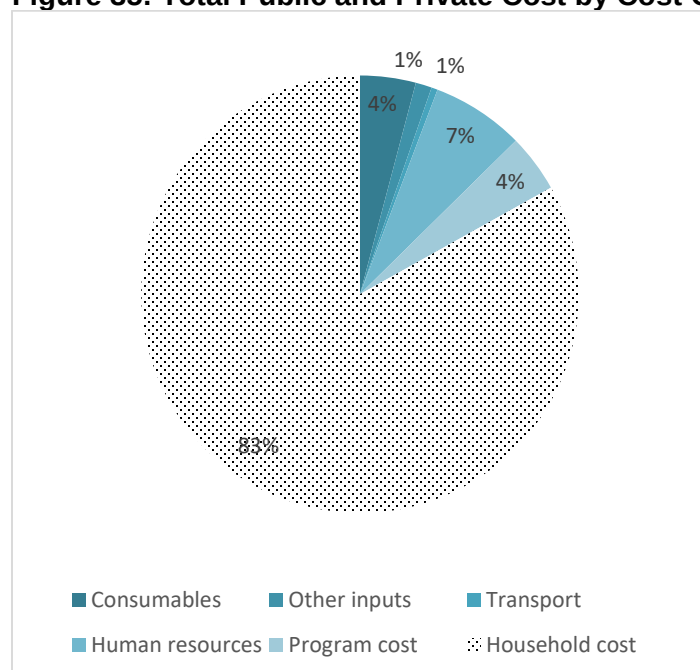
Figure 34: Total Public Cost of Direct Nutrition Interventions by Intervention



Cost by Cost Component: Public and Private

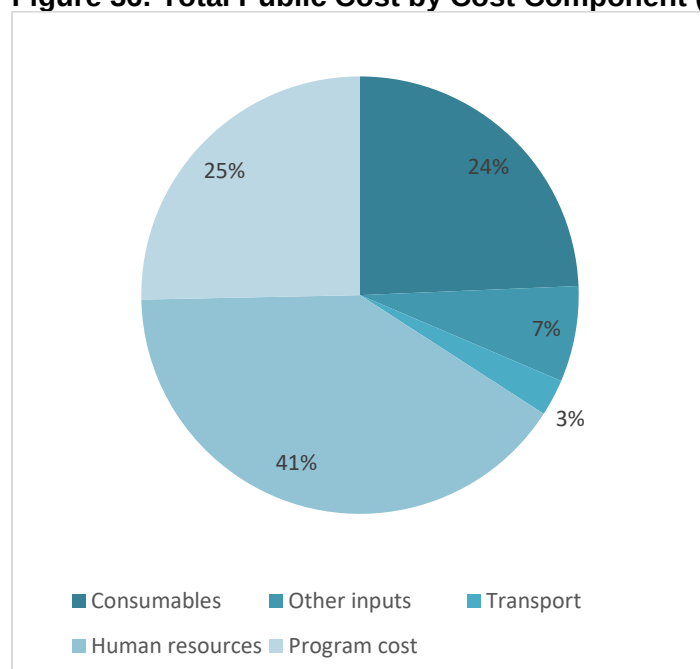
Figure 35 shows the proportion of the total (public plus private) cost by cost component. The cost of rice fortification and salt iodization borne by households account for about 83% of the total costs. The cost borne by the public-sector accounts for the remaining 17% of the cost of scaling up the direct nutrition interventions.

Figure 35: Total Public and Private Cost by Cost Component



Within the public sector costs, human resources account for about 41% of the total; consumables—mostly nutrition supplements and therapeutic and supplemental food—account for 24% of the total costs; program management, including supervision and M&E, account for 25%, equipment and other inputs account for about 7%, and transport for about 3% of the total cost (see Figure 36).

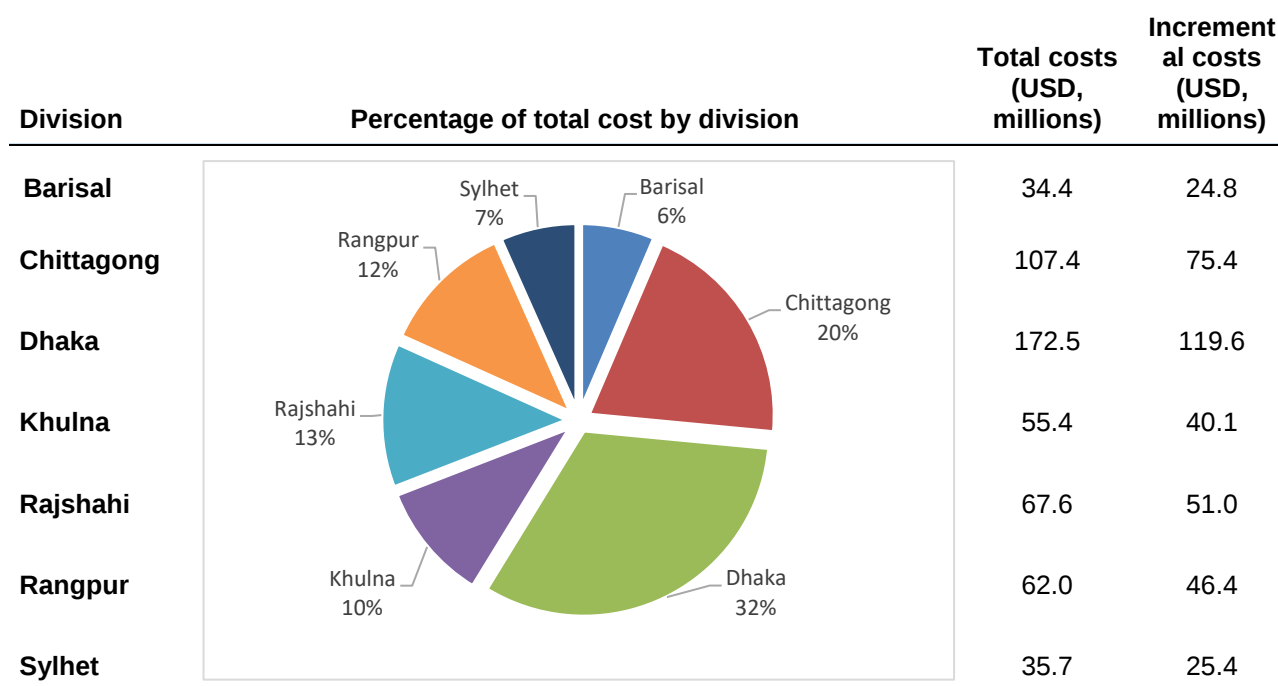
Figure 36: Total Public Cost by Cost Component (Excluding Costs Borne by Households)



Cost by Division

Implementing the package of high-impact intervention would require the greatest financial commitment in the Dhaka Division (about 32% of the total cost; see Figure 37). This is because Dhaka is the largest and the most populous division and the greatest number of intervention beneficiaries reside in that division. Implementation of the interventions in Chittagong would account for additional 20% of the total costs. The other five divisions would account for the remaining 48% of the costs. Annual costs by intervention and by division are included in Appendix E.

Figure 37: Total Cost by Division



PRIORITIZATION AND COST-EFFECTIVENESS ANALYSIS

We estimated the impact of expanding the coverage of the direct nutrition interventions on health and nutrition outcomes of children under age five. The projected number of lives saved and cases of childhood stunting averted were calculated using the Lives Saved Tool (LiST), which translates changes in the coverage of the interventions into estimates of morbidity and mortality reduction and changes in the prevalence of under-five stunting. LiST allows for modeling only of the scale-up of the interventions—that is, incremental changes in mortality, morbidity, and nutrition status of children under age five as the coverage of the interventions increases⁵. One limitation of LiST

⁵ LiST uses parameter estimates based on meta-analyses and systematic literature reviews to estimate the impact of changes in the coverage of interventions on multiple risk factors and dimension of child and maternal mortality and morbidity (e.g. disease-specific morbidity and mortality, prevalence of specific diseases, number of children and women affected by specific conditions, etc.), including nutrition status.

is that it does not permit estimating the annual impact and benefit resulting from the current coverage of the interventions. Therefore this section focuses only on the cost, impact, and benefits of *expanding* the current coverage.

Estimates of reductions in morbidity and mortality were used to calculate disability-adjusted life years (DALYs) averted. DALYs are a measure that combines mortality and morbidity, and therefore allow comparisons of the impact of interventions affecting different conditions (for example, stunting and wasting). The methodology used to calculate DALYs is described in Appendix F. The cost per DALY averted was used to assess the cost-effectiveness of the package of interventions and to compare their cost-effectiveness, as employed by Black et al. (2008). The method uses population attributable fractions (PAF) based on the comparative risk assessment project (Ezzati et al. 2002; Ezzati et al. 2004) to estimate the burden of infectious diseases attributable to different forms of undernutrition using most recent *Global Burden of Disease Study* (IHME 2010). DALY estimates in this study are neither discounted nor age-weighted, in line with the methodology used in the *Global Burden of Disease Study* and the *WHO Global Health Estimates* (2012).

In addition to the cost per DALY averted, we also calculated the cost per case of stunting averted to assess which of the interventions are most cost-effective for preventing stunting, and the cost per death averted to assess which interventions are most effective for reducing child mortality.

Prioritization analysis was conducted in two primary ways. First, we estimated cost per outcome for each intervention to examine their comparative cost-effectiveness and inform potential prioritization by interventions. Second, we estimated the cost per outcome of implementing the full package of the direct nutrition interventions for each of the divisions in Bangladesh. This analysis sought to identify the divisions in which the scale up would be the most cost effective to inform potential geographic prioritization.

It was not possible to estimate DALYs or lives saved for iron and folic acid supplementation, calcium supplementation, fortification of edible oil, or salt iodization because those interventions do not affect child mortality or morbidity directly. Iron and folic acid supplementation and calcium supplementation affect maternal morbidity, which is not directly modeled in LiST. The greatest impact of salt iodization is through the reduction of cognitive deficits—not child mortality or morbidity.

While we could not estimate the impact of salt iodization on mortality, morbidity, or DALYs averted, we did include its impact on reducing cognitive impairment in the estimation of economic benefits (see below). Finally, fortification of edible oil is not included in LiST and it was not possible to estimate its impact on mortality, morbidity, or to calculate the economic benefits associated with that intervention.

More information on model parameters can be found in the LiST/OneHealth manual under the following link:

<https://spectrummodel.zendesk.com/hc/en-us/articles/216764768-OneHealth-Tool-manual>

In addition, pathways linking interventions, risk factors, and health and nutrition outcomes in the LiST model, including the sources of model parameters, can be examined using the LiST visualizer available here: <http://listvisualizer.org/>

Results

Expanding coverage of the key direct nutrition interventions in Bangladesh from the current baseline coverage levels to 90% over the next 10 years results in averting almost 50,000 deaths and over 860,000 DALYs and preventing over 500,000 cases of stunting in children under five (see Table 7). Averting one death would cost about USD 7,700; averting one DALY, about USD 447, and preventing once case of stunting, about USD 765.

Table 7: Incremental Costs, Deaths, Cases of Stunting, and DALYs Averted, and Cost per Death, Case of Stunting, and DALY averted, by Region

Intervention	Total cost	Deaths averted (in 0–59 mo)	Cases of stunting averted	DALYs averted	Cost per death averted	Cost per case of stunting averted	Cost per DALY averted
Iron and folic acid supplementation during pregnancy	\$21,063,918	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Breastfeeding counseling	\$30,066,623	8,951	29,727	152,484	\$3,359	\$1,011	\$197
Complementary feeding education	\$27,242,400	511	127,153	8,845	\$53,282	\$214	\$3,080
<i>Infant and young child feeding package jointly</i>	\$57,309,022	9,462	156,880	161,330	\$6,057	\$365	\$355
Vitamin A supplementation for children	\$11,000,859	707	259	16,229	\$15,560	\$42,462	\$678
Deworming of children	\$12,984,402	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	\$23,339,193	3,560	n.a.	81,617	\$6,556	n.a.	\$286
Treatment of severe acute malnutrition	\$26,077,073	10,622	n.a.	186,757	\$2,455	n.a.	\$140
Public provision of complementary food	\$105,740,020	4,150	381,040	71,792	\$25,481	\$278	\$1,473
Rice fortification (public costs)	\$74,391,248	12,183	n.a.	188,218	\$6,106	n.a.	\$395
Salt iodization	\$9,119,778	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Calcium supplementation during pregnancy	\$16,043,639	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Management of moderate acute malnutrition	\$25,749,155	9,105	n.a.	155,071	\$2,828	n.a.	\$166
Edible oil fortification	\$1,966,264	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total	\$384,784,572	49,789	502,957	861,014	\$7,728	\$765	\$447

Note: n.a. = not applicable.

The WHO has set standard willingness-to-pay thresholds for determining the cost-effectiveness of health programs and interventions that are based on DALYs (WHO 2014a). Specifically, interventions and programs with a cost per DALY lower than the gross national income (GNI) per capita are considered to be very cost-effective. Interventions and programs with a cost per DALY between one and three times GNI per capita are considered to be cost-effective. Interventions and programs whose cost per DALY exceeds three times per capita GNI are considered not to be cost-effective.

Over 10 years, the implementation of the full package of the interventions over 10 years would avert over 860,000 DALYs. The cost per DALY averted is about USD 447—much lower than the Bangladesh GNI per capita of USD 1,211. Therefore, based on the WHO thresholds, the expansion of the full package of direct nutrition interventions can be considered very cost-effective.

Each of individual interventions included in the package is also very cost effective with cost per DALY averted lower than the per capita GNI with treatment of severe acute malnutrition, management of moderate acute malnutrition, and breastfeeding promotion showing the lowest cost per DALY averted (USD 140, USD 166, and USD 197, respectively). There are two exceptions: complementary feeding education and the public provision of complementary food. The cost per DALY averted for complementary feeding education is about USD 3,000 (about 2.8 times higher than the per capita GNI). This is because this intervention has a very high impact on stunting prevalence but, unlike other interventions included in the package, relatively low impact on child mortality. Nevertheless, it is still considered cost-effective based on the WHO criteria of cost-effectiveness. Furthermore, complementary feeding education is usually delivered as part of the infant and young child feeding package, together with breastfeeding promotion and hygiene counseling. When considered together, the infant and young child feeding package is not only very cost-effective based on the WHO criteria (cost per DALY averted is about USD 680), but it also saves more lives and prevents more cases of stunting than any other intervention. The public provision of complementary food—an intervention that is not currently implemented in Bangladesh—would be cost-effective (but not very cost-effective). The cost per DALY averted—USD 1,473—exceeds the WHO threshold of one time GNI per capita set for very cost-effective interventions but is below three times the GNI threshold, which means that this intervention can still be considered cost-effective.

When considering averting mortality in children under age five, the treatment of severe and moderate acute malnutrition are the most cost-effective interventions. Averting one death through severe acute malnutrition treatment costs about USD 2,500 and averting one death through treatment of moderate acute malnutrition costs about USD 2,800. Breastfeeding promotion is slightly less cost-effective, with cost per death averted of about USD 3,400.

When considering stunting reduction, infant and young child feeding counseling is the most cost-effective intervention, with a cost of USD 365 per case of stunting averted. Within the infant and young child feeding package, complementary feeding education is more cost-effective than breastfeeding promotion (USD 214 and USD 1,011 per case of stunting averted). Since both of those interventions are delivered as part of the same intervention package, considering them separately is not very informative programmatically. Nevertheless, the findings emphasize the importance of the complementary feeding counseling components of the infant and young child feeding package and of identifying health sector contact points for children to ensure the high quality of service delivery.

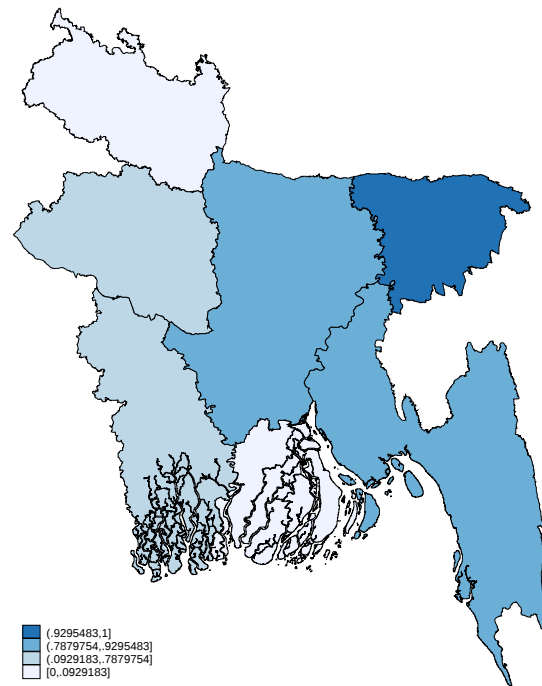
Table 8 compares the cost-effectiveness of expanding the coverage of the interventions in different divisions of Bangladesh. The results of the analyses show that the greatest number of deaths, cases of stunting, and DALYS would be averted in Dhaka and Chittagong. This is not surprising, given that these are the two most populous divisions (33% and 20% of the total population, respectively, live in those two divisions). Conversely, the lowest number of deaths and cases of stunting would be prevented in Barisal—the division with the smallest population (6% of the total population).

Table 8: Incremental Costs, Deaths, Cases of Stunting, and DALYs Averted, and Cost per Death, Case of Stunting, and DALY averted, by Division

Division	Incremental cost (USD)	Deaths averted	Cases of stunting averted	DALYs averted	Cost per death averted (USD)	Cost per case of stunting averted (USD)	Cost per DALY averted (USD)
Barisal	24,956,902	2,851	32,453	49,311	8,753	769	506
Chittagong	75,777,154	9,971	108,083	172,439	7,600	701	439
Dhaka	120,253,593	16,380	158,407	283,295	7,341	759	424
Khulna	40,360,677	5,379	43,116	93,024	7,504	936	434
Rajshahi	51,229,276	6,364	56,460	110,063	8,050	907	465
Rangpur	46,637,383	5,320	54,629	92,000	8,767	854	507
Sylhet	25,569,587	3,520	49,809	60,882	7,264	513	420
Total	384,784,572	49,785	502,957	861,014	7,729	765	447

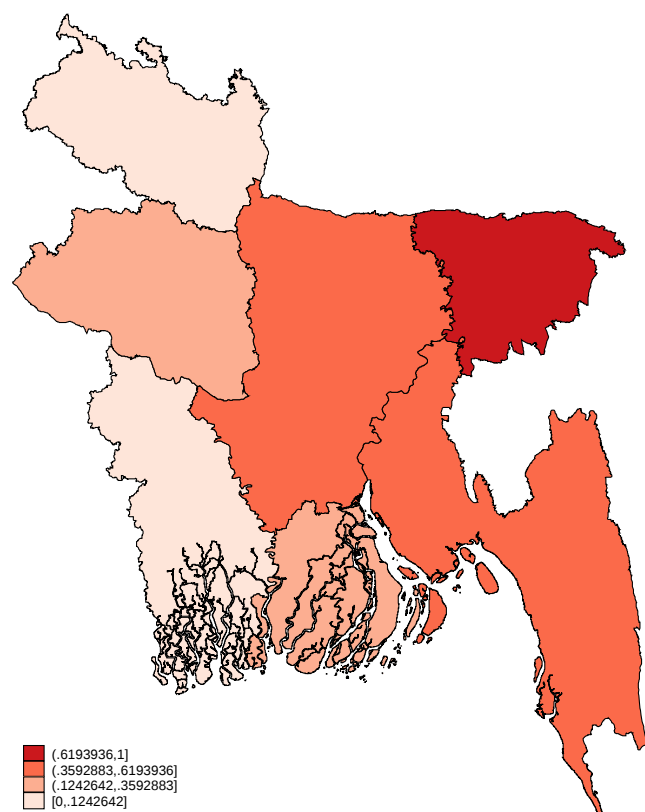
Table 21 also shows that the cost per death averted, case of stunting averted, and DALY averted would be the lowest in Sylhet, Chittagong, and Dhaka Divisions. For illustration purposes, we plotted the cost-effectiveness score (in terms of cost per DALY averted and per case of stunting averted) by division (see Figure 38). The score takes the value of 1 for the division with the highest cost-effectiveness (lowest cost per DALY averted) and the value of 0 for the division with the lowest cost-effectiveness (highest cost per DALY averted). The divisions with the darker shading have higher cost-effectiveness and the divisions with the lighter shading have lower cost-effectiveness. It should be noted that the differences in the cost per DALY averted between regions is substantial. For example, compared to Sylhet, the cost per DALY averted in Barisal is about 20% higher and in Rangpur it is about 21% higher.

Figure 38: Cost-Effectiveness Score by Division for DALYs



We constructed a similar cost-effectiveness map for cases of stunting averted (see Figure 39). The divisions with darker shading show the higher cost-effectiveness (lower cost per case of stunting averted) and the divisions with the lighter shading have lower cost-effectiveness (higher cost per case of stunting averted).

Figure 39: Cost-Effectiveness Score by Division for Cases of Stunting Averted



Note: The cost and impact estimates in this map are only for the four interventions affecting stunting in the LiST model: breastfeeding promotion, complementary feeding education, vitamin A supplementation, and public provision of complementary food.

Table 9 shows the cost per case of stunting averted by intervention and by division for the four interventions included in the analysis that affect stunting in the LiST model. The high cost-effectiveness of prioritizing stunting prevention in Sylhet is a result of the high baseline stunting prevalence. In fact, Sylhet has the highest stunting prevalence among all the divisions of Bangladesh (49.6% of children under age five are stunted in Sylhet according to the most recent BDHS data).

Table 9: Cost per Case of Stunting Prevented by Region and by Intervention
USD

Division	Breastfeeding counseling	Complementary feeding education	Vitamin A supplementation	Public provision of complementary food
Barisal	898	190	36,014	310
Chittagong	943	200	36,986	216
Dhaka	1,057	224	45,146	282
Khulna	1,275	270	50,642	359
Rajshahi	1,152	244	53,810	300
Rangpur	995	211	38,547	369
Sylhet	722	153	34,361	178

ESTIMATING ECONOMIC BENEFITS OF EXPANDING THE COVERAGE OF DIRECT NUTRITION INTERVENTIONS

We carried out a benefit-cost analysis to assess whether the cost of expanding the coverage of the direct nutrition intervention is offset by the benefits the expansion would generate. We estimated the economic benefits based on mortality, stunting, and micronutrient deficiency reductions resulting from the coverage expansion. One life year saved was valued as one time gross domestic product (GDP) per capita (current USD). In order to estimate the value of the reduction in stunting, we followed the methodology used in Hoddinott et al. (2013), and valued a year of life lived without stunting based on the assumption that stunted individuals lose an average of 21% of lifetime earnings. Future benefits were then age-adjusted and discounted at two potential discount rates (3% and 5%) in order to arrive at their present values. The present value of future benefits was then compared with the present value of the estimated 10-year public investment required, which allowed us to estimate the net present value (NPV) and internal rate of return of the investment. We also included benefits resulting from prevention of cognitive losses resulting from iodine deficiency. A detailed explanation of the benefit estimation methodology can be found in Appendix G.

In the base-case scenario of a 5% discount rate, which is the standard for health economics, the scale-up of the interventions from the current level to 90% would result in total net benefits from increases in economic productivity of about USD 5.6 billion over the productive lives of the children who benefited from the interventions (see Table 10). Under this scenario, the benefit-cost ratio would be 20.5, which means that every dollar invested in nutrition would bring in over 20 dollars in economic benefits. As part of sensitivity analysis, we used a 3% discount rate, according to the WHO CHOICE methodology. The lower discount rate yielded the total benefits of more than USD 14 billion and a benefit-cost ratio of 44.3.

Table 10: Cost, Benefits, and Benefit-Cost Ratios under Different Discount Rates

	Discount rate	
	5%	3%
Total cost (discounted; USD millions)	\$276	\$314
Net benefits (discounted; USD millions)	\$5,647	\$13,912
Benefit-cost ratio	20.5	44.3

The economic benefits, based on increases in productivity, depend on the assumptions regarding the future rate of economic growth. In the base case scenario, we have assumed that the economy of Bangladesh will grow at the current rate (about 4.8% per year). Economic benefit estimates are naturally lower under lower annual growth assumptions (see Table 11). Nevertheless, even under a conservative assumption of only 2% annual growth, the benefits substantially exceed costs with a benefit-cost ratio of 6.1.

Table 11: Cost, Benefits, and Benefit-Cost Ratios under Different Assumptions Regarding the Annual Economic Growth Rates and a Discount Rate of Cost and Benefit of 5%

	Assumed annual GDP growth rate		
	4.8%	3.0%	2.0%
Total cost (discounted; USD millions)	\$276	\$276	\$276
Net benefits (discounted; USD millions)	\$5,923	\$2,585	\$1,672
Benefit-cost ratio	20.5	9.4	6.1

PART IV – DISCUSSION AND POLICY IMPLICATIONS

The analyses presented in this report show that investing in the package of direct nutrition interventions in Bangladesh is cost-effective and that the benefits of doing so substantially outweigh the costs. It also presents two different but equally important ways for prioritization of the implementation of the direct nutrition interventions planned under NPAN2: by intervention and by geographic region.

Currently, no reliable data on nutrition expenditure in Bangladesh exist. This report provides a very perfunctory estimate of the current expenditure on direct-nutrition intervention in Bangladesh or about USD 15 million. As mentioned above, the estimate is derived simply by multiplying the estimated unit cost for each intervention by the number of individuals currently covered by the intervention. It is limited to the interventions included in the analysis, and does not include any cost related to the management of the national nutrition programs not captured in the unit cost (see the section on unit cost and Appendices A and C). While perfunctory, and included for illustration purposes only, this estimate is roughly consistent with the estimate of current budget allocations for direct nutrition interventions in Bangladesh produced by others. Based on the analysis of the budget of the National Food Security Plan, the SUN Movement Secretariat estimates that, in 2015, the nominal upper bound budget allocation for all nutrition interventions (both nutrition-specific and nutrition-sensitive) was about USD 2 billion. Within that total, the allocations for nutrition interventions delivered through the health sector were estimated about 10% of that total – roughly USD 238.4 million (SUN, 2017)⁶. Within that budget envelope, the bulk of allocations were for integrated maternal and child programs such as integrated management of child illness, that include some nutrition components. About USD 20 million could be traced as allocations to high-impact direct nutrition interventions. According to another analysis conducted by Results for Development Institute (R4D), in 2015, the budget allocations for high-impact interventions was about USD 63.3 million⁷. This estimate includes both “on budget” allocations, that is allocations from the budget of national programs, as well as “off-budget” allocations, that is, financing provided by international donors directly to NGOs or other non-government entities bypassing the official public financial management system. The allocations from the national budget are estimated at USD 28.5 million and allocations from donors (on and off budget)– at USD 34.7. Taken together, these estimates suggest that the current annual expenditure on nutrition direct interventions in Bangladesh is likely somewhere between USD15 million and USD 60 million, or between USD 0.9 and USD 0.38 per capita.

One way to assess the relative burden of the costs of the intervention scale up on the national budget is to compare them, in per capita terms, to current public expenditure on health. Excluding the public cost of programs that will be borne by sectors other than health (fortification programs and public provision of complementary food), the annual per capita cost of expanding the proposed set of direct nutrition interventions would be USD 0.12 annually, which is about 1.40% of the current per capita government expenditure on health (see Table 12).

⁶ <http://docs.scalingupnutrition.org/wp-content/uploads/2016/06/Nutrition-Investment-Snapshot-2016-Bangladesh.pdf>

⁷ <http://investinnutrition.org/countries/BGD>

Table 12: Total and Public Health Expenditure in Bangladesh and the Estimated Average Annual Cost of Expanding the Coverage of the Direct Nutrition Interventions as a Percentage of Public Health Expenditure

Expenditure category	Amount
Total health expenditure per capita (current USD)	USD 31.00
Public health expenditure as % of total health expenditure	27.90%
Public health expenditure per capita (current USD)	USD 8.65
Average annual per capita cost of expanding all direct nutrition interventions as a percentage of public health expenditure	USD 0.24
Average annual per capita cost of expanding all direct nutrition interventions as a percentage of public health expenditure	2.79%
Average annual per capita cost of expanding direct nutrition interventions excluding fortification and the public provision of complementary food	USD 0.12
Average annual per capita cost of expanding direct nutrition interventions excluding fortification and public provision of complementary food as percentage of public health expenditure	1.42%

Seen this way, the expansion of program coverage of the direct nutrition interventions may not appear onerous. However, recent projections suggest that total health spending in Bangladesh is likely to grow by about 3.6 % per year between 2013 and 2040 (Dieleman et al. 2016). Assuming that public health expenditure would increase at the same pace, expanding the coverage of the direct nutrition interventions would require that over 38% of the increases in public health expenditure be directed toward nutrition. While, theoretically, fiscal space that could accommodate the scale-up of nutrition interventions does exist in the health sector, in practice, such prioritization of nutrition in the health budget is unlikely. Therefore, additional sources of financing will need to be sought to expand the direct nutrition interventions.

Our analysis shows that investing in nutrition in Bangladesh will likely result in very substantial health and economic benefits. Scaling up the direct nutrition interventions would allow the prevention of almost 50,000 deaths in children under five and over 500,000 cases of stunting, and avert over 861,000 disability-adjusted life years (DALYs). The analysis shows that investments in nutrition in Bangladesh are very cost-effective, with a cost per DALY averted (USD 447), well below the GNI per capita threshold.

We estimate that one dollar invested in nutrition would result in over 20 dollars in economic benefits. The estimated benefit-cost ratio presented above is comparable to that presented in Hoddinott et al. (18; 2013; see also GNR 2015). Hoddinott et al. estimated the cost of scaling up direct nutrition interventions in a comparative statics framework, which does not take into account the fact that a child needs to be exposed to the interventions over the course of multiple years to ensure that she is not stunted when reaching the age of 59 months. Furthermore, Hoddinott et al. simply assumed that intervention scale-up would result in a 20% reduction in stunting prevalence. We used a more realistic scale-up scenario—a scale-up over 10 years, consistent with that proposed for the NPAN2 and a more rigorous approach to modelling the impact of the intervention

using the Lives Saved Tool (LiST) model. This allowed us to fully take into account the fact that reducing the risk of a child being stunted at age five requires several years of interventions. It also allowed us to model more accurately the impact of the interventions on the nutrition and health status of children in a way that takes into consideration country-specific prevalence and incidence of risk factors, such as diarrhea, wasting, pneumonia, and others.

Despite slight difference between our results and those of Hoddinott et al., our analysis demonstrates that investing in direct nutrition interventions offers a very attractive internal rate of return and benefit-cost ratio, with every USD 1 invested in nutrition generating over USD 20 in economic benefits. Even under a very conservative scenario of economic growth of 2%, much lower than the historic trajectory of growth in Bangladesh, the benefits are six times higher than the costs.

This analysis suggests that prioritizing coverage expansion in Sylhet, Dhaka, and Chittagong would be the most cost-effective geographic scale-up option. This would require a total of USD 221 million and prevent almost 30,000 deaths and over 316,000 cases of stunting, and avert over 516,000 DALYs. Compared with expanding the coverage of the interventions in all divisions, focusing the coverage expansion on Sylhet, Dhaka, and Chittagong would allow for reducing the cost per DALY averted by about 5% and the cost per case of stunting averted by about 10% (for the interventions affecting the risk of stunting). Prioritizing coverage expansion in Sylhet alone would reduce the cost per DALY averted by 6% and the cost per case of stunting averted by over 21%.

The fact that geographic targeting of interventions, particularly prioritizing regions with a high burden of malnutrition, can increase the efficiency of investment is intuitive and consistent with previous studies (for example, Dayton Eberwein et al. 2015). However, it needs to be noted that for the two interventions targeting the general population (rice fortification and salt iodization) geographic targeting would not be possible. Furthermore, excluding some regions from the expansion of interventions may be problematic from the equity standpoint. Nevertheless, our analyses suggest that, if available resources are limited, prioritizing Sylhet, as well as Dhaka, and Chittagong, at least in the short term, is a cost-effective expansion strategy.

The analyses presented above focus on the public-sector cost. However, we also estimate that expanding the coverage of the fortification of rice and edible oil, along with salt iodization, would entail costs that would likely be passed on to the consumers. The absolute costs of fortification borne by the consumers are very high (USD 2.5 billion over 10 years) because fortification interventions target the entire population. On the other hand, per capita costs are relatively modest—less than a 5% cost increase for rice fortification and significantly less than that for iodized salt. However, it is possible that, for the poor households, those costs may constitute a significant burden. It also should be noted that fortified rice has recently been included on a pilot basis in public food distribution through social safety net programs. In 2014 the Ministry of Women and Child Affairs, with support from WFP, initiated the distribution of fortified rice through its social safety net programs (Vulnerable Group Development and Vulnerable Group Feeding). In 2015, the Vulnerable Group Development program had reached about 60,000 beneficiaries in five upzilas. An in-depth analysis of the extent to which the cost of fortification estimated above can increase the risk of impoverishment and to what extent and how fortified staples could or should be subsidized is beyond the scope of this report. However, this issue should be considered as part of further studies and policy dialogue.

Limitations

Service Delivery Assumptions

Our analysis focuses on the cost of delivering direct nutrition services using services modalities currently in place or that have the potential to be delivered at scale (for example, moderate acute malnutrition screening and management, outpatient severe acute malnutrition treatment, and the public provision of complementary food). Where programs did not exist at scale, service delivery decisions had to be made for the purpose of modeling scale-up costs. However, such decisions need to be reviewed and modified based upon the discretion of the Ministry of Health and Family Welfare and other implementing agencies.

Our cost estimates are based on a number of assumptions regarding the supply of nutrition services and interventions. First, we assume supply is the limiting factor and that additional demand-generation activities are not necessary to stimulate the consumption of direct nutrition interventions; improving the quality and availability of supply-side will be sufficient to increase coverage to desired levels. This may not be true, particularly for interventions such as rice fortification and the promotion of optimum infant and young child feeding, where promotion efforts may be necessary to stimulate consumption. Second, we assume that the capacity to absorb the additional financing and scale up the intervention either exists currently or will be developed in the future. Further assessments of health system capacity—in terms of infrastructure, supply chain effectiveness, and human resources for health—are needed to determine whether this is indeed the case. Specifically, as a result of the absence of a human resource time use study, we are limited in our assumption of the incremental nature of the human resource costs included in our estimates.

Public Health Sector Perspective

This report sought to estimate the cost of expanding the direct nutrition interventions through the public health sector. However, it should be noted that currently public health services are reaching only a minority of the population in Bangladesh. According to the 2010 Household Income and Expenditure Survey (HIES) 79% of Bangladeshis accessed health care through non-public providers: 40.2% at the pharmacy/dispensary, 24.6% at the private doctor, and 14.3% at the private practice of a government doctor (BBS, 2010). At the same time, however, about 68.1% of pregnant women received ante-natal services through the public sector (at a satellite clinic, a union family welfare facility, or a thana/upazila health center) and only 16.3% saw a private provider.

As noted above, over 60% of the total health expenditure in Bangladesh comes from out of pocket spending. Consequently, recent studies have indicated that health financing in Bangladesh is highly regressive with the poorer household bearing proportionally higher burden of the cost of health care and contributing proportionally more to health financing than the wealthy households (Molla & Chi, 2017). The regressivity of health financing in Bangladesh is a key challenge in achieving universal health coverage. Out of pocket spending on health is also a substantial source of catastrophic and impoverishing health expenditure (Islam et al., 2017). This reinforces the rationale guiding NPAN2 according to which the scale up of direct nutrition interventions should take place through the public sector. At the same time, however, it needs to be noted that the utilization of the public health services, especially curative services for mothers, infants, and young children needs to increase substantially for such scale up to be possible.

Cost-Benefit and Cost-Effectiveness Calculations

Although this analysis compares effectiveness and cost-effectiveness of different interventions, it does not address different delivery modalities for a specific intervention. Such analysis is beyond the scope of this report. However, it would be very important for planning the expansion of nutrition interventions in Bangladesh. For example, the study of Puett et al. (2013) cited above has shown that outpatient treatment of severe acute malnutrition using ready-to-use therapeutic foods is much more cost-effective than the traditional inpatient treatment. Further analyses comparing cost-effectiveness of different service delivery platforms should be conducted.

The economic benefits presented above, based largely on mortality, morbidity, and cognitive deficits avoided in children under age five, do not include benefits from reductions in anemia and micronutrient deficiency resulting from the fortification of staples in the general population. Therefore, it is likely that the benefits are, in fact, underestimated.

We have assumed that the average unit cost will not change over the next 10 years. It is possible that the delivery of certain services will improve over time thanks to economies of scale, increased efficiency in service delivery, cheaper technologies and products, or other factors. It is also possible that, as the coverage increases, reaching the last 20% or 10% of beneficiaries will be more expensive and have higher marginal cost. Empirical literature on the over-time changes in the service delivery cost of nutrition interventions is very limited. One recent study examined the relationship between the coverage of a community-based SAM treatment program in Niger and the cost per beneficiary reached and reported lower marginal costs for communities with higher numbers of beneficiaries (Isanaka et al., 2016). This suggests that economies of scale may be preset in large-scale nutrition programs. However, not empirical data are available for other types of nutrition interventions or for multi-intervention programs. Therefore, it is impossible to determine which of the potential cost escalation or de-escalation scenarios are more realistic.

Comparison of the cost-effectiveness of expanding the coverage of direct nutrition interventions in different divisions is a key element of our analysis. To the extent possible, we have taken into account differences in the regional burden of malnutrition (stunting and wasting) and disease (especially diarrhea). However, because of the paucity of data, we were not able to fully address differences in the incidence of other diseases (for example, pneumonia, measles, and sepsis). If such differences are pronounced, they may affect the results related to DALYs and mortality. Such considerations are less relevant for the analyses comparing the impact of interventions on stunting.

Following the interventions proposed for the NPAN2, we included in this analysis vitamin A supplementation campaigns, which target children age 6–59 months, as well as the fortification of edible oil with vitamin A, which targets the general population. It is clear that fortification can reduce vitamin A deficiency in children and, therefore, reduce the need for supplementation campaigns. However, we were not able to estimate the impact of fortification on children because this intervention is not included in LiST. Other tools—most notably the MINIMOD model—allow for a more in-depth economic analysis of different interventions aimed at reducing micronutrient deficiencies, including that of vitamin A. MINIMOD also allows for an allocative efficiency analysis—that is, an analysis indicating an allocation of resources among different delivery platforms that maximizes their impact on children's health. An analysis using this tool conducted in Cameroon demonstrated that combining supplementation through campaigns with supplementation through health facilities, fortification of edible oil, and fortification of bouillon cubes could help reduce the per-child cost of preventing vitamin A deficiency by 44% (see Vosti et al., 2015) compared to delivering vitamin A through supplementation campaigns only. It is likely that efficiency gains could be made in Bangladesh through a correct mix of campaigns and

fortification. Such analyses could be considered in the future to inform the implementation of NPAN2.

Health and Nutrition Impact Estimates

Health and nutrition impact estimates generated using LiST use intervention effectiveness estimates based on meta-analyses and systematic literature reviews of randomized control trials (RCTs). The studies included in the meta-analyses come from multiple contexts and, generally, from middle and low-income countries. While the meta-analyses may not necessarily include studies from Bangladesh, the use of point estimates from meta-analyses of RCTs is generally considered to be the gold standard in mathematical modelling in health, and such estimates are believed to be generalizable to majority of country-contexts.

It should also be noted that during clinical trials on which the impact estimates used in LiST are based the delivery of the interventions is closely monitored and supervised and, consequently, services delivered are of very high quality (for example, they exhibit high fidelity with guidelines and protocols, are delivered by highly trained staff, and so forth). The real-life, large-scale programs are likely to be less effective. Therefore, the results presented above are likely to be overestimating the cost-effectiveness and economic benefits of the interventions. Nevertheless, given the absence of more accurate data from large-scale national programs, our estimates can be interpreted as reasonable upper-bound estimates.

Ideally, sensitivity analysis would incorporate the uncertainty around the point estimates of intervention effectiveness. Unfortunately, LiST does not include functionalities that would allow for such sensitivity analyses. This is in part because the causal pathways included in the model are very complex, with multiple interventions affecting simultaneously multiple outcomes both directly and indirectly, by impacting the prevalence of risk factors. Currently, no other tool exist that would allow for a more robust assessment of the sensitivity of the impact of interventions to the changing values of the effect point estimates. However, if such tools become available, future analyses should explicitly address this key source of uncertainty.

Analytical Scope

Finally, even though this report focuses almost exclusively on nutrition-specific interventions, the causes of malnutrition are multisectoral, so any longer-term approach to improving nutrition outcomes must also include nutrition-sensitive interventions. An important next step will be to extend the cost-effectiveness analysis to nutrition-sensitive interventions implemented outside of the health sector. More robust data on nutrition-sensitive interventions are needed to do this.

PART V – CONCLUSIONS

This report presents an analysis of the costs, benefits, and cost-effectiveness of implementing a set of key nutrition-specific interventions included in Bangladesh's second National Plan of Action on Nutrition (NPAN2).

The total public investment needed to implement the interventions is estimated to be USD 536.9 million over 10 years (or about USD 53.7 million annually). This includes USD 152.8 million to maintain the current coverage of the intervention and an additional USD 384.8 million to expand intervention coverage. In addition to these costs borne by the public sector, there would be substantial costs to consumers involved in expanding fortification of rice, edible oil, and salt.

The analyses demonstrate that making these investments is very cost-effective and that the benefits it would generate greatly outweigh the costs. Expanding coverage of the interventions over 10 years would result in averting almost 50,000 deaths and over 860,000 DALYs and preventing over 500,000 cases of stunting in children under five. Those gains would translate into increases in economic productivity worth about USD 5.6 billion over the productive lives of the children who benefited from the interventions. The benefit-cost ratio would be 20.5, which means that every dollar invested in nutrition would bring in over 20 dollars in economic benefits. Even under conservative assumptions regarding future economic growth, the economic benefits exceeded the cost more than six times.

If full scale up is not possible, geographic targeting in the short and medium term could lead to increased efficiency of investments. Priority should be given to scale up in Sylhet, Dhaka, and Chittagong Divisions, as scale up in these divisions is most cost-effective.

Overall, the findings of this report show that implementing a set of key nutrition interventions included in Bangladesh's NPAN2 would represent a cost-effective approach to reducing the high levels of child malnutrition in Bangladesh. Critical next steps are for the Government of Bangladesh and its partners to allocate sufficient funding needed to implement plan.

Finally, this report also seeks to contribute to the effort to systematically identify and collect unit cost of essential maternal and child health and nutrition services. Those efforts include the establishment of the Global Health Cost Consortium, funded by the Bill and Melinda Gates Foundation to provide policy makers with improved data to estimate the cost of scaling up HIV and tuberculosis programs, as well as the unit cost information collected as part of the global investment framework for nutrition (Shekar et al., 2017).

APPENDICES:

APPENDIX A: TRANSPORTATION COST CALCULATION

Division	Cost per km 3 ton truck (BDT)	Cost per kg per km (BDT)	% of tonnage capacity actually carried by the truck	Actual cost per kg per km (BDT)	Average distance travelled (km)	Average cost per kg (BDT)	Average cost per kg (USD)
Barisal	95.01	0.032	50%	0.063	194	12.27	\$0.18
Chittagong	75.01	0.025	50%	0.050	206	10.32	\$0.15
Dhaka	85.01	0.028	50%	0.057	101	5.72	\$0.08
Khulna	95.01	0.032	50%	0.063	215	13.63	\$0.19
Rajshahi	68.01	0.023	50%	0.045	226	10.23	\$0.15
Rangpur	68.01	0.023	50%	0.045	346	15.67	\$0.22
Sylhet	66.01	0.022	50%	0.044	227	10.00	\$0.14

Source: Central Medical Store Department (CMSD)

APPENDIX B: HUMAN RESOURCE COST CALCULATION

1st Class (Grade 5, median salary)

Division	Salary (BDT)	Medical allowance (BDT)	Rent allowance (BDT)	Total (BDT)	Total USD
Barisal	56,030	1,500	22,412	79,942	\$1,066
Chittagong	56,030	1,500	22,412	79,942	\$1,066
Dhaka	56,030	1,500	22,412	79,942	\$1,066
Khulna	56,030	1,500	22,412	79,942	\$1,066
Rajshahi	56,030	1,500	22,412	79,942	\$1,066
Rangpur	56,030	1,500	22,412	79,942	\$1,066
Sylhet	56,030	1,500	22,412	79,942	\$1,066

2nd class (Grade 11, median salary)

Division	Salary (BDT)	Medical allowance (BDT)	Rent allowance (BDT)	Total (BDT)	Total USD
Barisal	20,420	1,500	9,189	31,109	\$415
Chittagong	20,420	1,500	9,189	31,109	\$415
Dhaka	20,420	1,500	9,189	31,109	\$415
Khulna	20,420	1,500	9,189	31,109	\$415
Rajshahi	20,420	1,500	9,189	31,109	\$415
Rangpur	20,420	1,500	9,189	31,109	\$415
Sylhet	20,420	1,500	9,189	31,109	\$415

3rd Class (Grade 16; median salary)

Division	Salary (BDT)	Medical allowance (BDT)	Rent allowance (BDT)	Total (BDT)	Total USD
Barisal	15,200	1,500	8,360	25,060	\$334
Chittagong	15,200	1,500	8,360	25,060	\$334
Dhaka	15,200	1,500	8,360	25,060	\$334
Khulna	15,200	1,500	8,360	25,060	\$334
Rajshahi	15,200	1,500	8,360	25,060	\$334
Rangpur	15,200	1,500	8,360	25,060	\$334
Sylhet	15,200	1,500	8,360	25,060	\$334

Source: Bangladesh Ministry of Finance Public Servant Salary Grid

APPENDIX C: UNIT COSTS CALCULATIONS AND ASSUMPTIONS

This section summarizes how the unit cost was estimated for each of the interventions. We utilize the following cost component categories when disaggregating unit costs: consumables, other (non-consumable) inputs, transport, human resources, program costs, and household costs. Under our definitions, human resource costs include only the human resource costs associated with direct supervision. Human resource costs related to supervision, M&E, program management, and similar programmatic “overhead” activities are included as program costs, when available.

Iron and Folic Acid Supplementation in Pregnancy

The current policy recommendation in Bangladesh is daily iron and folic acid supplementation throughout pregnancy (180 days) and three months postpartum (90 days) for a total of 270 days. Even though in practice most mothers receive iron and folic acid supplementation only during prenatal care, we estimated the cost of pre- and postnatal care in order to be consistent with the policy.

The Government of Bangladesh procures and distributes iron and folic acid through two channels under the Ministry of Health and Family Welfare: the Directorate General of Health Services and the Directorate General of Family Planning. Distribution occurs most commonly through routine supplementation at health facilities as a part of antenatal and postnatal care visits. Though some women receive iron and folic acid supplements through community outreach offered by the Directorate General of Family Planning, this is assumed to be negligible.

Unit costs are based on one (1) tablet daily of iron and folic acid (ferrous fumarate 200 milligrams (mg) + folic acid 400 micrograms (µg)). Iron and folic acid supplement prices were obtained from the Central Medical Stores Depot (CMSD) for locally produced iron and folic acid supplement (Table 3). The cost of transporting the supplement from Dhaka to divisions and *upazila* (an administrative unit) health complexes were added based on the information provided by the CMSD.

It was assumed that iron and folic acid supplementation would be delivered by family welfare assistants, health assistants, or community health care providers for antenatal and postnatal care (average salary for class 3, grade 16).⁸ We assumed that women would attend four antenatal care visits, with approximately 2.5 minutes per visit devoted to the provision of iron and folic acid along with the promotion of optimum diet and rest. The total time taken for the four sessions is 10 minutes. The women are also assumed to attend four postnatal care visits, with health workers again spending 2.5 minutes per visit to provide iron and folic acid along with promotion of optimum diet (including iron-rich foods) for a total of 10 minutes. Health personnel salary information was obtained from the Ministry of Finance civil servant salary grid (see Appendix A for personnel cost calculation).

Table 1: Estimated Unit Cost (Cost per Beneficiary): Iron and Folic Acid Supplementation

Cost category	Unit cost (USD)	Percent
Consumables	USD 0.900	55%

⁸ The costs for assistants and providers were estimated using the median salaries for class 3 and grade 16 staff. See Appendix B for details).

Other (non-consumable) inputs		0%
Transport	USD 0.038	2%
Human resources	USD 0.696	43%
Program cost	n.a.	0%
Household cost	n.a.	0%
Total	USD 1.634	100%

Note: n.a. = not applicable.

Calcium Supplementation during Pregnancy

Currently Bangladesh has no policy guidelines for calcium supplementation in pregnancy, although the National Micronutrient Strategy proposes supplementation aligned with the WHO guidelines (WHO 2013). The unit cost estimated here assumes twice daily calcium supplementation with two tablets of 500 mg calcium carbonate beginning in the 20th week of gestation for 20 weeks (assuming 40 weeks gestation) for a total of 280 tablets. Prices for calcium carbonate tablets were obtained from the CMSD for locally produced supplement. The cost of transporting the supplement from Dhaka to divisions and upazila health complexes was added based on the information provided by the CMSD (see Table 4).

It was assumed that calcium supplementation would be delivered by family welfare assistants, health assistants, or community health care providers (average class 3, grade 16) during antenatal care visits. It was further assumed that women would attend four antenatal care visits, with approximately 2.5 minutes per visit devoted to the provision of the calcium supplements and recommendations to consume calcium-rich foods. The total human resource time required for the four sessions is 10 minutes. Health personnel salary information was obtained from the Ministry of Finance civil servant salary grid.

Table 2: Estimated Unit Cost (Cost per Beneficiary): Calcium Supplementation

Cost category	Unit cost (USD)	Percent
Consumables	USD 0.750	51%
Other (non-consumable) inputs	n.a.	0%
Transport	USD 0.039	3%
Human resources	USD 0.696	47%
Program cost	n.a.	0%
Household cost	n.a.	0%
Total	USD 1.486	100%

Note: n.a. = not applicable.

Promotion of Optimum Infant and Young Child Feeding

As a part of the mainstreamed nutrition approach supported under the 4th Health, Population, and Nutrition Sector Development Plan, infant and young child feeding promotion is mainstreamed through the existing health and family planning infrastructure. Counseling on and promotion of optimum infant and young child feeding includes messages that promote early initiation of breastfeeding within one hour of birth; exclusive breastfeeding through six months of age; the timely introduction and gradual increase of age-appropriate adequate, nutritious, and diverse complementary foods; continued breastfeeding through age two years; feeding during and after illness; and essential hygiene actions at key moments. Two delivery approaches were included in the costing: (1) one-to-one sessions and (2) group-based courtyard sessions.

Based on the national protocol and discussion with key stakeholders, we assumed that a woman would attend 24 visits between conception and the child's second birthday (4 antenatal care visits, 4 postnatal care visits, 10 growth monitoring and promotion visits,⁹ and 6 Expanded Programme on Immunization, or EPI, visits). We also assumed that courtyard sessions would take place approximately once per month. It is expected that a woman would attend 8 such sessions, which provide infant and young child feeding counseling. On average, the sessions are assumed to run 30 minutes and be attended by 13 women.

The unit cost for infant and young child feeding promotion consists of other (non-consumable) inputs, human resources, and program costs (see Table 5).

Non-consumable (other) inputs are required for the provision of the intervention, and include the cost of equipment, communication materials, and job aids used by the providers. Each child is provided with one growth monitoring card to be retained by the mother and brought to each follow-up session. Training for health assistants, community health providers, and family welfare volunteers and assistants is provided using a standardized infant and young child feeding

⁹ Although it is recommended that women attend growth monitoring and promotion visits every month until their children are age two, this is not feasible and we have modified our assumptions accordingly.

module,¹⁰ and each facility is provided with one infant and young child feeding behavior change communication kit, a set of growth-monitoring equipment (including one (1) height board, one (1) salter scale, mid-upper arm circumference measuring tapes, one (1) set of weighing trousers), and Sonali Alo flash cards (5 cards out of 25 are allocated to infant and young child feeding–related behaviors). The transportation costs are largely associated with the cost of transporting the growth-monitoring equipment and could not be disaggregated from product cost (so these are included in “other inputs”).

Human resource costs include the cost of direct service provision. It is assumed that quality infant and young child feeding counseling will require on average 2.5 minutes per visit during antenatal care visits and 7.5 minutes per individual contact following birth, which amounts to 180 minutes per pregnant woman over the course of two years. In addition, 18.5 minutes of staff time per woman would be required for the group-based courtyard session during the same timeframe. We assumed that the infant and young child feeding services would be delivered by family welfare assistants, health assistants, or community health care providers (Class 3, Grade 16).

Program costs include the cost of supervision, and, in particular, the recently created position of District Nutrition Manager (class 1, grade 9) to provide oversight for the delivery of direct nutrition interventions. We assumed that one District Nutrition Manager would provide supervision in each district, for a total of 64 districts.

Table 3: Estimated Unit Cost (Cost per Beneficiary): Promotion of Optimum Infant and Young Child Feeding

Cost category	Unit cost (USD)	Percent
Consumables	n.a.	0%
Other (non-consumable) inputs	USD 0.44	12%
Transport	n.a.	0.00%
Human resources	USD 3.12	88%
Program cost	USD 0.001	0%
Household cost	n.a.	0%
Total	USD 3.56	100%

Note: n.a. = not applicable.

Vitamin A Supplementation

In Bangladesh, vitamin A supplementation is provided through twice-annual National Vitamin A Campaign (NVAC) days. Children age 6–11 months are provided with one capsule of 100,000 international units (IU) of retinol; children age 12–59 months are provided with a capsule containing 200,000 IU of retinol.¹¹

¹⁰ Training (pre-service and in-service) of service providers was not included in the cost estimates.

¹¹ Because of the difficulty of conducting age verification in the field, it is believed that children older than age five are provided with vitamin A. The costs of procuring and distributing the excess retinol are

We estimate the unit cost by using the National Nutrition Services budgets for the NVAC campaign, supplemented with additional transportation and supervision costs that were not included in the NVAC budget. All input costs (consumable and other) were calculated based on the budget for the two most recent NVAC campaigns provided by the NNS (see Table 6). The estimated cost of transport from Dhaka down to the upazila level (not included in the NNS budget) was added to the cost of retinol based on information from the CMSD.

Human resource costs include only the costs for direct service provision. Over 36,000 volunteers are deployed throughout the country to support the distribution of capsules at EPI outreach centers in the community. Volunteers attend a one-day training orientation and are provided with a field brochure. Volunteers are not paid, but receive a small per diem payment of 100 Bangladesh taka (BDT; USD 1.40) for the NVAC days and for training, which is included in the human resource cost. In addition to volunteers, about 50,000 health workers are involved in the provision of vitamin A supplementation (class 3, grade 16).

A cascade of supervisors is needed from central level down to division levels, and their pay is included in program costs. Based on the consultation with stakeholders, we assumed that 100 supervisors from the central/national level would be deployed to supervise the NVAC; 10 additional supervisors in each of 64 districts (total of 640); and 2 additional supervisors from the district level (total of 4,554). For each level of supervisor, the human resource cost per child was calculated using the following methodology:

1. It is assumed that each supervisor will spend 480 minutes (8 hours) on supervision per NVAC day.
2. The total number of children “covered” by a single supervisor is determined by dividing the total number of supervisors required at that level by the total number of beneficiaries.
3. The total minutes of supervision time per child is the product of (supervision minutes x number of supervisors at that level) / children per supervisor.
4. It is assumed that each supervisor has an average salary of BDT 79,942.¹²
5. The cost per child is obtained by the product (salary per minute by minutes per child)
6. The total human resource cost of supervision is the sum of the cost per child for supervisors at the national, division, district, and union levels.

captured in the program costs used to generate unit cost estimates. Thus this unit cost estimation may exceed the true cost of distribution to children ages 6–59 months, though the human resource cost of additional robust screening is unknown.

¹² This figure is based on the Ministry of Finance salary grid for Class 1 Grade 5 median salary with medial and housing allowance.

Table 4: Estimated Unit Cost (Cost per Beneficiary): Vitamin A Supplementation

Cost category	Unit cost (USD)	Percent
Consumables	USD 0.053	15%
Other (non-consumable) inputs ^a	USD 0.110	32%
Transport	n.a.	0%
Human resources	USD 0.134	39%
Program cost	\$0.049	14%
Household cost	n.a.	0%
Total	\$0.352	100%

Note: a Other inputs include the NVAC program's cost for scissors, flags, volunteer lists, planning sheets, tally forms, supervision checklists, NVAC reports, field brochures, interpersonal communication forms, and NVAC folders.
n.a. = not applicable.

Therapeutic Zinc and Oral Rehydration Solution for the Treatment of Diarrhea

The unit cost of the treatment of acute diarrhea is based on the WHO and UNICEF guidelines and the national Integrated Management of Childhood Illnesses protocol, which recommend the use of oral rehydration solution as well as the provision of 10 to 20 milligrams of zinc for 10 to 14 days for the treatment of each individual case.

The unit cost estimate includes consumables, human resources, and transport costs (see Table 7). We assumed that a child presenting with acute diarrhea will be seen by a subassistant community medical officer (class 3, grade 16) for a total of 10 minutes. The child will be provided with one sachet of low osmolality oral rehydration solution at the facility and two additional sachets for consumption at home. The child will also receive zinc tablets to consume once daily for the following 10–14 days (10–14 x 20 mg zinc tablets provided to children 6–59 months and 10–14 x 10 mg zinc tablets to children 0–5 months). It was assumed that both oral rehydration solution and zinc will be provided to the child free of charge—that is, these interventions will require no out-of-pocket payment. Prices of locally produced oral rehydration solution and zinc tablets were obtained from the CMSD. The costs of transporting those medical inputs from Dhaka to divisions and upazila health complexes were added based on the information provided by the CMSD.

Table 5: Estimated Unit Cost (Cost per Beneficiary): Therapeutic Zinc and Oral Rehydration Solution for the Treatment of Diarrhea

Cost category	Unit Cost (USD)	Percent
Consumables	USD 0.428	53.04%
Other (non-consumable) inputs	n.a.	0%
Transport	USD 0.001	0.77%
Human resources	USD \$0.373	46.19%
Program cost	n.a.	0%
Household cost	n.a.	0%
Total	USD 0.802	100%

Note: n.a. = not applicable.

Deworming of Children

The Government of Bangladesh recommends regular distribution of deworming tablets only to children age 24–59 months as a part of the anemia control program.¹³ Deworming medication is now provided to children 24–59 months as part of EPI campaigns. The EPI campaign chooses one month out of every six months to mobilize around deworming. In each union, there are 24 EPI centers, with each center operational on a different day per month, such that the entire union can be covered in one month. Health assistants visit households to mobilize the community prior to the date of service provision. Although deworming tablets are available in health facilities, it is assumed that delivery through this modality makes a negligible contribution to overall coverage prevalence.

Health assistants conduct community mobilization for six days per distribution period, spending on average 4 hours per day. The health assistant can reach an average of 125 children per day, spending 1.9 minutes per child on mobilization. It is assumed that one additional minute is spent per child to dispense the albendazole at the EPI center, for a total of 2.9 minutes of health worker time per child per distribution cycle. Input cost for albendazole tablets was obtained from the CMSD. The cost of transporting the tablet from Dhaka to divisions and upazilas health complexes was added based on the information provided by the CMSD (see Table 8).

Table 6: Estimated Unit Cost (Cost per Beneficiary): Deworming of Children

Cost category	Unit Cost (USD)	Percent
Consumables	USD 0.088	21%
Other (non-consumable) inputs	USD 0.110	27%
Transport	USD 0.030	7%
Human resources	USD 0.134	33%
Program cost	USD 0.049	12%
Household cost	n.a.	0%
Total	USD 0.411	100%

Note: n.a. = not applicable.

Provision of Micronutrient Powders to Infants and Young Children

The National Strategy for Prevention and Control of Anemia recommends the use of micronutrient powders to prevent anemia and other micronutrient deficiencies (IPHN 2007). The recommendation is for one sachet daily of micronutrient powders containing 12.5 mg of elemental iron, 300 ug of retinol, and 5 mg of elemental zinc. However, Bangladesh is currently procuring MNP-5, which also contains 0.16 mg of folic acid and 30 mg of vitamin C.

¹³ Note that this is in contrast to the WHO guidelines that recommend deworming for children 12–59 months. In the past, the country's national deworming program had been implemented in conjunction with the NVAC campaign. However, community concerns surfaced related to children's illness when receiving deworming and threatened to derail the successful NVAC program. The two programs were delinked in order to maintain the integrity and coverage of the NVAC.

We assumed that micronutrient powder sachets will be provided on a six-month cycle. One cycle of micronutrient powders supplementation includes the provision of a two-month supply of micronutrient powders (60 sachets, 1 sachet to be consumed per day) followed by a four-month discontinuation of supplementation. This cycle will be repeated twice (for a total of three rounds before the child's second birthday). Thus, each child completes, on average, 1.5 rounds of supplementation annually.

We model delivery of micronutrient powders based on what is in place through the Directorate General of Family Planning in select districts. We assume that family welfare assistants (class 3, grade 16) will provide micronutrient powders as a part of their home visits. Upon identifying a household where there is a child of the target age of 6–23 months, the family welfare assistants will provide a two-month supply of micronutrient powders. On average, approximately 3 minutes is spent per visit describing to the mother the appropriate use of the micronutrient powders and answering questions.

Input cost for micronutrient sachets were obtained from the CMSD. The cost of transporting the sachets from Dhaka to divisions and upazilas health complexes was added based on the information provided by the CMSD (see Table 9).

Table 7: Estimated Unit Cost (Cost per Beneficiary): Multiple Micronutrient Powder Supplementation

Cost category	Unit Cost (USD)	Percent
Consumables	USD 3.791	54%
Other (non-consumable) inputs	USD 0.080	1%
Transport	n.a.	0%
Human resources	USD 1.090	15%
Program cost	USD 2.118	30%
Household cost	n.a.	0%
Total	\$7.078	100%

Note: n.a. = not applicable.

Management of Moderate Acute Malnutrition

The unit costs of moderate acute malnutrition management were calculated based on the United Nations' World Food Programme (WFP) moderate acute malnutrition management program. WFP estimates that the treatment of one case of moderate acute malnutrition costs about USD 48. Children enrolled in the program receive about 200 g of supplemental food product (SuperCereal Plus, a fortified wheat-soy blend) per day until recovery (a weight-for-height Z-score higher than 2 standard deviations below the WHO norm) for an average of 75 days. Based on the interviews with WFP staff, the total input and transport costs were about USD 29.80 per case treated, the human resource cost was about USD 12.50 (26%) per case treated, and program management cost was USD 6.72 (14%).¹⁴ No budget information was available that would allow for a more detailed disaggregation of the unit cost components (see Table 10).

¹⁴ Because of the receipt of aggregated data, the human resource costs for NGOs to identify children and provide growth monitoring and promotion services as well as behavior change communication

Table 8: Estimated Unit Cost (Cost per Beneficiary): Management of Moderate Acute Malnutrition

Cost category	Unit Cost (USD)	Percent
Consumables and transport	USD 29.8	60%
Other (non-consumable) inputs	n.a.	1%
Human resources	USD 12.5	26%
Program cost	USD 6.72	14%
Household cost	n.a.	0%
Total	USD 48.00	100%

Note: n.a. = not applicable.

Treatment of Severe Acute Malnutrition According to the National Protocol

Bangladesh adopted a national protocol for the treatment of severe acute malnutrition in 2012 (IPHN 2012). In practice, severe acute malnutrition is still treated mostly in in-patient settings, which, according to anecdotal evidence, is one of the key reasons behind low coverage. Because the NPAN2 includes a plan for a rapid expansion of the outpatient protocol, this report develops estimates for outpatient rather than inpatient treatment cost.

Because no large-scale program delivered through the public sector exists, we approximated unit costs based on costs of a treatment program delivered by an NGO and reported in Puett et al. 2013. The treatment protocol from Puett et al. is consistent with that in the national protocol and includes ready-to-use therapeutic foods equivalent to the in-patient treatment with F-100 therapeutic milk, a single dose (5 mg) of folic acid, and a course of Cotrimoxazole (two doses daily for five days). In addition, the unit cost estimate includes the cost of human resources (community health workers delivering the treatment), as well as the cost of monitoring and supervision, training for staff (initial training and refresher training), growth monitoring, and home visits in the home of children diagnosed with severe acute malnutrition (see Table 11). For details see Puett et al., 2013.

Table 9: Estimated Unit Cost (Cost per Beneficiary): Treatment of Severe Acute Malnutrition According to the National Protocol

Cost category	Unit cost (USD)	Percent
Consumables	USD 41.587	27%
Other (non-consumable) inputs	n.a.	0%
Transport	n.a .	0%
Human resources	USD 6.939	4%

cannot be separated from the NGO overhead costs, and all NGO costs are included as human resource costs. Thus, the human resource costs are likely an overestimate, while the program costs are likely an underestimate.

Program cost	USD 108.037	69%
Household cost	n.a.	0%
Total	USD 156.564	100%

Note: n.a. = not applicable.

Salt Iodization

The Government of Bangladesh made salt iodization mandatory with the passage of the Salt Iodization Act in 1989.¹⁵ The Control of Iodine Deficiency Disorders (CIDD) project was established under the Bangladesh Small and Cottage Industries Corporation in the Ministry of Industries in 1995. However, weak monitoring; insufficient law enforcement at the factory, retail, and community levels; high consumer cost; the availability of crude salt; insufficient use of mass communication; and low political commitment contribute to persistent gaps in program coverage of iodized salt (IPHN 2015).

To estimate the unit cost of salt iodization we utilize current CIDD program costs and national salt iodization requirements (Table 12). It is estimated that Bangladesh has an average annual salt requirement of 900,000 metric tonnes (MT). Domestic salt production is generally sufficient to meet the national requirement, all of which must be fortified to achieve universal salt iodization.

The CIDD project centrally procures all potassium iodate (KIO₃) premix to be imported into Bangladesh through a fixed revolving fund to minimize costs. The KIO₃ is then sold to producers. The project provides a subsidy to the producers by paying the cost of freight, customs duty plus value added tax (VAT), and clearing and forwarding on the premix. These cost components are included in the operating budget of the project. Thus, the KIO₃ is sold to producers at a fixed market price that includes only the cost of premix. The present market rate of fortificant is, on average, USD 32,500 per MT. To achieve universal salt iodization, 100% of the salt must be iodized at a level of 45–50 parts per million (or 90 milligrams KIO₃ fortificant per 1 kg of salt).¹⁶ At this level, 81 MT of fortificant are required to adequately iodize the full salt requirement.

For the three operating years 2012/13 through 2014/15, the Bangladesh Small and Cottage Industries Corporation CIDD project expenditure report enumerated USD 1,986,253 in average annual operating expenditures (excluding the cost of KIO₃ procurement). The project budget consisted of funds from the following sources: the Government of Bangladesh, UNICEF, the Micronutrient Initiative, and the Global Alliance for Improved Nutrition (GAIN). We assume that, in order to become a sustainable government program, 100% of the funding will need to come from the GOB. We divided the project aid expenditure report into the following cost categories and added the cost of fortificant required to achieve current levels of coverage in order to estimate the total public and private cost salt iodization.

During operating years 2012/13 through 2014/15, the total amount of KIO₃ procured relative to the requirement (50.3%) is roughly equivalent to the share of households consuming adequately iodized salt (54.3%).

¹⁵ Salt used in the food industries and/or for livestock was exempted under this law.

¹⁶ We have used the requirement for salt iodization under the existing law rather than that proposed in the revised salt law (30-50 ppm of KIO₃)

To estimate the cost for scaling up, we determine costs to households and costs to government. At current levels of coverage, the government spends USD 0.023 per person. It is assumed that salt producers pass on 100% of the cost of fortificant to consumers. Assuming a stable price of fortificant, producers incur USD 0.02 or BDT 1.23 per person, which will be passed on to households (Table 12).

Table 10: Cost Component Calculation: Salt Iodization

Cost component	USD	Percent of total cost	Percent of total cost	USD per person (at 54.3% coverage)
Public cost components				
Customs duty, VAT + port charge and carrying	42,9747	22%	13%	n.a.
Publicity	137,778	7%	4%	n.a.
Human resources	82,213	4%	2%	n.a.
Quality control and quality validation	243,867	12%	3%	n.a.
Miscellaneous ^a	1,092,649	55%	36%	n.a.
Subtotal: Average annual public costs	1,986,253	100.0%	58%	USD 0.023
Private cost components				
Fortificant (at current coverage)	1,429,447.50	n.a.	42%	n.a.
Subtotal: Household costs	1,429,447.50	n.a.	42%	USD 0.02
Total cost for current coverage	3,415,700.83	n.a.	100%	USD 0.043

Note: a This includes program costs such as capital and capital-related recurrent costs, study tours, surveys and research, operating materials, meeting costs, and similar costs. n.a. = not applicable; VAT = value added tax.

The government will incur costs related to the clearance of additional fortificant as well as additional program management costs. Over the three operating years, the KIO3 procured was sufficient to adequately iodize 50.2% of all salt. Although the government will not incur any additional costs to procure sufficient KIO3 to iodize 100% of the salt requirement (these costs will be passed on to consumers), it will incur additional costs for freight, customs duty and VAT, and customs clearing and forwarding; these must be scaled up proportionately to achieve 100% salt iodization. We assume that simply procuring the additional fortificant will not be sufficient to achieve 100% adequate salt iodization. The National Micronutrient Strategy suggests that the following additional measures are necessary to achieve universal salt iodization: developing appropriate packaging and labeling standards, developing and implementing an incentive system for producers; providing price supports to low-income families to improve affordability; scaling up awareness and advocacy at the retail level; and implementing a Retailer Rapid Test Kit to prevent marketing of non-iodized salt for human consumption. These costs will all be borne by the Program. Therefore, we assume that to achieve universal salt iodization, cost components 1 through 4 (customs duty, VAT and port charge and carrying; publicity; human resources; and

quality control and quality validation) will have to increase proportionate to the scale-up from 54.3% to 100%. Cost component 5, miscellaneous, will be allowed to remain constant.

Fortification of Edible Oil with Vitamin A

Oil fortification is an effective strategy to combat vitamin A deficiency. Pregnant and lactating women as well as young children are at increased risk of vitamin A deficiency because of their high nutrient needs. According to the National Micronutrient Status Survey 2011–12, 20.5% of children (6–59 months) had subclinical vitamin A deficiency (serum retinol < 0.7 mmol/l). In the same survey, 2.7% of pregnant women and 2.4% of lactating women were night blind, a clinical sign of vitamin A deficiency; nearly half of pregnant and lactating women showed signs of subclinical deficiency (serum retinol <1.05 mmol/l) (icddr,b 2013).

The Ministry of Industries developed the Fortification of Edible Oil in Bangladesh project in 2010. Phase I of implementation continued through June 2013. In November 2013 the Government of Bangladesh endorsed the National Edible Oil Fortification Law for the mandatory fortification of all edible oil with vitamin A at a level of 20,000 international units of vitamin A per kilogram. In November 2015, the rules for vitamin A oil fortification were passed and all refineries were mandated to comply.

The Ministry of Industries is the key government agency responsible for implementing the project Fortification of Edible Oil in Bangladesh. Other key partners in this intervention are the Ministry of Health and Family Welfare; the Bangladesh Standards and Testing Institute; the Institute of Public Health and Nutrition; and development partners including the Micronutrient Initiative, UNICEF, and the Global Alliance for Improved Nutrition. The Ministry of Industries works in partnership with private sector refineries to ensure the fortification of edible oil. There are currently (2016) 36 functioning edible oil refineries; the Ministry of Industries has signed memoranda of understanding with 33 of the 36 refineries; the rest were anticipated to come on board soon after.

The project proceeded in two phases, with Phase 1 lasting from January 2010 through June 2013 and Phase II from July 2013 through December 2016. During Phase I of the Project, the government signed memoranda of understanding with 16 private sector refineries, providing premix at a full subsidy, as well as providing dosing pumps to select refineries and procuring a high-performance liquid chromatography (HPLC) machine to the Bangladesh Standards and Testing Institution (BSTI). Thus, during Phase I, the government had remarkably high overhead and programmatic costs; we did not use these costs in our calculations because the support that they require would not extend into the future.

The unit costs are generated based on program costs from Phase II of the Edible Oil Program. Phase II has a total project cost of USD 2,343,893 from July 2013 through December 2016, for an average annual cost of USD 686,017. During Phase II, the government procured 9.5 MT of fortificant to distribute to new producers and paid the 5% advance income tax on the fortificant, for a total cost of USD 648,375 over the project period. We have assumed that the practice of providing free fortificant will discontinue for Phase III, but that the annual balance of USD 189,583 will remain available to the project to be directed toward additional training for BSTI and refinery staff, building the staff and transportation capacity of BSTI to support quality assurance, sensitization, and outreach.

We assume that the production of adequately fortified oil will continue to be scaled up over the course of 2016 to reach 100% production by 2017. This will require that producers privately purchase 56 MT (56,000 kg) of premix at an average cost of USD 65/kg. The producers will also be liable for 5% import tax on the fortificant. Based upon previous experience (icddr,b 2013

modeling) we assume that the producers will also incur annualized capital costs at a rate of 5% of the total cost of fortificant and internal quality control costs also estimated at a rate of 5% of total fortificant cost. We assume that the private sector will pass on 100% of these additional costs to households (Table 13).

Table 11: Unit Cost Calculation: Fortification of Edible Oil with Vitamin A

Cost component	Unit cost (USD)	Percent of total public cost	Percent of total cost	USD per person
<i>Public cost components</i>				
Program operation	686,017	100%	14.1%	0.004
<i>Private cost components</i>				
Premix	3,640,000	n.a.	74.7%	n.a.
Import tax	182,000	n.a.	3.7%	n.a.
Annualized capital costs	182,000	n.a.	3.7%	n.a.
Internal quality control	182,000	n.a.	3.7%	n.a.
Subtotal: Private sector costs	4,186,000	n.a.	86%	0.026
Total cost for 100% coverage	4,87,2018	n.a.	100%	0.030

Note: n.a. = not applicable.

Rice Fortification

We estimated the cost of fortifying rice with six micronutrients—vitamins A, B1, B1, and zinc, folic acid, and iron. The data were provided by WFP based on its pilot rice fortification program. According to WFP, the incremental cost of fortifying 1 kilogram of rice is about BDT 1.75 or about USD 0.02. Premix (fortificant) accounts for about 70% of the incremental costs, and capital and recurrent costs for another 27% (see Table 14). These costs are incurred by the producers and passed on to the consumers. Premix duty and tax and quality control account for about 1% and 2% of the incremental cost, respectively. We classified duty and tax as public (opportunity) cost because in the analyses presented below, we assumed that they will be waived in order to promote the consumption of fortified rice. Therefore they represent the revenue forgone by the Government of Bangladesh to reduce consumers' cost and support fortification.

Table 12: Estimated Cost of Rice Fortification by Cost Component (Cost per kg of Fortified Rice)

Cost component	Unit cost (USD)	Unit cost (BDT)	Share of total cost	Share of total public cost
<i>Private cost components</i>				
Premix	USD 0.018	BDT 1.225	70%	n.a
Capital cost and recurrent cost	USD 0.007	BDT 0.4725	27%	n.a
<i>Public cost components</i>				
Premix duty and tax	USD 0.0003	BDT 0.0175	1%	33%
Quality control	USD 0.001	BDT 0.035	2%	67%
Total cost	USD 0.025	BDT 1.75	100%	100%

Note: n.a. = not applicable.

WFP estimates that the annual consumption of rice in Bangladesh is about 35 million MT or about 217.4 kg per capita per year. Based on this estimate, we calculated the total annual per capita cost of rice fortification to be about USD 5.17 with a public cost of about USD 0.15 (3% of the incremental cost).

Public Provision of Complementary Food

Public provision of complementary food is an intervention aimed at preventing malnutrition in food insecure populations (see Bhutta et al. 2013). At present there is no government program for the public provision of complementary food in Bangladesh. However, social safety net programs such as the Vulnerable Group Development and Vulnerable Group Feeding provide food aid to economically vulnerable women and children, and nutrition social safety net actions are included in the NPAN2 draft. Therefore public provision of complementary food to children 6–23 months living under the poverty line was included in this analysis.

Because no large-scale programs exist, unit costs are adapted from program costs for the delivery of complementary feeding by WFP. A number of assumptions were made regarding program design. We assume that beginning at age 6 months, each poor child will receive a daily food ration for 18 months and will exit the program upon the child's second birthday. We assume that an extra-fortified blended food called wheat-soy blend (SuperCereal Plus or SC+) will be used as the ration.¹⁷ We adopt a SuperCereal Plus ration based upon a recent trial in Bangladesh (Christian et al. 2015), which provided 32.7 g of SuperCereal Plus daily for children 6–11 months and 63.4 g of SC+ daily for children 12–18 months.¹⁸ The average annual cost is derived by dividing in half the total cost of feeding one child from age 6 months to age 24 months.

Our unit cost estimates assume that food would not be provided through the health sector but as a standalone program delivered by NGOs (Table 15).¹⁹ In this model, NGO staff provide growth monitoring and promotion, behavior change communication, and food provision, and are engaged in monitoring and reporting.

¹⁷ Though other fortified food options are available, we model the use of SuperCereal Plus because of its ready availability and its use by WFP worldwide for targeted supplementary feeding for the management of acute malnutrition and for the prevention of wasting and stunting.

¹⁸ Using the data from Christian et al. 2015, rations provided 20% of recommended energy intake for children age 6–11 months and 28% of recommended energy intake for children age 12–18 months. The trial did not include children 18–23 months, and so we assume that children 18–23 months will receive the same ration as those 12–18 months, perhaps resulting in an underestimation of total ration required.

¹⁹ Because of the receipt of aggregated data, the human resource costs for NGOs to identify children and to provide growth monitoring and promotion services as well as behavior change communication cannot be separated from the NGO overhead costs. The human resource costs are likely an overestimate, while the program costs are likely an underestimate.

Table 13: Estimated Unit Cost (Cost per Beneficiary): Public Provision of Complementary Food

Cost category	Unit Cost (USD)	Percent
Consumables	13.7	62
Transport	1.7	8
Human resources	5.8	26
Program cost	0.8	4
Household cost	n.a.	n.a.
Total	22.1	100

Note: n.a. = not applicable.

SUMMARY: UNIT COST CALCULATION

Table 16 presents a summary of the unit costs estimated for the direct nutrition interventions. The table includes the average unit cost as well as minimum and maximum estimated costs. The variation in the unit cost results from the difference in the estimated cost of transporting inputs from Dhaka to different regions.²⁰ Consequently the cost differences are most pronounced for interventions where transportation cost accounts for a large proportion of the unit cost. It should be noted that total costs for the treatment of severe acute malnutrition, management of moderate acute malnutrition, and public provision of complementary food could not be disaggregated to specifically identify transportation's share of total costs. Because the input costs for those interventions account for a substantial proportion of the overall cost and because the inputs are bulky (and therefore transportation cost would likely account for a substantial proportion of the cost) it is likely that differences in unit cost for those interventions would be substantial. Unfortunately, available data did not allow for direct estimation of those differences.

Table 14: Average, Minimum, and Maximum Unit Cost (Annual Cost per Beneficiary) or the Direct Nutrition Interventions Included
USD

Intervention	Average	Minimum	Maximum
Iron and folic acid supplementation during pregnancy	1.80	1.78	1.82
Calcium supplementation during pregnancy	1.49	1.47	1.51
Promotion of optimum infant and young child feeding ^a	3.56	3.56	3.56
Vitamin A supplementation for children	0.35	0.35	0.35
Therapeutic zinc and oral rehydration solution for the treatment of diarrhea	0.83	0.82	0.85
Deworming of children	0.38	0.38	0.39
Treatment of severe acute malnutrition	170.97	170.97	170.97
Management of moderate acute malnutrition	48.00	48.00	48.00
Salt iodization (public)	0.02	0.02	0.02

²⁰ Much smaller difference in salaries of health care provider resulting from difference in housing allowance were also taking into account but had much smaller impact of unit cost than the differences in the cost of transport.

Salt iodization (total)	0.04	0.04	0.04
Fortification of edible oil with vitamin A (public only)	0.004	0.004	0.004
Fortification of edible oil with vitamin A (total)	0.03	0.03	0.03
Public provision of complementary food	22.1	22.10	22.10
Rice fortification (public only)	0.15	0.15	0.15
Rice fortification (total)	5.07	5.07	5.07

Note: a In the section presenting impact and cost-effectiveness analysis, this intervention is split into breastfeeding promotion and education regarding optimum complementary feeding. This is because the LiST model treats those two interventions as separate, with different impact pathways on child health and nutrition status.

APPENDIX D: BASELINE INTERVENTION COVERAGE BY DIVISION

Division	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Rangpur	Sylhet	National
Iron Folic Acid coverage (% of pregnant women who took IFA during pregnancy) (FSNSP 2014)	23.00%	30.00%	30.00%	15.00%	27.00%	40.00%	13.00%	27.00%
Breastfeeding Promotion (% pregnant women with 4 or 4+ visits; BDHS 2014)	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%
Complementary feeding education (% pregnant women with 4 or 4+ visits; BDHS 2014)	14.00%	21.70%	26.30%	27.10%	25.65%	35.80%	16.00%	24.70%
Vitamin A supplementation (Source: BDHS 2014)	64.10%	65.00%	62.00%	64.50%	56.60%	65.50%	55.50%	62.10%
Deworming (FSNSP 2014)	60.00%	62.00%	62.00%	49.00%	53.00%	58.00%	57.00%	58.00%
Zinc for the treatment of diarrhea (BDHS 2014)	52.30%	38.70%	39.70%	35.70%	20.85%	38.1%*	42.70%	38.10%
SAM treatment	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MAM management	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% of households consuming iodized salt (15+ PPM) (MICS 2014)	62.40%	59.30%	64.60%	60.10%	36.30%	33.80%	50.70%	54.30%
Public provision of complementary food	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Rice fortification	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Calcium supplementation in pregnancy	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Fortification of edible oil with vitamin A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

*Data for Rajshahi not available. National average data was used.

APPENDIX E: ANNUAL TOTAL AND SCALE-UP (INCREMENTAL) COST BY INTERVENTION AND DIVISION
IFA SUPPLEMENTATION IN PREGNANCY

Full implementation cost:

Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$19,251	\$34,114	\$53,439	\$77,374	\$106,068	\$139,674	\$178,069	\$221,555	\$270,272	\$324,362	\$1,424,177
Chittagong	\$114,084	\$172,365	\$243,485	\$327,862	\$425,922	\$538,099	\$663,787	\$804,047	\$959,271	\$1,129,859	\$5,378,782
Dhaka	\$185,683	\$280,541	\$396,297	\$533,629	\$693,230	\$875,810	\$1,080,380	\$1,308,667	\$1,561,309	\$1,838,957	\$8,754,502
Khulna	\$15,489	\$37,906	\$70,613	\$113,952	\$168,275	\$233,940	\$310,821	\$399,505	\$500,316	\$613,585	\$2,464,402
Rajshahi	\$58,971	\$94,578	\$139,098	\$192,823	\$256,050	\$329,083	\$411,581	\$504,220	\$607,273	\$721,022	\$3,314,698
Rangpur	\$109,375	\$143,484	\$182,673	\$227,102	\$276,937	\$332,343	\$392,872	\$459,108	\$531,203	\$609,311	\$3,264,408
Sylhet	\$7,559	\$21,018	\$41,481	\$69,182	\$104,361	\$147,262	\$197,822	\$256,425	\$323,293	\$398,652	\$1,567,056
National	510,411	784,005	1,127,086	1,541,925	2,030,842	2,596,211	3,235,333	3,953,527	4,752,938	5,635,748	\$26,168,026

Scale-up (incremental) costs only:

Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$14,863	\$34,188	\$58,123	\$86,817	\$120,424	\$158,818	\$202,305	\$251,022	\$305,111	\$1,231,671
Chittagong	\$0	\$58,281	\$129,401	\$213,778	\$311,838	\$424,015	\$549,703	\$689,963	\$845,187	\$1,015,774	\$4,237,940
Dhaka	\$0	\$94,858	\$210,613	\$347,945	\$507,547	\$690,127	\$894,697	\$1,122,983	\$1,375,625	\$1,653,274	\$6,897,669
Khulna	\$0	\$22,417	\$55,124	\$98,463	\$152,786	\$218,451	\$295,332	\$384,016	\$484,827	\$598,097	\$2,309,515
Rajshahi	\$0	\$35,607	\$80,128	\$133,852	\$197,079	\$270,112	\$352,611	\$445,249	\$548,303	\$662,052	\$2,724,993
Rangpur	\$0	\$34,109	\$73,298	\$117,728	\$167,562	\$222,968	\$283,497	\$349,733	\$421,828	\$499,936	\$2,170,659
Sylhet	\$0	\$13,460	\$33,923	\$61,624	\$96,802	\$139,703	\$190,264	\$248,867	\$315,735	\$391,094	\$1,491,471

National	0	273,594	616,676	1,031,514	1,520,431	2,085,800	2,724,922	3,443,117	4,242,527	5,125,337	21,063,918
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BREASTFEEDING PROMOTION

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$266,326	\$298,570	\$333,036	\$369,787	\$408,887	\$450,404	\$493,622	\$539,249	\$587,342	\$637,961	\$4,385,184
Chittagong	\$931,339	\$1,044,099	\$1,164,625	\$1,293,141	\$1,429,875	\$1,575,058	\$1,726,194	\$1,885,750	\$2,053,931	\$2,230,946	\$15,334,957
Dhaka	\$1,530,069	\$1,715,319	\$1,913,328	\$2,124,464	\$2,349,099	\$2,587,617	\$2,835,913	\$3,098,043	\$3,374,342	\$3,665,156	\$25,193,349
Khulna	\$502,422	\$563,252	\$628,271	\$697,601	\$771,363	\$849,684	\$931,216	\$1,017,291	\$1,108,018	\$1,203,511	\$8,272,629
Rajshahi	\$594,449	\$666,421	\$743,350	\$825,378	\$912,652	\$1,005,318	\$1,101,785	\$1,203,625	\$1,310,970	\$1,423,955	\$9,787,903
Rangpur	\$496,889	\$557,048	\$621,352	\$689,918	\$762,868	\$840,326	\$920,961	\$1,006,087	\$1,095,815	\$1,190,257	\$8,181,521
Sylhet	\$328,822	\$368,634	\$411,188	\$456,562	\$504,838	\$556,097	\$609,458	\$665,791	\$725,170	\$787,668	\$5,414,228
National	4,650,315	5,213,343	5,815,150	6,456,851	7,139,582	7,864,504	8,619,149	9,415,835	10,255,588	11,139,454	\$76,569,771

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$32,245	\$66,711	\$103,461	\$142,561	\$184,078	\$227,297	\$272,923	\$321,016	\$371,636	\$1,721,928
Chittagong	\$0	\$112,760	\$233,287	\$361,803	\$498,536	\$643,720	\$794,855	\$954,411	\$1,122,592	\$1,299,608	\$6,021,572
Dhaka	\$0	\$185,250	\$383,260	\$594,395	\$819,030	\$1,057,548	\$1,305,845	\$1,567,974	\$1,844,274	\$2,135,087	\$9,892,663
Khulna	\$0	\$60,830	\$125,849	\$195,179	\$268,941	\$347,262	\$428,794	\$514,869	\$605,596	\$701,089	\$3,248,410
Rajshahi	\$0	\$71,972	\$148,901	\$230,929	\$318,203	\$410,869	\$507,335	\$609,176	\$716,521	\$829,506	\$3,843,412
Rangpur	\$0	\$60,160	\$124,463	\$193,029	\$265,979	\$343,438	\$424,072	\$509,198	\$598,926	\$693,368	\$3,212,635
Sylhet	\$0	\$39,812	\$82,365	\$127,740	\$176,015	\$227,274	\$280,635	\$336,969	\$396,347	\$458,845	\$2,126,003
National	0	563,028	1,164,836	1,806,536	2,489,267	3,214,189	3,968,834	4,765,520	5,605,274	6,489,140	30,066,623

COMPLEMENTARY FEEDING EDUCATION

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$241,309	\$270,525	\$301,753	\$335,052	\$370,479	\$408,096	\$447,255	\$488,596	\$532,172	\$578,036	\$3,973,274
Chittagong	\$843,856	\$946,024	\$1,055,229	\$1,171,674	\$1,295,563	\$1,427,109	\$1,564,049	\$1,708,617	\$1,861,001	\$2,021,389	\$13,894,511
Dhaka	\$1,386,346	\$1,554,195	\$1,733,605	\$1,924,908	\$2,128,443	\$2,344,556	\$2,569,530	\$2,807,037	\$3,057,383	\$3,320,880	\$22,826,883
Khulna	\$455,228	\$510,344	\$569,256	\$632,074	\$698,907	\$769,872	\$843,745	\$921,734	\$1,003,939	\$1,090,463	\$7,495,563
Rajshahi	\$538,611	\$603,823	\$673,525	\$747,849	\$826,924	\$910,887	\$998,292	\$1,090,566	\$1,187,828	\$1,290,200	\$8,868,504
Rangpur	\$450,215	\$504,724	\$562,987	\$625,112	\$691,210	\$761,393	\$834,453	\$911,583	\$992,883	\$1,078,453	\$7,413,013
Sylhet	\$297,935	\$334,007	\$372,564	\$413,676	\$457,417	\$503,862	\$552,210	\$603,252	\$657,053	\$713,680	\$4,905,658
National	4,213,501	4,723,642	5,268,921	5,850,345	6,468,945	7,125,774	7,809,533	8,531,385	9,292,259	10,093,101	\$69,377,407

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$29,216	\$60,444	\$93,743	\$129,170	\$166,787	\$205,946	\$247,287	\$290,863	\$336,727	\$1,560,184
Chittagong	\$0	\$102,168	\$211,373	\$327,818	\$451,708	\$583,254	\$720,193	\$864,761	\$1,017,145	\$1,177,533	\$5,455,952
Dhaka	\$0	\$167,849	\$347,259	\$538,562	\$742,097	\$958,210	\$1,183,184	\$1,420,691	\$1,671,037	\$1,934,534	\$8,963,424
Khulna	\$0	\$55,116	\$114,028	\$176,845	\$243,679	\$314,643	\$388,517	\$466,506	\$548,711	\$635,234	\$2,943,280
Rajshahi	\$0	\$65,211	\$134,914	\$209,238	\$288,313	\$372,276	\$459,680	\$551,955	\$649,217	\$751,589	\$3,482,392
Rangpur	\$0	\$54,509	\$112,772	\$174,898	\$240,995	\$311,178	\$384,238	\$461,368	\$542,668	\$628,238	\$2,910,865
Sylhet	\$0	\$36,072	\$74,628	\$115,741	\$159,482	\$205,926	\$254,274	\$305,316	\$359,118	\$415,745	\$1,926,303

National	0	510,142	1,055,420	1,636,844	2,255,444	2,912,274	3,596,033	4,317,884	5,078,758	5,879,601	27,242,400
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VITAMIN A SUPPLEMENTATION

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$110,214	\$121,704	\$133,896	\$146,810	\$160,466	\$174,885	\$189,786	\$205,442	\$221,870	\$239,090	\$1,704,163
Chittagong	\$396,316	\$435,826	\$477,665	\$521,900	\$568,595	\$617,820	\$668,582	\$721,843	\$777,661	\$836,097	\$6,022,305
Dhaka	\$601,265	\$670,680	\$744,698	\$823,448	\$907,066	\$995,687	\$1,087,729	\$1,184,747	\$1,286,861	\$1,394,195	\$9,696,376
Khulna	\$210,521	\$232,038	\$254,850	\$278,991	\$304,501	\$331,415	\$359,204	\$388,383	\$418,984	\$451,042	\$3,229,930
Rajshahi	\$191,803	\$220,262	\$251,032	\$284,182	\$319,780	\$357,898	\$397,978	\$440,590	\$485,795	\$533,659	\$3,482,978
Rangpur	\$214,709	\$235,582	\$257,661	\$280,981	\$305,576	\$331,479	\$358,160	\$386,133	\$415,427	\$446,075	\$3,231,783
Sylhet	\$102,013	\$117,921	\$135,173	\$153,811	\$173,875	\$195,406	\$218,101	\$242,274	\$267,959	\$295,196	\$1,901,729
National	1,826,840	2,034,012	2,254,976	2,490,123	2,739,858	3,004,590	3,279,541	3,569,410	3,874,558	4,195,354	\$29,269,264

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$11,490	\$23,682	\$36,596	\$50,252	\$64,671	\$79,572	\$95,228	\$111,656	\$128,876	\$602,024
Chittagong	\$0	\$39,509	\$81,349	\$125,583	\$172,279	\$221,503	\$272,266	\$325,527	\$381,345	\$439,780	\$2,059,142
Dhaka	\$0	\$69,416	\$143,433	\$222,183	\$305,801	\$394,422	\$486,464	\$583,482	\$685,596	\$792,930	\$3,683,728
Khulna	\$0	\$21,517	\$44,328	\$68,470	\$93,980	\$120,894	\$148,683	\$177,862	\$208,463	\$240,521	\$1,124,719
Rajshahi	\$0	\$28,459	\$59,229	\$92,379	\$127,977	\$166,095	\$206,175	\$248,787	\$293,992	\$341,856	\$1,564,949
Rangpur	\$0	\$20,873	\$42,953	\$66,273	\$90,867	\$116,771	\$143,452	\$171,424	\$200,719	\$231,367	\$1,084,698
Sylhet	\$0	\$15,908	\$33,160	\$51,798	\$71,862	\$93,393	\$116,089	\$140,261	\$165,946	\$193,183	\$881,599
National	0	207,172	428,135	663,283	913,018	1,177,749	1,452,701	1,742,570	2,047,718	2,368,514	11,000,859

DEWORMING (24 to 59 months)

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$106,138	\$119,607	\$134,039	\$149,463	\$165,907	\$183,399	\$201,650	\$220,949	\$241,320	\$262,791	\$1,785,264
Chittagong	\$396,321	\$442,076	\$490,864	\$542,772	\$597,888	\$656,303	\$716,972	\$780,921	\$848,229	\$918,978	\$6,391,325
Dhaka	\$659,987	\$736,182	\$817,428	\$903,870	\$995,654	\$1,092,930	\$1,193,961	\$1,300,454	\$1,412,542	\$1,530,358	\$10,643,366
Khulna	\$133,542	\$161,345	\$192,127	\$225,978	\$262,992	\$303,263	\$346,341	\$392,725	\$442,500	\$495,754	\$2,956,567
Rajshahi	\$184,851	\$217,088	\$252,310	\$290,609	\$332,076	\$376,805	\$424,219	\$474,927	\$529,012	\$586,560	\$3,668,458
Rangpur	\$185,042	\$210,801	\$238,546	\$268,334	\$300,226	\$334,283	\$369,979	\$407,843	\$447,930	\$490,294	\$3,253,278
Sylhet	\$118,268	\$135,501	\$154,112	\$174,142	\$195,634	\$218,629	\$242,785	\$268,450	\$295,662	\$324,458	\$2,127,641
National	1,784,150	2,022,600	2,279,427	2,555,169	2,850,377	3,165,612	3,495,907	3,846,270	4,217,196	4,609,193	\$30,825,899

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$13,469	\$27,901	\$43,325	\$59,768	\$77,261	\$95,512	\$114,811	\$135,182	\$156,653	\$723,882
Chittagong	\$0	\$45,755	\$94,543	\$146,451	\$201,567	\$259,982	\$320,651	\$384,600	\$451,908	\$522,657	\$2,428,114
Dhaka	\$0	\$76,195	\$157,441	\$243,883	\$335,667	\$432,944	\$533,974	\$640,467	\$752,555	\$870,372	\$4,043,497
Khulna	\$0	\$27,804	\$58,586	\$92,437	\$129,450	\$169,721	\$212,799	\$259,183	\$308,958	\$362,212	\$1,621,150
Rajshahi	\$0	\$32,236	\$67,459	\$105,758	\$147,225	\$191,954	\$239,368	\$290,076	\$344,161	\$401,708	\$1,819,944
Rangpur	\$0	\$25,759	\$53,503	\$83,292	\$115,184	\$149,240	\$184,936	\$222,801	\$262,888	\$305,252	\$1,402,854
Sylhet	\$0	\$17,232	\$35,844	\$55,874	\$77,366	\$100,360	\$124,517	\$150,182	\$177,394	\$206,190	\$944,960
National	0	238,450	495,277	771,020	1,066,227	1,381,462	1,711,758	2,062,120	2,433,046	2,825,043	12,984,402

ZINC AND ORS FOR THE TREATMENT OF DIARRHEA

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$136,947	\$161,584	\$188,562	\$217,952	\$249,826	\$284,258	\$320,815	\$359,957	\$401,750	\$446,262	\$2,767,911
Chittagong	\$268,463	\$357,398	\$460,240	\$577,431	\$709,423	\$856,676	\$1,018,048	\$1,195,071	\$1,388,159	\$1,597,733	\$8,428,642
Dhaka	\$443,032	\$583,124	\$744,315	\$927,273	\$1,132,681	\$1,361,236	\$1,611,099	\$1,884,678	\$2,182,602	\$2,505,507	\$13,375,547
Khulna	\$66,986	\$92,584	\$122,671	\$157,391	\$196,890	\$241,320	\$290,372	\$344,491	\$403,814	\$468,476	\$2,384,994
Rajshahi	\$31,910	\$60,443	\$98,488	\$146,359	\$204,377	\$272,870	\$351,619	\$441,237	\$542,022	\$654,277	\$2,803,602
Rangpur	\$56,990	\$76,409	\$98,934	\$124,663	\$153,699	\$186,145	\$221,753	\$260,859	\$303,557	\$349,939	\$1,832,948
Sylhet	\$104,939	\$133,869	\$166,698	\$203,547	\$244,542	\$289,810	\$338,944	\$392,445	\$450,426	\$513,005	\$2,838,226
National	1,109,268	1,465,411	1,879,907	2,354,617	2,891,438	3,492,314	4,152,649	4,878,739	5,672,329	6,535,199	\$34,431,870

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$24,637	\$51,615	\$81,005	\$112,879	\$147,311	\$183,868	\$223,010	\$264,804	\$309,315	\$1,398,444
Chittagong	\$0	\$88,935	\$191,777	\$308,968	\$440,959	\$588,212	\$749,585	\$926,608	\$1,119,695	\$1,329,270	\$5,744,008
Dhaka	\$0	\$140,091	\$301,282	\$484,241	\$689,649	\$918,204	\$1,168,066	\$1,441,646	\$1,739,569	\$2,062,475	\$8,945,223
Khulna	\$0	\$25,598	\$55,685	\$90,405	\$129,905	\$174,334	\$223,386	\$277,506	\$336,828	\$401,490	\$1,715,136
Rajshahi	\$0	\$28,533	\$66,578	\$114,448	\$172,466	\$240,960	\$319,708	\$409,326	\$510,112	\$622,367	\$2,484,498
Rangpur	\$0	\$19,418	\$41,943	\$67,673	\$96,709	\$129,154	\$164,763	\$203,869	\$246,566	\$292,948	\$1,263,045
Sylhet	\$0	\$28,931	\$61,759	\$98,609	\$139,603	\$184,871	\$234,005	\$287,506	\$345,487	\$408,066	\$1,788,838
National	0	356,143	770,640	1,245,349	1,782,170	2,383,046	3,043,381	3,769,471	4,563,061	5,425,932	23,339,193

TREATMENT OF SEVERE ACUTE MALNUTRITION ACCORDING TO THE NATIONAL PROTOCOL

Full implementation cost (Note: because current coverage of outpatient SAM treatment is assumed to be 0, full implementation costs and scale-up costs are the same)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$7,138	\$28,878	\$65,717	\$118,162	\$186,733	\$271,530	\$373,204	\$492,228	\$629,081	\$2,172,671
Chittagong	\$0	\$20,797	\$84,137	\$191,467	\$344,266	\$544,047	\$791,106	\$1,087,335	\$1,434,111	\$1,832,834	\$6,330,100
Dhaka	\$0	\$15,682	\$63,441	\$144,370	\$259,583	\$410,223	\$596,510	\$819,873	\$1,081,349	\$1,381,994	\$4,773,025
Khulna	\$0	\$7,882	\$31,886	\$72,560	\$130,467	\$206,178	\$299,806	\$412,069	\$543,486	\$694,591	\$2,398,924
Rajshahi	\$0	\$14,897	\$60,266	\$137,144	\$246,590	\$389,690	\$566,652	\$778,835	\$1,027,223	\$1,312,820	\$4,534,117
Rangpur	\$0	\$15,713	\$63,569	\$144,661	\$260,108	\$411,052	\$597,715	\$821,529	\$1,083,534	\$1,384,786	\$4,782,668
Sylhet	\$0	\$3,567	\$14,429	\$32,835	\$59,039	\$93,300	\$135,669	\$186,470	\$245,940	\$314,318	\$1,085,567
National	0	85,675	346,606	788,754	1,418,215	2,241,222	3,258,988	4,479,316	5,907,871	7,550,425	\$26,077,073

MANAGEMENT OF MODERATE ACUTE MALNUTRITION

Full implementation cost (Note: because current coverage is assumed to be 0, full implementation costs and scale-up costs are the same)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$7,091	\$28,689	\$65,286	\$117,387	\$185,508	\$269,749	\$370,757	\$489,000	\$624,955	\$2,158,422
Chittagong	\$0	\$18,131	\$73,352	\$166,924	\$300,137	\$474,311	\$689,701	\$947,960	\$1,250,285	\$1,597,900	\$5,518,703
Dhaka	\$0	\$20,546	\$83,120	\$189,152	\$340,104	\$537,470	\$781,542	\$1,074,191	\$1,416,774	\$1,810,677	\$6,253,577
Khulna	\$0	\$7,745	\$31,332	\$71,301	\$128,202	\$202,600	\$294,603	\$404,916	\$534,053	\$682,535	\$2,357,288
Rajshahi	\$0	\$15,373	\$62,192	\$141,527	\$254,473	\$402,146	\$584,766	\$803,731	\$1,060,059	\$1,354,785	\$4,679,052
Rangpur	\$0	\$11,205	\$45,332	\$103,161	\$185,488	\$293,128	\$426,242	\$585,848	\$772,688	\$987,517	\$3,410,609
Sylhet	\$0	\$4,506	\$18,229	\$41,484	\$74,590	\$117,875	\$171,404	\$235,586	\$310,720	\$397,109	\$1,371,505

National	0	84,597	342,247	778,835	1,400,381	2,213,039	3,218,007	4,422,989	5,833,580	7,455,479	\$25,749,155
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PUBLIC PROVISION OF SUPPLEMENTAL COMPLEMENTARY FOOD

Full implementation cost (Note: because current coverage is assumed to be 0, full implementation costs and scale-up costs are the same)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$25,037	\$101,288	\$230,495	\$414,441	\$654,946	\$952,365	\$1,308,978	\$1,726,440	\$2,206,439	\$7,620,428
Chittagong	\$0	\$58,220	\$235,536	\$535,996	\$963,745	\$1,523,019	\$2,214,640	\$3,043,912	\$4,014,684	\$5,130,879	\$17,720,632
Dhaka	\$0	\$111,346	\$450,462	\$1,025,094	\$1,843,165	\$2,912,777	\$4,235,504	\$5,821,488	\$7,678,091	\$9,812,816	\$33,890,744
Khulna	\$0	\$38,480	\$155,676	\$354,264	\$636,982	\$1,006,630	\$1,463,753	\$2,011,856	\$2,653,482	\$3,391,224	\$11,712,347
Rajshahi	\$0	\$42,125	\$170,419	\$387,815	\$697,308	\$1,101,964	\$1,602,380	\$2,202,391	\$2,904,783	\$3,712,394	\$12,821,578
Rangpur	\$0	\$50,149	\$202,884	\$461,692	\$830,143	\$1,311,885	\$1,907,628	\$2,621,940	\$3,458,135	\$4,419,594	\$15,264,049
Sylhet	\$0	\$22,046	\$89,190	\$202,965	\$364,940	\$576,719	\$838,614	\$1,152,633	\$1,520,234	\$1,942,901	\$6,710,242
National	\$0	\$347,403	\$1,405,454	\$3,198,321	\$5,750,724	\$9,087,941	\$13,214,884	\$18,163,197	\$23,955,848	\$30,616,248	\$105,740,020

RICE FORTIFICATION (PUBLIC COSTS ONLY)

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$137	\$16,450	\$60,579	\$133,468	\$236,085	\$369,417	\$533,629	\$729,978	\$959,359	\$1,222,690	\$4,261,791
Chittagong	\$480	\$57,525	\$211,843	\$466,736	\$825,586	\$1,291,847	\$1,866,098	\$2,552,727	\$3,354,873	\$4,275,737	\$14,903,452
Dhaka	\$788	\$94,507	\$348,030	\$766,788	\$1,356,331	\$2,122,338	\$3,065,758	\$4,193,800	\$5,511,622	\$7,024,482	\$24,484,442
Khulna	\$259	\$31,033	\$114,281	\$251,787	\$445,372	\$696,903	\$1,006,689	\$1,377,100	\$1,809,827	\$2,306,598	\$8,039,848
Rajshahi	\$306	\$36,717	\$135,214	\$297,906	\$526,950	\$824,552	\$1,191,082	\$1,629,339	\$2,141,328	\$2,729,091	\$9,512,485
Rangpur	\$256	\$30,691	\$113,023	\$249,014	\$440,467	\$689,228	\$995,602	\$1,361,933	\$1,789,895	\$2,281,195	\$7,951,304
Sylhet	\$169	\$20,310	\$74,794	\$164,788	\$291,485	\$456,105	\$658,853	\$901,277	\$1,184,486	\$1,509,610	\$5,261,879
National	2,395	287,233	1,057,764	2,330,486	4,122,275	6,450,389	9,317,711	12,746,153	16,751,390	21,349,403	\$74,415,200

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$16,313	\$60,441	\$133,331	\$235,947	\$369,279	\$533,492	\$729,841	\$959,222	\$1,222,552	\$4,260,419
Chittagong	\$0	\$57,046	\$211,363	\$466,257	\$825,106	\$1,291,368	\$1,865,618	\$2,552,247	\$3,354,393	\$4,275,257	\$14,898,655
Dhaka	\$0	\$93,719	\$347,242	\$765,999	\$1,355,543	\$2,121,550	\$3,064,970	\$4,193,012	\$5,510,834	\$7,023,694	\$24,476,561
Khulna	\$0	\$30,774	\$114,022	\$251,528	\$445,114	\$696,644	\$1,006,431	\$1,376,841	\$1,809,568	\$2,306,339	\$8,037,261
Rajshahi	\$0	\$36,411	\$134,908	\$297,600	\$526,644	\$824,246	\$1,190,776	\$1,629,033	\$2,141,022	\$2,728,785	\$9,509,423
Rangpur	\$0	\$30,435	\$112,767	\$248,758	\$440,211	\$688,972	\$995,347	\$1,361,677	\$1,789,639	\$2,280,939	\$7,948,745
Sylhet	\$0	\$20,141	\$74,625	\$164,619	\$291,316	\$455,936	\$658,683	\$901,108	\$1,184,317	\$1,509,441	\$5,260,185
National	0	284,838	1,055,368	2,328,091	4,119,880	6,447,994	9,315,316	12,743,758	16,748,995	21,347,008	74,391,248

SALT IODIZATION (PUBLIC COSTS ONLY)

Full implementation cost:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$78,339	\$87,211	\$96,662	\$106,709	\$117,369	\$128,658	\$140,372	\$152,711	\$165,691	\$179,328	\$1,253,048
Chittagong	\$247,406	\$279,842	\$314,660	\$351,930	\$391,721	\$434,107	\$478,403	\$525,293	\$574,839	\$627,108	\$4,225,310
Dhaka	\$482,358	\$531,415	\$583,411	\$638,428	\$696,551	\$757,864	\$821,155	\$887,600	\$957,275	\$1,030,257	\$7,386,314
Khulna	\$137,092	\$154,407	\$172,957	\$192,776	\$213,902	\$236,371	\$259,809	\$284,588	\$310,741	\$338,301	\$2,300,944
Rajshahi	\$59,173	\$81,139	\$106,868	\$136,482	\$170,103	\$207,857	\$249,476	\$295,342	\$345,567	\$400,267	\$2,052,273
Rangpur	\$42,883	\$60,878	\$82,272	\$107,174	\$135,697	\$167,954	\$203,740	\$243,369	\$286,946	\$334,575	\$1,665,490
Sylhet	\$63,851	\$76,183	\$89,756	\$104,608	\$120,779	\$138,307	\$156,985	\$177,038	\$198,501	\$221,410	\$1,347,416
National	1,111,102	1,271,074	1,446,586	1,638,108	1,846,121	2,071,118	2,309,939	2,565,941	2,839,561	3,131,246	\$20,230,795

Scale-up (incremental) costs only:

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$8,872	\$18,323	\$28,370	\$39,030	\$50,319	\$62,033	\$74,373	\$87,353	\$100,989	\$469,663
Chittagong	\$0	\$32,436	\$67,254	\$104,524	\$144,315	\$186,701	\$230,997	\$277,886	\$327,433	\$379,702	\$1,751,249
Dhaka	\$0	\$49,057	\$101,053	\$156,070	\$214,193	\$275,506	\$338,797	\$405,242	\$474,917	\$547,899	\$2,562,733
Khulna	\$0	\$17,316	\$35,865	\$55,685	\$76,810	\$99,279	\$122,717	\$147,496	\$173,649	\$201,209	\$930,027
Rajshahi	\$0	\$21,966	\$47,696	\$77,309	\$110,930	\$148,684	\$190,303	\$236,169	\$286,394	\$341,094	\$1,460,546
Rangpur	\$0	\$17,995	\$39,389	\$64,291	\$92,814	\$125,071	\$160,857	\$200,486	\$244,063	\$291,692	\$1,236,659
Sylhet	\$0	\$12,331	\$25,904	\$40,757	\$56,927	\$74,456	\$93,133	\$113,186	\$134,649	\$157,558	\$708,902
National	0	159,972	335,484	527,006	735,020	960,016	1,198,837	1,454,839	1,728,459	2,020,144	9,119,778

CALCIUM SUPPLEMENTATION IN PREGNANCY

Full implementation cost (Note: because current coverage is assumed to be 0, full implementation costs and scale-up costs are the same)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$3,038	\$12,289	\$27,965	\$50,282	\$79,462	\$115,547	\$158,813	\$209,462	\$267,699	\$924,557
Chittagong	\$0	\$10,570	\$42,763	\$97,314	\$174,974	\$276,514	\$402,082	\$552,642	\$728,892	\$931,544	\$3,217,294
Dhaka	\$0	\$17,163	\$69,433	\$158,004	\$284,099	\$448,965	\$652,846	\$897,304	\$1,183,474	\$1,512,513	\$5,223,800
Khulna	\$0	\$5,750	\$23,263	\$52,938	\$95,185	\$150,421	\$218,730	\$300,633	\$396,512	\$506,753	\$1,750,184
Rajshahi	\$0	\$6,745	\$27,288	\$62,098	\$111,655	\$176,449	\$256,577	\$352,652	\$465,121	\$594,438	\$2,053,023
Rangpur	\$0	\$5,716	\$23,125	\$52,624	\$94,620	\$149,529	\$217,432	\$298,850	\$394,159	\$503,747	\$1,739,802
Sylhet	\$0	\$3,729	\$15,086	\$34,330	\$61,726	\$97,547	\$141,844	\$194,958	\$257,134	\$328,625	\$1,134,979
National	0	52,711	213,246	485,272	872,541	1,378,888	2,005,057	2,755,851	3,634,754	4,645,318	\$16,043,639

FORTIFICATION OF EDIBLE OIL WITH VITAMIN A (PUBLIC COSTS ONLY)

Full implementation cost (Note: because current coverage is assumed to be 0, full implementation costs and scale-up costs are the same)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Barisal	\$0	\$370	\$1,497	\$3,406	\$6,124	\$9,678	\$14,073	\$19,343	\$25,512	\$32,605	\$112,609
Chittagong	\$0	\$1,294	\$5,234	\$11,911	\$21,417	\$33,845	\$49,214	\$67,643	\$89,215	\$114,020	\$393,792
Dhaka	\$0	\$2,126	\$8,599	\$19,568	\$35,185	\$55,603	\$80,853	\$111,128	\$146,569	\$187,320	\$646,950
Khulna	\$0	\$698	\$2,824	\$6,426	\$11,553	\$18,258	\$26,549	\$36,491	\$48,128	\$61,509	\$212,436
Rajshahi	\$0	\$826	\$3,341	\$7,603	\$13,670	\$21,602	\$31,412	\$43,174	\$56,944	\$72,776	\$251,347
Rangpur	\$0	\$690	\$2,793	\$6,355	\$11,426	\$18,057	\$26,257	\$36,089	\$47,598	\$60,832	\$210,096
Sylhet	\$0	\$457	\$1,848	\$4,205	\$7,561	\$11,949	\$17,376	\$23,882	\$31,499	\$40,256	\$139,034

National	\$0	\$6,460	\$26,135	\$59,474	\$106,936	\$168,993	\$245,734	\$337,750	\$445,465	\$569,317	\$1,966,264
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APPENDIX F: METHODOLOGY FOR ESTIMATING DALYs AVERTED, LIVES SAVED, AND CASES OF STUNTING AVERTED

Estimating DALYs averted

To estimate the disability-adjusted life years (DALYs) averted from each intervention, the lives saved, and stunting cases averted are first modeled using LiST.²¹ LiST is a part of an integrated set of tools that comprise the Spectrum policy modeling system. Once the demographic and health data have been updated, the coverage and scale-up plan for each intervention is introduced into LiST. Table E1 presents data sources.

Table E1: LiST Estimates Data Sources

Variable	Source
Demographic data	
First year population	UN DESA 2015
Sex ratio at birth	UN DESA 2015
Life expectancy	UN DESA 2015
Family planning	
Unmet need	LiST default, based on averages calculated for countries with similar levels of fertility
Total fertility rate	UN DESA 2015
Age-specific fertility rate	UN DESA 2015
Health, mortality, economic status	
Vitamin A deficiency	Black et al. 2013
Zinc deficiency	Wessells and Brown 2012
Diarrhea incidence	Fischer Walker 2012: 2010 data from this paper; 2005 data from unpublished addendum
Severe pneumonia incidence	Rudan et al. 2013
Malaria exposure (women)	Guerra et al. 2008
Stunting distribution	MICS 2006; data are drawn from DHS, MICS, and other nationally representative household surveys
Wasting distribution	None specified; default is to recalculate data for consistency across countries, using DHS and MICS datasets
Neonatal mortality	UN IGME No date; estimates for years 1996–2015; dataset last updated September 2015
Infant mortality	UN IGME No date; estimates for years 1996–2015; dataset last updated September 2015
Child mortality	UN IGME No date; estimates for years 1996–2015; dataset last updated September 2015
Distribution of causes of death	WHO estimates (2000–2015); publication forthcoming
Maternal mortality ratio	WHO estimates (2000–2015); publication forthcoming
Household poverty status	World Bank national poverty estimates (population living below USD 1.25 per day)
Household size	Data are drawn from DHS, MICS, and other nationally representative household surveys

Note: DHS = Demographic and Health Survey; IGME = Inter-agency Group for Child Mortality Estimation; MICS = Multiple Indicator Cluster Survey.

²¹ See <http://livesavedtool.org/> for more information on LiST.

LiST can estimate the impact of each intervention in isolation from other implemented interventions or calculate the simultaneous impact of a set of interventions implemented at the same time. The second, simultaneous method is likely to yield slightly lower estimates because interventions may have overlapping benefits. This analysis presents the individual or isolated results of the 10 interventions for full coverage (with totals calculated using the simultaneous method).

For each intervention, deaths averted are disaggregated by cause of death. To estimate the impact of interventions in terms of DALYs, the years of life lost (YLL) and years lost to disability (YLD) are estimated separately:

$$(YLL \text{ averted})_{CoD} = (Deaths \text{ averted})_{CoD} * (Life \text{ expectancy at average age of death})_{CoD}$$

$$(Total \ YLL \text{ averted})_{intervention} = \sum (YLL \text{ averted})_{CoD}$$

$$(YLD \text{ averted})_{CoD} = (YLL \text{ averted})_{CoD} * [(Total \ annual \ YLD)_{CoD} / (Total \ annual \ YLL)_{CoD}]$$

$$(Total \ YLD \text{ averted})_{intervention} = \sum (YLD \text{ averted})_{CoD}$$

where

CoD = cause of death.

For each cause of death impacted by an intervention, YLL averted are calculated as a product of the number of deaths averted and the average age at death from that cause (Yang et al. 2013). Results from the 2013 update of *Global Burden of Disease* (IHME 2013) are used to create a ratio of age-specific total YLD and total YLL for each cause of death in a country. This ratio is then used as a multiplier for YLL averted to estimate the YLD averted for each cause (Montagu et al. 2013; Weinberger, Fry, and Hopkins 2015). For curative interventions, it is assumed that there will be some disability prior to provision of the intervention and the intervention will only avert half of the YLD.

DALYs averted by each intervention is estimated as the sum of YLL averted and YLD averted across all causes of death impacted by a given intervention:

$$(DALY \text{ averted})_{intervention} = (total \ YLL \text{ averted})_{intervention} + (total \ YLD \text{ averted})_{intervention}$$

The estimated DALYs averted will be presented as such (for example, undiscounted) and will also be discounted by 3%, which is the standard discount rate for health interventions and is also recommended by the WHO for cost-effectiveness analysis (WHO 2014a). Sensitivity analysis will be performed by varying the discount rate between 0% and 7%, as recommended by the WHO.

Estimating Lives Saved

The projected number of lives saved is also calculated using LiST, which translates measured coverage changes into estimates of reductions in mortality. Because of limitations in LiST, the

calculation for the number of lives saved is based on only subset of the 10 interventions;²² thus the estimates presented are likely to underestimate the actual number of lives saved.

Estimating Cases of Stunting Averted

In order to estimate the number of cases of under-five stunting averted attributable to the annual investment in the scaling up of nutrition interventions, LiST is used to model changes in the prevalence of stunting over five years, during which the interventions are projected to have reached 90% of the target population. Next, changes in the prevalence of stunting over five years with no scale-up of the interventions are modeled. Then the difference between the estimated stunting prevalence in Year 5 with the scale-up and the prevalence in Year 5 absent the scale-up is taken, and this percentage point difference is multiplied by the total population of children under five years of age.

The reason for using stunting prevalence in Year 5 relates to the assumptions built into the LiST model, which assumes that stunting is itself a risk factor for becoming stunted in the next time period. As a result, stunting prevalence remains flat during the first two years of the scale-up, before dropping precipitously until Year 5, after which the prevalence begins to level out. The assumption is made that continuing investments to maintain scale after Year 5 will serve to maintain the gains in stunting prevalence reduction, and therefore this reduction is presented as a benefit attributable to a one-year investment in scaling up nutrition.

On the other hand, when estimating stunting reduction (and lives saved) attributable to a five-year scale-up plan, this scale-up is modeled directly in LiST and the annual results over five years are used in the cost-benefit analysis. Using annual results over five years provides a more accurate portrayal of the direct benefits attributable to a five-year scale-up plan, and it does not assume that the scale will necessarily be maintained following the end of the period covered in the plan.

²² These interventions include breastfeeding counseling, complementary feeding education, vitamin A supplementation, zinc supplementation for the treatment of diarrhea, the treatment of severe acute malnutrition, and the management of moderate acute malnutrition.

APPENDIX G: METHODOLOGY FOR ESTIMATING ECONOMIC BENEFITS

Benefits were calculated based on estimates of lives saved and cases of stunting averted obtained from the LiST model (see above). In the base-case scenario, one life saved at age five was valued as one times GDP per capita. One case of stunting averted was valued at 21% of GDP per capita based on estimates of the impact of childhood stunting on adult wages (Hoddinott et al. 2013) and further adjusted to account for the proportion of income from wages (52%) (based on Lubker 2007). Benefits resulting from the prevention of cognitive losses resulting from iodine deficiency were also included.

The following equation summarizes the approach to the valuation of health outcomes and calculation of monetary benefits:

$$B = LS * (1 - P) * GDPpc + LS * P * GDPpc * (1 - S) * L + CS * GDPpc * S * L + IS * GDPpc * I$$

where:

- B = monetary benefits
- LS = unique lives saved
- CS = unique cases of stunting prevented
- IS = additional children who benefited from salt iodization
- P = prevalence of stunting
- $GDPpc$ = GDP per capita
- S = percent of wage income gained as a result of the child not being stunted
- I = percent of wage income gained as a result of the child not suffering from iodine deficiency
- L = proportion of income from labor

The benefits were calculated over the lifetime of children benefitting from the interventions. Conservatively, it was assumed that the children would start earning wages at the age of 18 and earn until the age of 72 (the life expectancy at birth in Bangladesh).

LiST is a cohort model that produces annual estimates of prevalence and mortality in a cohort of children 0–59 months of age. Over five years, the same child would contribute to stunting prevalence and mortality averted five times as he or she ages through the cohort (once at 0–11 months, then again at 12–23 months, and so forth). Consequently, the same child could be saved from being stunted or from dying multiple times during that time period (for example, a child could be at risk of dying from diarrhea at age 1, then again at age 2, then again at age 3 and so forth).

To avoid counting and assigning a monetary value multiple times to stunting or mortality averted in the same child, based on the LiST output, estimates were made of unique lives saved and unique cases of stunting averted. More specifically, every year, the number of cases of stunting averted and lives saved in children 48–59 months old who would be aging out of the LiST cohort in that year were estimated. Consistent with the extant literature, it was assumed that after children reach five years of age, their stunting status is irreversible and that children who are not stunted at age five would remain not stunted and vice versa.

Net present value was calculated using the following formula:

$$NPV = \sum_{t=0}^n \frac{(Benefits - Costs)_t}{(1 + r)^t}$$

where:

r = discount rate

t = year

n = analytic horizon (in years)

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This report presents an analysis of the costs, benefits, and cost-effectiveness of implementing a set of key nutrition interventions included in Bangladesh's second National Plan of Action on Nutrition (NPAN2). The total public investment needed to implement the interventions is estimated to be USD 536.9 million over 10 years (or about USD 53.7 million annually). This includes USD 152.8 million to maintain the current coverage of the intervention and an additional USD 384.8 million to expand their coverage gradually to reach 90% over 10 years. The analyses demonstrate that investing in nutrition in Bangladesh is very cost-effective and that the benefits it would generate greatly outweigh the initial investment costs. Expanding coverage of the interventions would, over 10 years, result in preventing almost 50,000 deaths and over 500,000 cases of stunting in children under five years of age and in averting over 860,000 DALYs. Those gains would translate into increases in economic productivity worth about USD 5.6 billion over the productive lives of the children who benefited from the interventions. The benefit-cost ratio would be 20.5, which means that every dollar invested in nutrition would bring in over 20 dollars in economic benefits. Averting one death would cost about USD 7,700; averting one DALY, about USD 447, and preventing once case of stunting, about USD 765. Geographic targeting in the short and medium term could lead to increased efficiency of investments.

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