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Saving Brains: Literature review of reproductive, neonatal, child and maternal health and nutrition Interventions to mitigate basic risk factors to promote child development

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Introduction

Significant reductions in child and maternal mortality have been achieved worldwide in the past two decades. However, recent surveys in *Lancet* also indicate that currently about 200 million children under five years of age in developing countries fail to reach their full cognitive developmental potential. This creates a vicious cycle whereby poverty increases the risk factors related to neonatal, child and maternal health during the First 1000 Days, which have long-lasting effects on cognitive development, socioemotional skills, executive function/self-regulation and physical health, all of which affect productivity in adulthood. Preventing exposure to, and effect of, these risk factors in the First 1000 Days has the potential to increase the productive wealth embodied in individuals' intellectual, social and physical capabilities. There is increasing evidence that reducing the four risk factors in the First 1000 Days of life has substantial impacts on child cognitive, socioemotional and physical development – and on outcomes over the life cycle. However, not only impacts but also costs of interventions must be considered. Most of the literature has focused on impacts, with little or no attention to costs. A visible exception is the Copenhagen Consensus, which has promoted developing benefit-cost ratios based on the best available scientific evidence to compare a wide range of projects.

Progress falls short of reaching the Millennium Development Goals and effective coverage rates remain low or stagnant for many essential reproductive, maternal, child and newborn health interventions. It is not for a lack of evidence on what works. In fact, the WHO, the partnership for maternal, newborn and child health and other advocacy groups have identified essential and effective interventions related to reproductive, maternal, newborn and child health[1]. In the past several years, there have been a number of recent global initiatives looking at the additional investment which will be required to strengthen health systems and service delivery to increase the delivery and coverage of these evidence-based interventions that would address many of the risk factors related to the first 1000

days[2-8]. These initiatives using the best available impact and cost models have provided important budgetary estimates of overall total costs and cost per beneficiary using the available data from WHO, international drug and commodity lists and published country studies. While they tell us broadly about the budgetary requirements of packages of interventions, information on specific intervention unit costs are not readily available. In most cases, they do not capture the private household costs or shared governmental program costs reflected at the national and sub-national levels, which are highly contextual depending on region, country and target population.

As part of the overall strategy of Team1000+ to build a state-of-the-art economic model to assess the impacts and costs of the four early life risk factors, there is also a sub-component to estimate the resource costs of selected interventions to reduce the risk factors. As noted, much of the literature on maternal newborn and child risk factors related to the First 1000 days focuses on ascertaining the impacts of interventions, but pays little or no attention to costs of such interventions. Both impacts and costs are critical for judging whether an intervention is warranted on economic grounds. The objective of this paper is to present the results of a literature survey on the resource costs of possible interventions for risk factors related to nutrition and optimal infant feeding, disease prevention, pregnancy and birth outcomes, and caring behaviors and maternal depression. The focus of this review is on intervention costs and does not capture private household costs, such as out-of-pocket payments or indirect costs associated with reduced labor productivity.

Methods

Search Strategy and Article Retrieval

We conducted a systematic search of published literature on the following online databases: PubMed, NHS-EED, Embase, DARE, EconLit, HEED, and PEDE. We used the following search term categories in combination: cost analysis, low- and middle-income countries, and health terms pertaining to the first 1000 days of human life.

We split the health terms into sub-groups regarding reproductive, maternal, neonatal, and child health, as well as nutrition. See appendix 1 for full list of search terms. The search was limited to articles published on or after January 1st, 2000. To supplement the search, we consulted expert opinions for recommendations, and searched reference lists to identify relevant studies, called the snowballing strategy. We did not conduct a systematic search for grey literature, although our search captured some non-journal sources.

We omitted search terms, and subsequent article output, for infectious disease interventions related to HIV/AIDS, TB, PMTCT, or vaccine preventable diseases (other than rotavirus, HiB and pneumococcal disease) and malaria. Many of the interventions for HIV/AIDS and TB are targeted to adult male and female populations, and not necessarily pregnant women. For HIV/AIDS, the Futures Group has an online database providing unit costs by type of intervention and by country. For vaccine preventable diseases and PMTCT, there are recent reviews that can be used to obtain unit costs for these interventions[9-16]. Given the breadth of data in these areas, we chose to focus on the other reproductive, maternal and child health and nutrition risk factors where existing reviews were not available.

After the initial search, we reviewed titles and abstracts, excluding articles that had any of the following characteristics: not economic evaluations; did not have data regarding a low- or middle-income country (as defined by the World Bank); did not refer to reproductive, maternal, or child health interventions; not in English; published before January 2000.

Two independent reviewers screened the full text of articles that passed the initial inclusion criteria. We did use both the Drummond Checklist and Mogyorosy and Smith's 2012 literature review for guidance in creating our own guidelines regarding quality and inclusion[17, 18]. Considering the full text, we included studies that included the following criteria:

- At least one type of economic evaluation, such as cost analysis, cost-effective analysis, or cost-utility analysis. Only economic evaluations with clear unit cost data were considered. (i.e. we did not consider studies with net costs presented in ratios with DALYs, QALYs or YLL that did not provide some disaggregation of costs).
- Either original unit cost data regarding a CVD intervention, or unit costs from a credible and known source, such as WHO CHOICE data.
- Direct intervention costs from the provider perspective, defined as the cost to implement the intervention, regardless of payer or indirect costs. Studies from alternative perspectives were considered if they delineated provider costs.
- A description of the intervention and analysis, including the time and location of data collection.
- The year and currency of all costs presented.
- Article availability in English.

Data Extraction

We extracted cost information from the articles that met our inclusion criteria, which was entered into an Excel spreadsheet. For each study, we noted the disease condition, target population, type of treatment or intervention, and level of care. We also recorded information on the study methods, such as type of economic evaluation, perspective, sample size, cost categories, and cost metrics.

We searched each article for total treatment or intervention costs, and extracted the total costs or unit costs, most often defined as the as treatment cost per person or cost per event. We extracted multiple cost data points from a single publication if the study presented more than one intervention or if the study presented costs from various countries.

We converted the extracted local currency units to 2012 values using the World Bank consumer price indices of the country listed; we used the World Bank 2012 conversion rates to put all costs in 2012 US Dollars. Once the total costs were extracted and converted to a common currency, we grouped similar interventions and qualitatively compared the magnitudes and variability of total and input costs.

Results

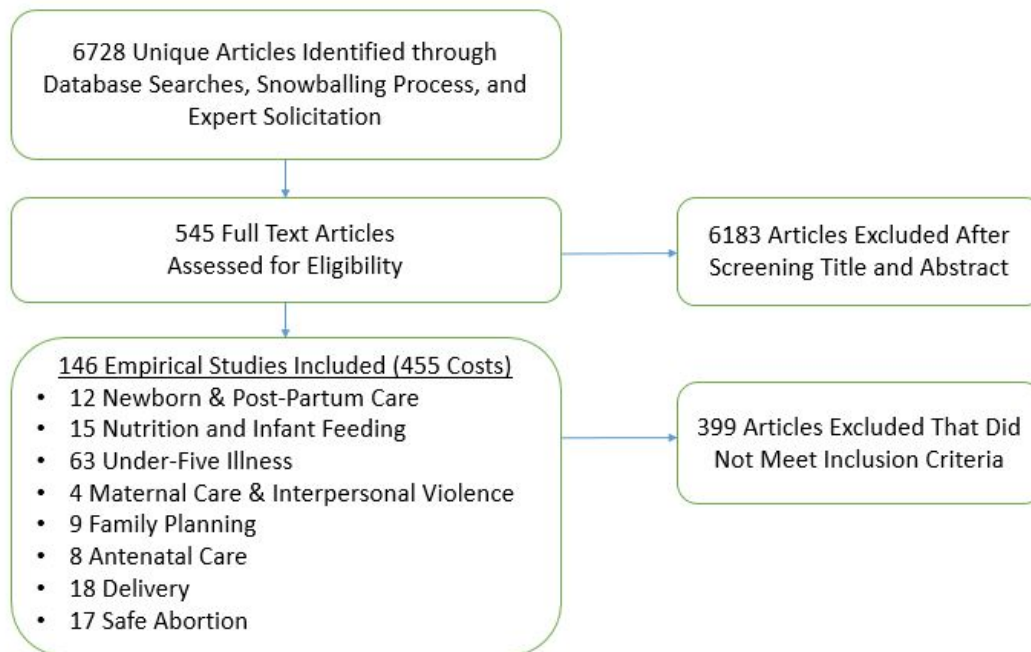
Search results

Using the search strategy described above, PubMed and other databases yielded 6728 unique articles. After assessing for eligibility, 545 full text articles were assessed for eligibility. Of these, 399 articles were excluded for not meeting inclusion criteria. The final set of 146 studies included: 9 studies for family planning, 8 for antenatal care, 18 for delivery, 17 for safe abortion, 12 for newborn and post-partum care, 15 for nutrition and infant feeding, 4 for maternal care and interpersonal violence, and 63 for child illness. See Figure 1 for the search strategy[19-161].

A total of 455 unit costs were extracted, with 73 unit costs for delivery, 56 for safe abortion, 40 for family planning and 30 for antenatal care services. A majority of costs were for under-five illness (180), followed by 41 for nutrition and infant feeding and 23 for newborn and post-partum care. Our search for maternal depression did not yield any studies, and we identified only a few studies on maternal care and interpersonal violence, which provided only 12 unit costs.

The majority of the articles were published after 2007, coming from studies conducted in Sub-Saharan Africa and South Asia, with about 80 percent of these countries falling into low and lower- middle-income classification. Articles were split fairly evenly between low- and lower-middle income countries, however articles regarding abortion and child illness were predominantly in lower-middle. Nutrition articles were evenly split by income class but mostly in sub-Saharan Africa. Articles concerning neonatal costs were more frequently from south Asian and Latin American regions. Most articles focused on a single country, while nine articles presented results from multi-country studies.

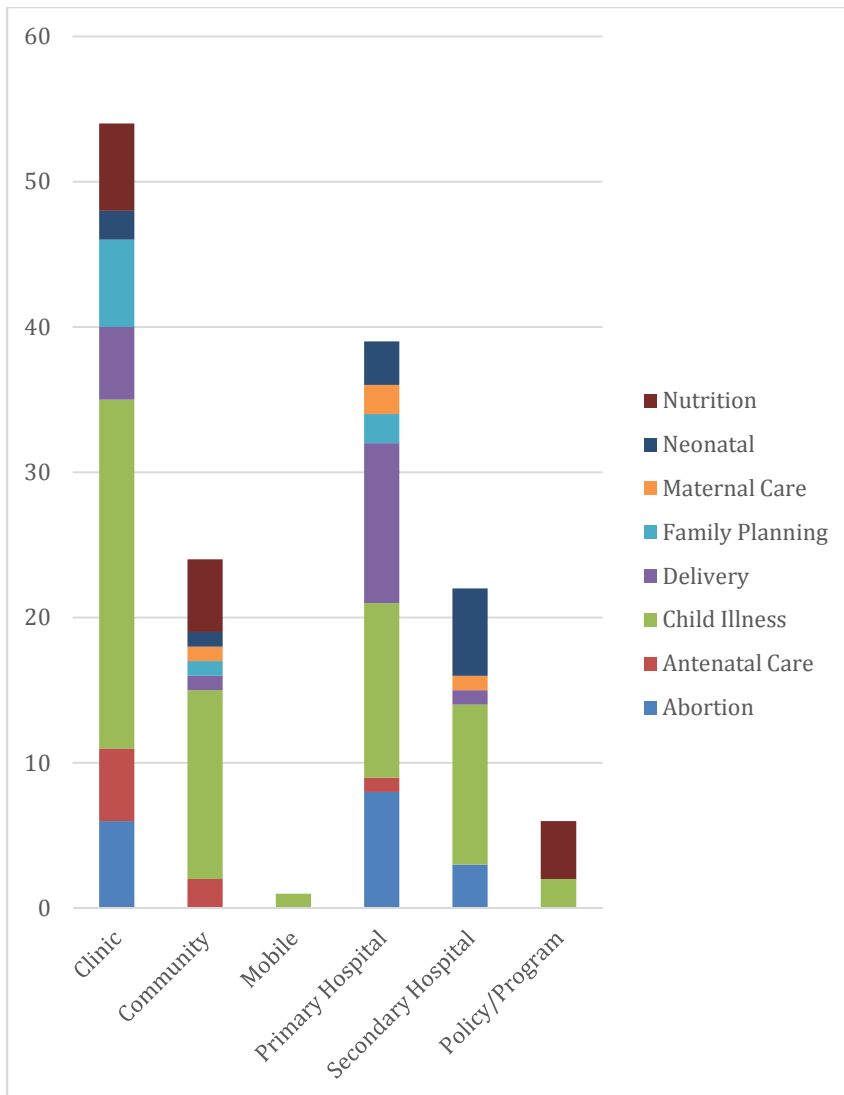
Figure 1. Flow chart of identification, screening, and eligibility of included studies



Study characteristics

Figures 2 through 5 describe the characteristics of the combined set of articles. Overall, the set of studies reflects recent studies in some of the poorest countries in Sub-Saharan Africa and South Asia. Most of the articles have been published within the last 5 to 6 years, with 75 percent published in 2008 or later. The greatest number of articles estimates the costs of interventions or treatment for preventable childhood illness, followed by reproductive health, with 61 and 53 studies respectively.

Figure 2. Articles by condition for reproductive, neonatal, child illness, nutrition and maternal care



For reproductive health studies, the bulk of the articles were for costs of abortion, delivery or family care and capture services delivered in health centers (40%), and primary hospitals (43%). For child illness, 51 percent of the articles are related to treatment or prevention costs for diarrheal disease or fever, and an additional 10 percent for pneumonia. Of the 21 articles for nutrition, over 70 percent focus on child nutrition, 20 percent for infant nutrition and 10 percent for mother and children. For neonatal health 9 of the 10 articles provide costs on newborn care, for treating premature newborns or costs associated with preterm or low birth weight. Maternal, neonatal and child health studies capture costs of services provided across multiple settings, including a greater number of community settings, when

compared to studies for reproductive health. Campaigns play a more prominent role in child health and nutrition, compared to reproductive health services.

Figure 3. Number of articles by World Bank region and condition

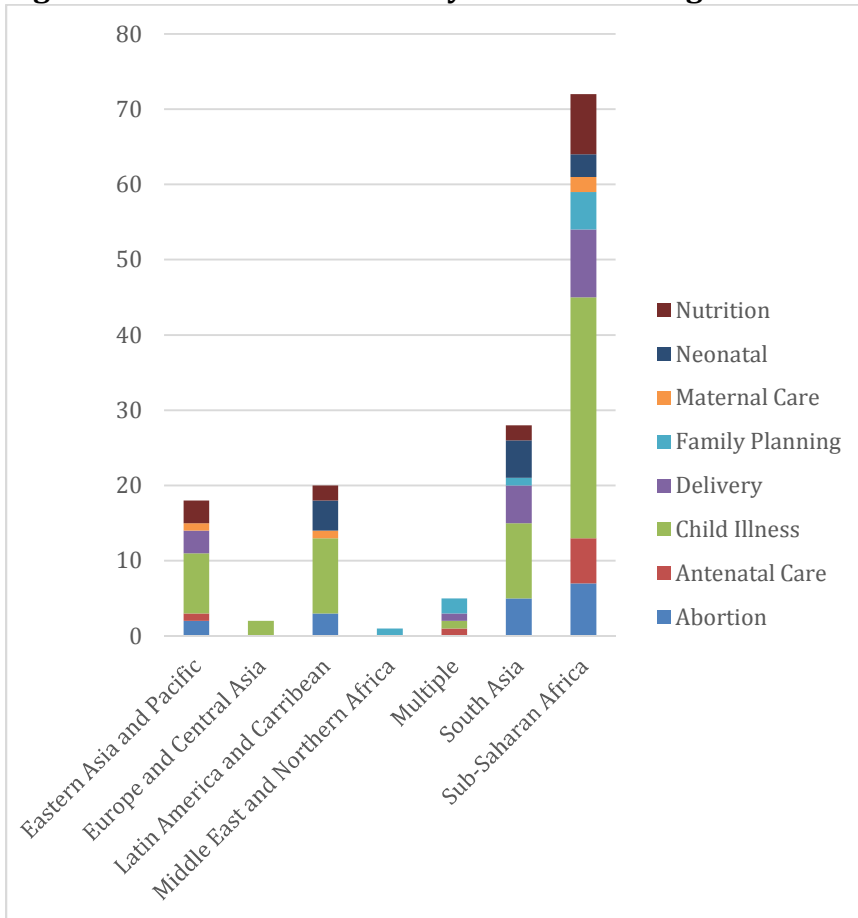


Figure 4. Articles by income classification and condition

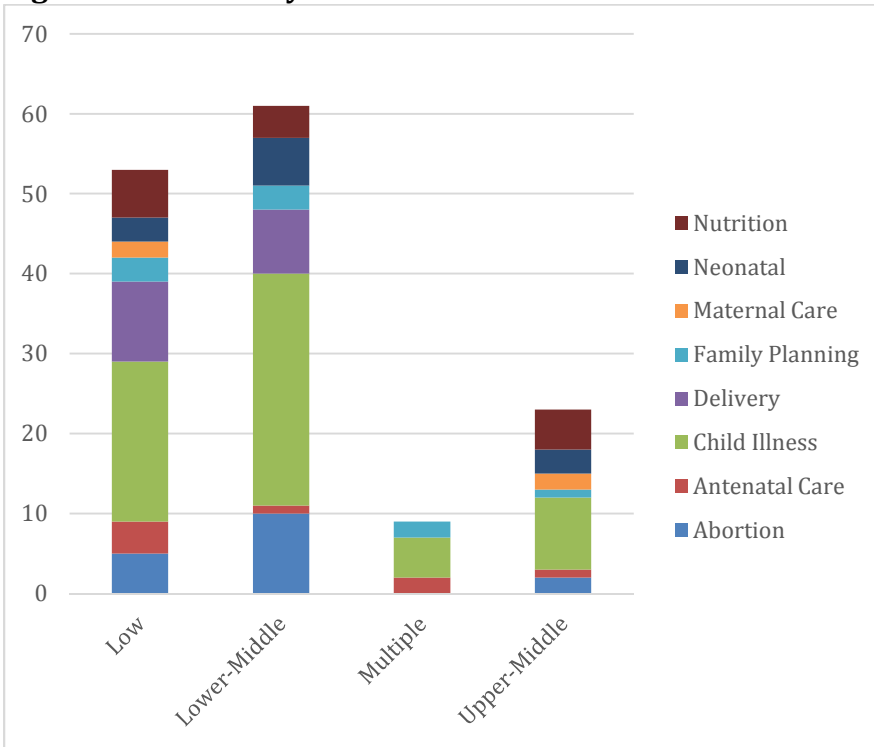
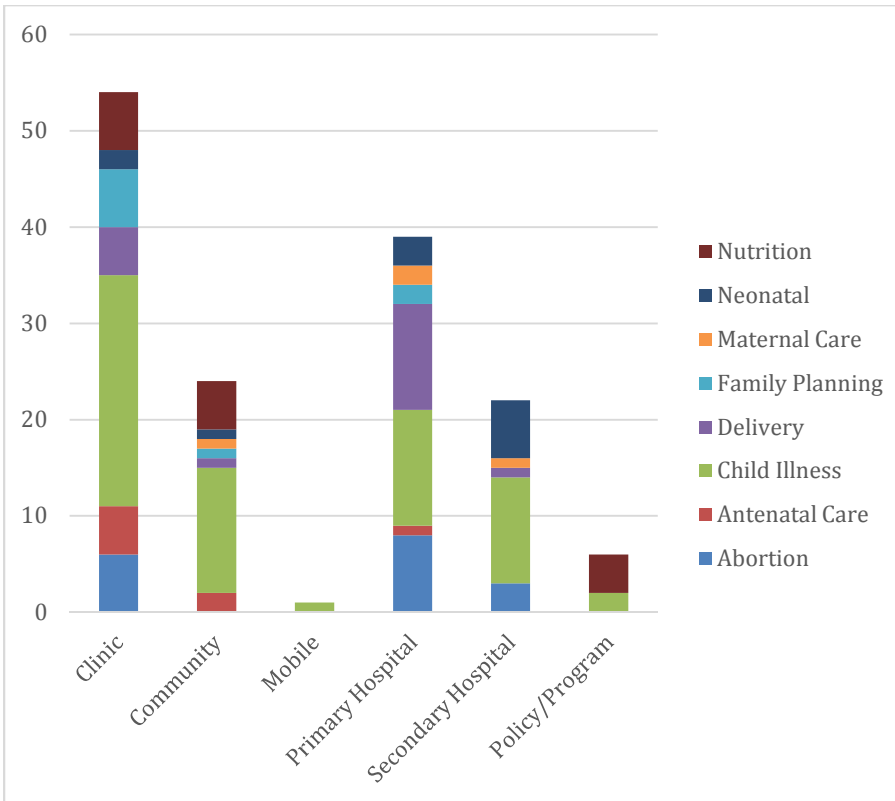


Figure 5. Articles by condition and level of care



Summary of study methods in literature reviewed

The majority of costs were extracted from cost analyses (N=91) however nearly 40% of the studies were cost-effectiveness analyses (N=50). There were also 3 cost of illness studies and 2 cost-benefits studies. The highest share of cost studies came from reproductive health and childhood preventable diseases. Most cost studies were empirical, with about one-third estimated from models. Almost half of the studies relied on data from retrospective studies, while one-third were prospective studies and the remaining were modeled and not based on primary data. Studies used a variety of methods, with the majority based on ingredients approach (53%) or record review (45%). These varied by condition, with studies in reproductive health and nutrition most likely to be based on ingredients based costing, while interventions for newborn care were predominantly based on record review. For estimating costs for preventable childhood illnesses about half the studies used ingredients approach and half used record reviews. See Appendix 2 for details on methods used across studies.

Unit costs

In this section, we briefly present a description of the unit costs for interventions to address risk factors associated with the first 1000 days. The results are organized along the lines of reproductive, neonatal, child health and nutrition and maternal interventions. While details are provided below, in general, average unit costs are lower for family planning interventions, ANC visits, and for normal deliveries at home or health centers with trained birth attendants, and tend to increase in cost with the complexity of the service (i.e. treatment of obstetric or abortion complications, treatment of severely acute malnourished child and a range of community based nutrition interventions). For instance, breastfeeding support and prevention of micronutrient deficiencies are inexpensive compared to nutrition education programs and treatment of severe acute malnutrition. Malaria prevention and treatment of febrile illness and diarrheal disease are less expensive

per child than treatment of pneumonia and meningitis, which typically require inpatient admission.

Family planning, delivery and complications

Family planning costs associated with temporary methods varies depending on country and FP method (Tables 1-3). The average cost per beneficiary is higher for permanent methods of contraception compared to temporary methods (US \$25 per beneficiary, when excluding results from Iran, compared to US \$2.45 per visit to receive contraceptives). However the average cost per couple year protection is lower for permanent methods at US\$9 per CYP, compared to US \$27 per CYP for temporary methods. Data from two African countries exhibit in variability in costs, ranging from \$0.41 per visit to obtain male condoms and \$1.14 per visit for injectable contraceptives in Lesotho, to \$3.19 for condom distribution and \$2.80 for injectable contraceptives in Uganda. When excluding Iran from the countries with data on temporary methods, the costs per couple year projection (CYP) range from around \$9 to \$33 for a range of modern family planning methods. Permanent methods, such as tubal ligation and vasectomy, are similar and range from \$2 to \$25. Lesotho's lower costs per visit and CYP are likely due to methodological differences compared to other studies.

Antenatal care (ANC) costs include ANC visits, screening for syphilis and delivery costs at different locations. Tables 3-7 provide the average unit costs of ANC visits by type of facility and for some specific treatment costs as part of pregnancy. The average cost of an ANC visit in African settings was US \$6.20 and varied from US \$3.50 per woman to US \$16 depending on the country setting and service delivery level. A key component of many ANC visits is the prevention of congenital syphilis among infants through maternal syphilis screening. Syphilis screening per se is inexpensive with average incremental costs ranging from \$1.50 to \$5 per woman screened and increasing to US \$20 to US \$100 per woman screened when treatment rates are considered. There is limited information for the treatment of anemia, management of STIs and malaria prevention for pregnant women, but the little data

available indicate that incremental unit costs are low compared to average ANC visit costs per woman.

Delivery costs varied depending on the location of the birth and delivery method. On average, vaginal births at home supported by skilled birth attendants were US \$8 per delivery (range US \$6 to US \$9), vaginal births at health centers (range US\$18 to US \$62) and hospitals (range US \$1.82 to US \$ 152) had an average cost of US \$35 per delivery, and caesarian section deliveries averaged \$175 per delivery (range US \$60 to US \$580). On average, unit costs for treating a range of obstetric complications for hemorrhage, pre-eclampsia/eclampsia, obstructed labor and sepsis cost US\$89.68 per delivery. However there was variability in treatment of specific complications, both across the range of complications, and across different country settings within specific complications. Sepsis and obstructed labor were less expensive to treat at US \$61 and US \$67 per delivery, respectively, while treatment of pre-eclampsia/eclampsia and maternal hemorrhage were about US \$100 per delivery.

Tables 8-9 provide the costs associated with abortions and abortion complications. Average unit costs for abortion range from around US \$8 per person in Vietnam to US \$160 in Mexico, depending on the country, type of hospital (public or private) and procedure. Post abortion complications ranged from US \$25 per woman treated to US \$2,368 per woman, with an average cost of treating post-abortion complications at US \$300 per woman across countries and conditions. The wide range in abortion and post abortion costs is consistent with recent reviews[31, 162, 163].

Newborn care

The treatment of premature and low-birth-weight infants is expensive, with the average unit cost per newborn US \$1,038 across different countries and types of care, as seen in Table 10. Inpatient costs when using Kangaroo mother care can reduce the costs, but overall, treatment costs range from US \$1,845 to US \$2,278 per infant treated. Hospitalization of newborns in intensive care units in public tertiary

hospitals ranged from US \$19 to US \$213 per bed-day in India. In Bangladesh, costs ranged from US \$133 to US \$170 per child treated, depending on the type of skin emollients used to prevent mortality among hospitalized preterm infants, and in Nigeria, the average cost of treating very low birth weight babies was US \$350 per newborn. Variation in these costs reflects different newborn symptoms treated, length of stay in hospital and different components of care for the mother and newborn.

Treatment of childhood illness

Malaria Costs

Table 11 presents malaria treatment and prevention costs, with all data from African countries. One study outlined the costs of bed nets and their distribution across 5 countries. The unit cost of delivering a bed net ranged US \$4.60 per net in Malawi to US \$17.45 per bed net in Senegal, largely driven by the treated bed net cost, ranging from US \$4 - US \$13. Intermittent preventative treatment (IPT) costs ranged from US \$1.35 - US \$13.65 per child treated. These costs varied by medication, treatment frequency, and method of delivery. Malaria treatment included inpatient care, outpatient care, or some combination, of which inpatient care is generally the most costly. Total treatment costs ranged from US \$5.77 – \$50.48 per child, inpatient treatment costs ranged from US \$25.36 - US \$191.88 per admission and outpatient costs ranged from US \$2.66 – \$40.60 per visit. The costs ranged based on the combination of anti-malarial drugs used, the use of antibiotics, diagnostic strategies, and the treatment platforms.

Pneumonia treatment

Of the eleven studies that present pneumonia treatment costs, Brazil represents the only cost data from an upper-middle income country (Table 12). Pneumonia treatment in Brazil ranges from US \$45.22 - US \$2,564.14 per child treated, depending on the cause and severity of pneumonia. Average inpatient admission costs ranged from US \$87.05 - US \$355.62 per admission, with outliers of ventilator

assistance in Nicaragua and pneumonia with sepsis in Pakistan, which were US \$3,938 - US \$10,094.93 per inpatient admission. Costs ranged from US \$1.00 - US \$58.35 per visit for general outpatient treatment, with higher costs in Pakistan for severe pneumonia and pneumonia with sepsis (US \$158.53 and US \$809.28 per visit respectively).

Diarrheal treatment

Diarrheal treatment costs were generally split into inpatient and outpatient treatment, whose ranges were US \$4.81 - US \$437.00 per admission and US \$0.65 - US \$328.17 per visit respectively (Table 13). Tertiary inpatient treatment for rotavirus in South Africa, an upper-middle income country, cost US \$1,336.03 per admission, which was an outlier in our data. An outpatient rotavirus visit in Kazakhstan increased from US \$32.58 to US \$328.17 as the condition went from moderate to severe classification. School and campaign-based deworming programs cost US \$0.68-US \$1.51 per child treated. Adding zinc to an ORS treatment course costs about US \$.63 per child treated. South Africa and Brazil, the only upper-middle income countries represented in this data, did not have significantly higher costs than other countries.

Meningitis Treatment

Inpatient costs for childhood meningitis, from two articles regarding Kenya and India, ranged from US \$288 - \$583 per inpatient admission, while outpatient costs ranged from US \$1.02 - \$8.99 per visit (Table 14). Costs from one article in Pakistan put inpatient costs at US \$3,744.62 per admission and US \$1,236.66 per visit. The article attributes these high costs to immediate referral to tertiary hospitals and a relatively long average inpatient stay.

Nutrition Interventions

Tables 15-16 provides the unit costs for a range of nutrition specific interventions to promote breastfeeding, reduce micronutrient deficiencies, treat the severely acute malnourished child and more general community based nutrition programs, that include nutrition counseling. Overall, the least expensive programs are

micronutrient interventions, which are population-based interventions, reaching large numbers of individuals. In 2004, a cost analysis of national vitamin A supplementation programs in Ghana and Zambia found that the average cost per child dosed with vitamin A was US \$1.14[164]. However since then, there are surprisingly few studies of the costs of micronutrient interventions. More complex interventions come at a higher cost, as evidenced by the average costs associated with breastfeeding promotion (US \$165 per woman) and community based management of severe acute malnutrition (US \$155 per child).

Maternal care and interpersonal violence

This review found very little on the costs of interventions to support maternal care and care practices for their infants and children, and there were no studies to extract unit costs of interventions to address maternal depression. Two of the studies that focused on maternal support are also closely linked to promotion of healthy newborn outcomes. These types of interventions tend to be community based and are designed to reach large numbers of women. In Bangladesh, the unit cost per person exposed to individual or group counseling or mass media ranged from US \$0.61 to US \$0.85 per contact. These same programs increase in cost when taking into consider the number of newborns reached by the program. The average unit cost of a women's group in Nepal was US \$41.17 per newborn, and was US \$13.09 per newborn in Malawi. Volunteer peer counseling in Malawi had a lower cost at US \$4.97 per newborn. Although there were no studies on maternal depression, we included some estimates of medical costs to treat women affected by interpersonal violence (Tables 17-18).

General child health costs

The literature on unit costs provides some information on inpatient and outpatient costs by country, as well as for different child health platforms for preventing or treating preventable disease (Table 19). As expected, inpatient care is more expensive than outpatient care. For African settings, general hospitalization varies from about US \$12.57 per admission in a public clinic in Malawi to US \$807.07 for treatment of severe adverse drug reaction in Nigeria. In Zambia, a study explored

the average inpatient and outpatient costs in a single urban health center. While recognizing its limitations as a small sample (N=1), the study provides insights into how costs vary by type of service. For instance, the cost per outpatient department visit was US \$3.65, and increased to US \$31.61 and US \$58.35 to treat diarrhea and pneumonia, respectively. An inpatient department visit costs US \$21.88, and increases to US \$94.82 and US \$261.37 for inpatient treatment of diarrhea and pneumonia. One third of all patient care costs are for out patient visits, while 30 percent are for HIV and AIDS treatment. Patient care costs for maternal and child health comprise 9 percent of total costs, while only 2 percent of patient care costs are allocated to the family planning services.

The higher cost of treating severe drug reaction among children accounts for a small percent of fatalities in Nigeria, but the study offers insights into cost of hospital care to treat adverse drug reaction in South Africa. The majority of the costs are typically related to personnel, indirect overhead costs and medications. In Brazil, an upper middle-income country, a general outpatient visit is US \$29.05 per visit. For preventative services, child health days offer a less expensive mechanism for delivering services, showing an average unit cost of US \$1.54, reflecting a campaign style that reaches higher numbers of children than in routine settings. The average cost of integrated management of childhood illness (which includes prevention as well) is higher at district level health facilities is about US \$10 per child.

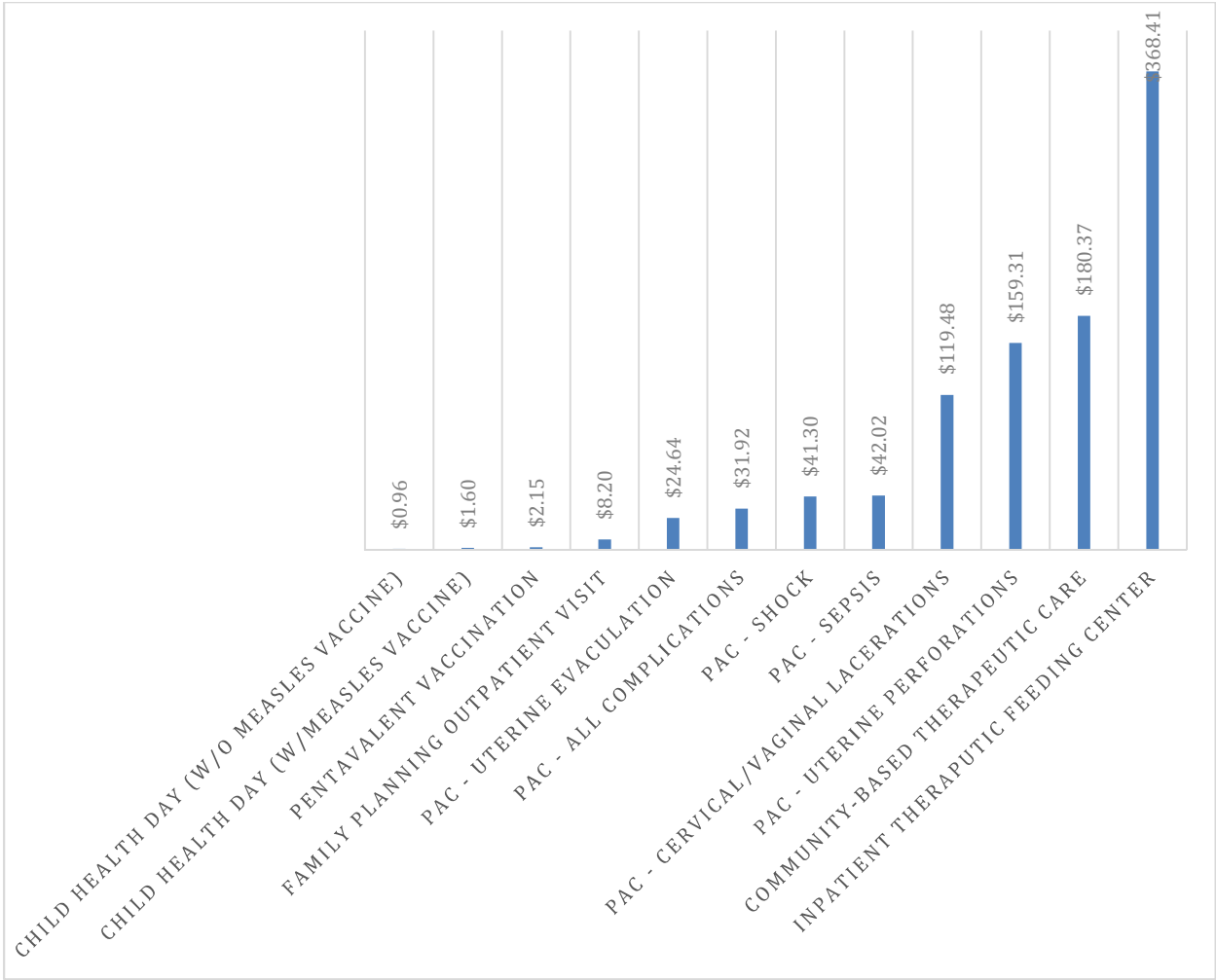
Reproductive, child and maternal health costs by country

In this section, we present the available data on intervention costs drawn from the literature on reproductive, maternal, neonatal, infant and child health for four countries—Ethiopia, India, Peru, and Vietnam. These countries were selected to accommodate data sets and analyses on the impact of nutrition on cognitive development from the Young Lives study. Data from the current literature review have been reorganized by country and specific be found in Figures 7-10.

Ethiopia

As seen in Figure 6, we extracted 12 unit costs for Ethiopia covering child health days, vaccination, family planning safe abortion and treatment of severely malnourished children. While these present the costs of interventions, Pearson et al (2011) have published on the user fees and maternity services in Ethiopia, based on hospital charges. While the study is not included in our review since it presents charges and not costs, their study indicates that less than 7 percent of women gave birth in health facilities, and that although maternity services are free of charge, 65% still charge for certain aspects of care, including drugs and supplies. The average user fee costs for normal deliveries was US \$7.70 (2008 US dollars) [25].

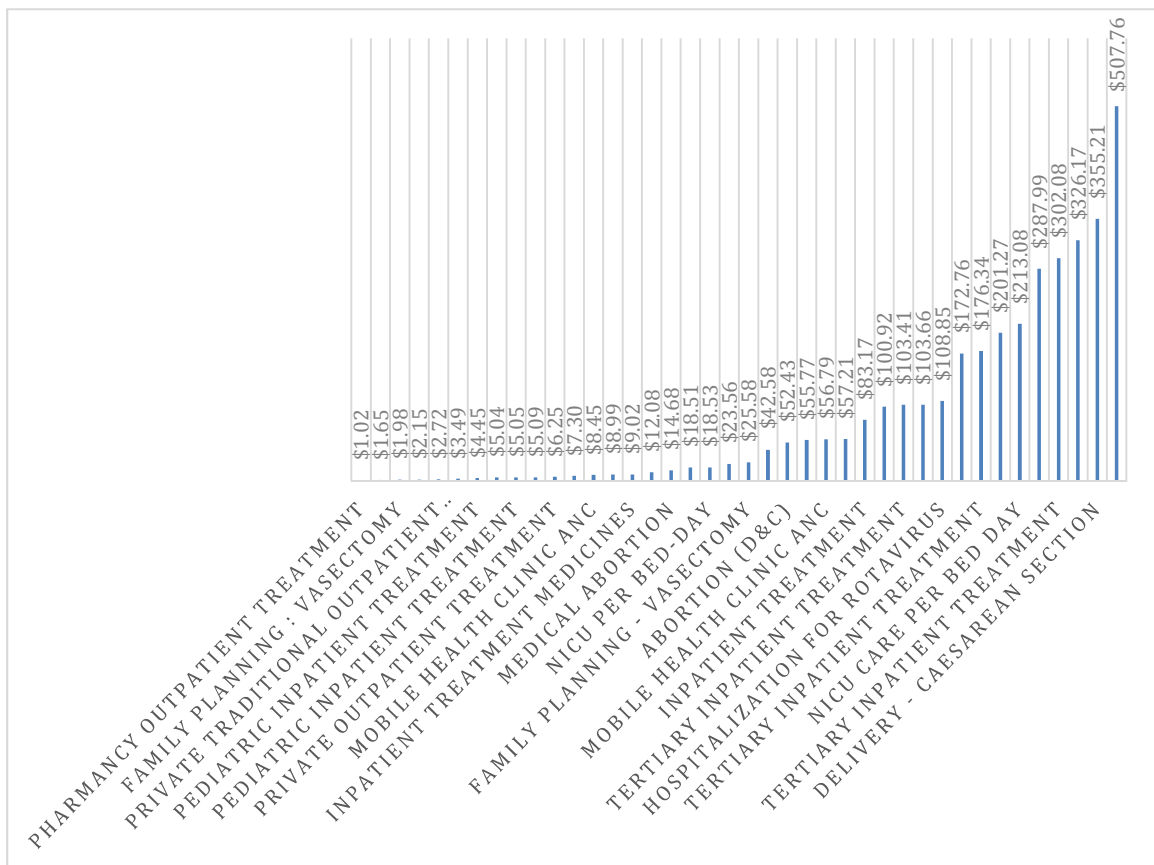
Figure 6. Unit costs by condition for Ethiopia (USD 2012)



India

India's costs are predominantly for treatment of childhood illness for diarrhea, pneumonia and meningitis at different levels of care, and limited information on delivery costs. Around half the costs for inpatient and outpatient treatment of childhood illness falls below US \$10 per child treated (Figure 7). Unit costs increase for inpatient costs of treating more severe cases of Pneumonia, meningitis and diarrheal disease in a range of hospital settings, with the most expensive treatment costs in tertiary hospitals.

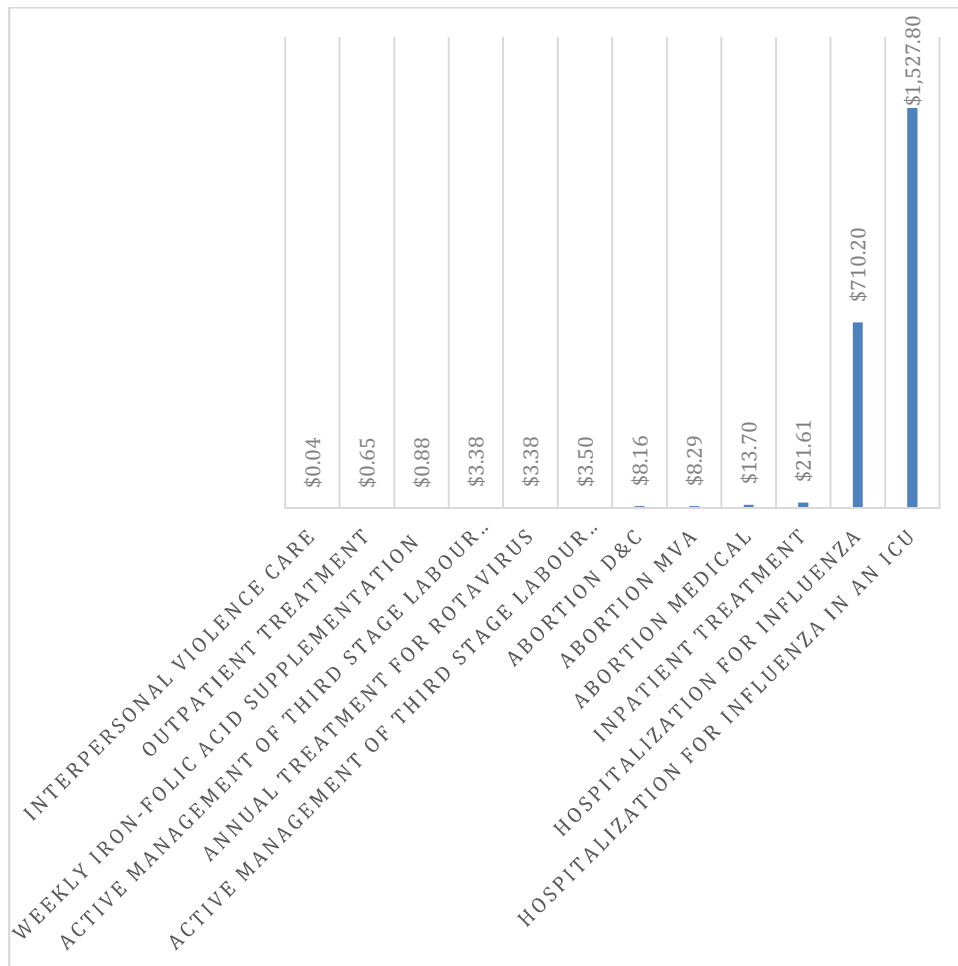
Figure 7. Reproductive and child health unit costs by intervention for India (USD 2012)



Vietnam

The majority of unit costs for Vietnam fall under US \$25 for a limited range of intervention (Figure 8). The majority of costs are under US \$22 per person, and a number of child and maternal health are a dollar or less.

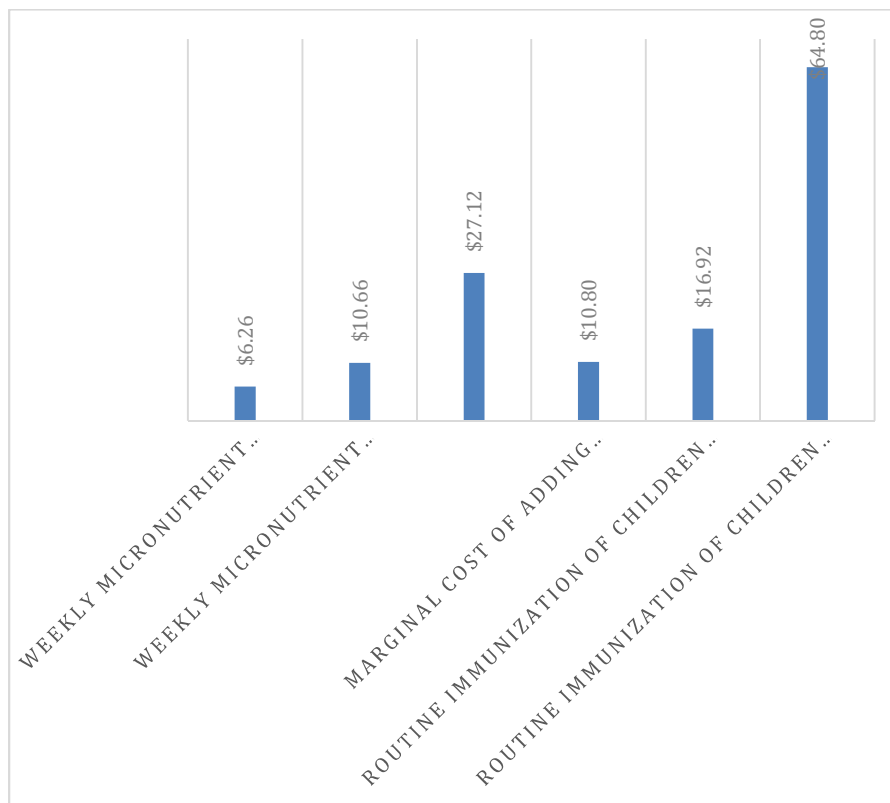
Figure 8. Reproductive, maternal and child health unit costs by intervention for Vietnam (USD 2012)



Peru

We obtained six studies with costs for child health and nutrition. From this limited sample the average unit costs are higher in Peru, as might be expected for this Latin American middle-income country, with the program costs for delivery vaccines in school at US \$2.03 per dose delivered to school based delivery of vaccines to a cost of US \$28 per fully immunized child for the basic six antigens. Child nutrition interventions range from US \$4.40 per child for micronutrient supplementation to US \$19 per child for nutrition education.

Figure 9. Child health unit costs by intervention for Peru (USD 2012)



In reviewing country level data, the results are somewhat disappointing in the lack of information on costs of interventions across the risk factors for the first 1000 days. Individual studies may provide greater insight into cost shares and cost components, but likely a combination of unit costs from the literature and average unit costs from WHO-CHOICE (Figure 10) will be needed to construct estimates of intervention costs.

Figure 10: WHO-CHOICE Unit costs for inpatient and outpatient visits (2008)

| Inpatient visit costs | | | | | | | | | | | | |
|------------------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|
| Peru | | | India | | | Ethiopia | | | Vietnam | | | |
| | Primary-level hospital | Secondary-level hospital | Teaching hospital | Primary-level hospital | Secondary-level hospital | Teaching hospital | Primary-level hospital | Secondary-level hospital | Teaching hospital | Primary-level hospital | Secondary-level hospital | Teaching hospital |
| | \$ 81.70 | \$ 85.23 | \$ 110.21 | \$ 22.84 | \$ 23.83 | \$ 30.81 | \$ 5.37 | \$ 5.60 | \$ 7.24 | \$ 21.47 | \$ 22.39 | \$ 28.96 |
| | \$ 42.94 | \$ 44.80 | \$ 57.93 | \$ 8.47 | \$ 8.83 | \$ 11.42 | \$ 1.98 | \$ 2.07 | \$ 2.68 | \$ 8.08 | \$ 8.43 | \$ 10.91 |

| Outpatient visit costs | | | | | | | | | | | | | | | | |
|-------------------------------|-------------------------|---------------------------|------------------------|--------------------------|-------------------------|---------------------------|------------------------|--------------------------|-------------------------|---------------------------|------------------------|--------------------------|-------------------------|---------------------------|------------------------|--------------------------|
| Peru | | | | India | | | | Ethiopia | | | | Vietnam | | | | |
| | Health Centre (no beds) | Health Centre (with beds) | Primary-level hospital | Secondary-level hospital | Health Centre (no beds) | Health Centre (with beds) | Primary-level hospital | Secondary-level hospital | Health Centre (no beds) | Health Centre (with beds) | Primary-level hospital | Secondary-level hospital | Health Centre (no beds) | Health Centre (with beds) | Primary-level hospital | Secondary-level hospital |
| | \$ 12.13 | \$ 14.98 | \$ 17.07 | \$ 17.78 | \$ 4.81 | \$ 5.94 | \$ 6.77 | \$ 7.05 | \$ 1.68 | \$ 2.08 | \$ 2.37 | \$ 2.47 | \$ 4.60 | \$ 5.68 | \$ 6.47 | \$ 6.74 |
| | \$ 6.38 | \$ 7.87 | \$ 8.97 | \$ 9.35 | \$ 1.78 | \$ 2.20 | \$ 2.51 | \$ 2.61 | \$ 0.62 | \$ 0.77 | \$ 0.87 | \$ 0.91 | \$ 1.73 | \$ 2.14 | \$ 2.44 | \$ 2.54 |

Source: WHO-CHOICE Unit costs

Discussion

This systematic review of literature can be used as a source of unit cost data for modeling the costs of interventions to reduce the risk factors associated with cognitive development. Our analysis of unit costs has confirmed what other reviews have found-- that there is a persistent gap in standardized high quality data. In some areas, where cost and cost-effectiveness studies have been conducted and published dating back to the 1990s, such as micronutrient deficiencies, there is a surprising lack of representative and standardized data on long running interventions, such as vitamin A or iron capsule supplementation. Similarly, in the area of family planning, where modern contraceptive use still lags behind in terms of effective coverage, there is very little new information on country level costs of scaling up interventions to increase the supply and demand of family planning services. In other areas, such as maternal depression, where there are fewer interventions or published evaluations, there is very little economic literature to draw on, and hence no unit cost data to capture resource use and costs. A variety of methodological approaches confound the expected variation in costs due to country context and different choices of interventions being evaluated.

In general, average unit costs are lower for family planning interventions, antenatal care visits for pregnant women and for normal deliveries at home or health centers with trained birth attendants. Unit costs tend to increase with the complexity of the service (i.e. treatment of obstetric or abortion complications, treatment of severely acute malnourished child and a range of community based nutrition interventions). For instance, breastfeeding support and prevention of micronutrient deficiencies are inexpensive compared to nutrition education programs and treatment of severe acute malnutrition. Malaria prevention and treatment of febrile illness and diarrheal disease are less expensive per child (US \$20 to US \$100) than treatment of pneumonia and meningitis, which typically require inpatient admission (US\$ 150

per visit, or US \$800 per child treated for pneumonia; US \$300 to US \$500 for inpatient care).

We assessed the quality of cost data found in 146 articles and chose to liberally include unit costs if the data source and methods were clearly explained. However, our approach comes with some caveats for data comparisons and interpretation. First, like many recent reviews of the cost literature in low and middle-income countries, we found substantial variation in unit costs across country settings for similar interventions. In addition, we found it challenging to understand resource use and how the input costs were estimated[11, 15, 31, 165]. In the vast majority of studies included in our review, authors made no effort to distinguish explicitly between tradable and non-tradable goods and in many cases they did not provide a breakdown of resource use or input costs. Because of this limitation, we did not net out tradable commodities from the unit cost estimates since it would require that we make assumptions that may introduce distortions, without the benefit of increasing the comparability of results. Studies that have netted out the tradable commodities find significant variation in unit costs across country settings, noting that differences in the evaluation methodology are a key driver in unit cost variation. A second related issue is that for many interventions there may have been only one observation to draw on, making it difficult to identify a range of cost for high and low estimates.

A third important caveat is that while this review provides information on specific program unit costs, unit costs presented here may not always include the health system or demand generation costs that are essential for delivering the intervention or treatment and ensuring access and high coverage by beneficiaries. Therefore, unit costs may underestimate the full resource costs for delivering health services and interventions during the first 1000 days.

The companion excel files provide the unit cost data that can be used as inputs into models in several ways, once the input requirements of the economic impact and

cost model are defined. First, pivot tables can easily be used to estimate average unit costs by condition and country or region. In some cases where there is more than one observation, means and ranges can be derived by region. Second, if there is a country or region where a single unit cost estimate is not available, it may be possible to conduct additional analysis of a subset of articles to standardize costs for specific interventions by using cost estimates from a neighboring country with similar country context.

Although beyond the scope of this literature review, as part of the Disease Control Priorities project, we will be reviewing the data more carefully to identify a subset of unit costs that will allow us to separate out costs associated with goods that are traded from goods and services that are not traded, converting to standard US dollars and International dollars and looking at determinants of variability in unit costs. In addition, we will be identifying the studies with the best quality disaggregated data to predict unit costs for key interventions.

Conclusion

This review has captured up to date information on unit costs for reproductive, neonatal, maternal and child health and nutrition interventions. We have described our findings, but the real value of this exercise has been the compilation of unit cost data in 2012 USD that can support modeling of the costs of interventions to reduce the risks of the first 1000 days of life. Additional analytical methods will be required to standardized costs to meet the needs of the economic impact modeling teams.

Tables

Table 1: Family Planning Costs, Permanent Methods (USD 2012)

| | Per Beneficiary | Per CYP |
|--|-----------------|---------|
| Female Sterilization (Tubal Ligation) | | |
| Afghanistan[52] | \$26.47 | |
| Iran[166] | | \$24.59 |
| Lesotho[167] | \$14.92 | |
| Nigeria[168] | \$27.78 | |
| Male Sterilization (Vasectomy) | | |
| Afghanistan[52] | \$19.08 | |
| India[37] | \$25.58 | \$1.98 |
| Iran[166] | | \$9.2 |
| Kenya[37] | \$35.89 | \$4.02 |
| Lesotho[167] | \$16.36 | |
| Mexico[37] | \$43.24 | \$5.43 |
| Nigeria[168] | \$19.63 | |

Table 2: Family Planning Costs, Temporary Methods (USD 2012)

| | OP Visit | CYP |
|-------------------------------------|----------|---------|
| Oral Contraception | | |
| Iran[166] | | \$18.66 |
| Lesotho[167] | \$0.92 | |
| Nigeria[168] | | \$16.15 |
| Uganda[34] | \$1.99 | |
| Male Condom | | |
| Iran[166] | | \$21.31 |
| Lesotho[167] | \$0.41 | |
| Nigeria[168] | | \$13.48 |
| Uganda[34] | \$3.19 | |
| Diaphragm | | |
| Lesotho[167] | \$0.44 | |
| Injectable Contraception | | |
| Iran[166] | | \$41.39 |
| Lesotho[167] | \$1.14 | |
| Nigeria[168] | | \$16.11 |
| Uganda[34] | \$2.80 | |
| Implants | | |
| Iran[166] | | \$73.23 |
| Zambia[33] | | \$18.28 |
| Intrauterine Device (IUD) | | |
| Iran[166] | | \$11.85 |
| Kenya[41] | | \$32.86 |
| Lesotho[167] | \$1.2 | |
| Nigeria[168] | | \$15.87 |
| Zambia[33] | | \$10.49 |
| Lactational Amenorrhea (LAM) | | |
| Lesotho[167] | \$0.27 | |

Table 3: Antenatal Care and Family Planning Health Care Costs (USD 2012)

| Antenatal Care Costs | Country | Per Woman | Per Visit | Per Case |
|---|-------------|-----------|-----------|-----------------|
| General ANC: Hospital[46] | Uganda | \$6.40 | | |
| General ANC: Hospital[46] | Malawi | \$5.31 | | |
| General ANC: Hospital[46] | Ghana | \$4.29 | | |
| General ANC: Public Health Center[46] | Uganda | \$5.90 | | |
| General ANC: Public Health Center[46] | Malawi | \$3.50 | | |
| General ANC: Public Health Center[46] | Ghana | \$3.67 | | |
| General ANC: 4 Visits[168] | Nigeria | | | \$28.33 |
| Inpatient ANC[169] | Tanzania | | \$3.56 | |
| General ANC[34] | Uganda | \$4.69 | | |
| General ANC[64] | Ghana | | \$15.84 | |
| Mobile Health Clinic ANC[170] | India | | \$8.45 | |
| IPT Prevention for Pregnant Women[32] | Uganda | | | \$2.08 |
| STI Syndromic Treatment[34] | Uganda | | \$2.69 | |
| Anemia Treatment[168] | Nigeria | | | \$0.81 - \$1.22 |
| Anemia Treatment[52] | Afghanistan | \$1.55 | | |
| Family Planning Health Care Costs | Country | Per Woman | Per Visit | Per CYP |
| Annual Coverage (Public Sector Facilities)[171] | Pakistan | \$57.17 | | |
| Family Planning Outpatient Visit (Average)[39] | Ethiopia | | \$8.20 | |
| Family Planning Outpatient Visit (Average) [39] | Pakistan | | \$6.37 | |
| Family Planning Public Sector Facilities[171] | Pakistan | | | \$21.13 |

Table 4: Antenatal Syphilis Screening and Treatment Costs (USD 2012)

| | Screening Only | Screening & Treatment |
|-------------------------|----------------|-----------------------|
| Rapid Test (ICS) | | |
| Bolivia[20] | \$4.52 | \$99.58 |
| China[63] | \$2.98 | |
| Mozambique[20] | \$1.56 | \$21.31 |
| Kenya[172] | \$3.06 | |
| Lab Test (RPR) | | |
| Bolivia[20] | \$2.72 | \$76.30 |
| Mozambique[20] | \$1.37 | \$18.51 |
| Uganda[34] | \$5.10 | |
| Tanzania[173] | \$1.92 | \$26.69 |

Table 5: Delivery Complication Care Costs per Delivery (USD 2012)

| Emergency Obstetric Surgery | |
|------------------------------------|--------------------|
| Burkina Faso[43] | \$124.38 |
| Mozambique[59] | \$54.02 - \$201.82 |
| Maternal Hemorrhage | |
| Nigeria[168] | \$34.71 - \$150.78 |
| Afghanistan[52] | \$97.79 |
| Ghana[46] | \$66.43 |
| Malawi[46] | \$70.16 |
| Uganda[46] | \$112.92 |
| Pre-eclampsia/Eclampsia | |
| Nigeria[168] | \$73.82 - \$116.17 |
| Afghanistan[52] | \$87.01 |
| Malawi[46] | \$75.17 |
| Uganda[46] | \$165.17 |
| Obstructed Labor | |
| Nigeria[168] | \$23.63-\$109.96 |
| Afghanistan[52] | \$69.33 |
| Sepsis | |
| Nigeria[168] | \$39.08-\$83.90 |
| Afghanistan[52] | \$37.46 |

Table 6: Delivery Costs per Delivery (USD 2012)

| Vaginal Delivery in a Facility | |
|--------------------------------|--------------------|
| Afghanistan[52] | \$31.85 |
| Bangladesh[174] | \$0.85 - \$2.19 |
| Burkina Faso[48] | \$89.05 |
| Burkina Faso[62] | \$1.88 |
| Ghana[46] | \$8.86-13.48 |
| Ghana[64] | \$40.35 |
| Guatemala[175] | \$2.56 - \$2.86 |
| India[176] | \$57.21 |
| India[177] | \$42.58 |
| Indonesia[61] | \$135.14 |
| Lao PDR[54] | \$34.70 |
| Malawi[46] | \$16.89 |
| Nigeria[168] | \$41.74 |
| Pakistan[58] | \$48.63 |
| Senegal[65] | \$25.30 |
| Tanzania[169] | \$8.96 – \$17.49 |
| Uganda[34] | \$9.75 |
| Uganda[46] | \$13.30 - \$45.58 |
| Uganda[178] | \$5.29 |
| Zambia [175] | \$7.16 - \$10.18 |
| Vaginal Delivery in Home | |
| Afghanistan[52] | \$5.16 - \$7.23 |
| India[177] | \$12.08 |
| Nigeria[168] | \$9.53 |
| Caesarean Section | |
| Bangladesh[174] | \$1.75 - \$2.28 |
| Burkina Faso[57] | \$96.56 - \$218.14 |
| Ghana[46] | \$73.52 |
| India[177] | \$355.21 |
| Indonesia[61] | \$580.94 |
| Lao PDR[54] | \$178.14 |
| Madagascar[55] | \$107.88 |
| Malawi[46] | \$77.31 |
| Pakistan[58] | \$194.51 |
| Senegal[65] | \$562.54 |
| Uganda[178] | \$61.18 |
| Uganda[46] | \$108.90 |
| Uganda[34] | \$92.53 |
| Tanzania[169] | \$98.50 |

Table 7: Delivery Complication Care Costs (USD 2012)

| Active Management of Third Stage Labor | | |
|--|-----------|------------------|
| Adding AMTSL (Ampoule)[56] | Vietnam | \$3.38 |
| Adding AMTSL (Uniject) [56] | Vietnam | \$3.50 |
| Vaginal delivery in facility with AMTSL[175] | Guatemala | \$2.56 - \$2.86 |
| Vaginal delivery in facility with AMTSL[175] | Zambia | \$7.16 - \$10.18 |

Table 8: Abortion Procedure Costs Per Procedure (USD 2012)

| Non-Specified Procedure | |
|------------------------------------|-----------------|
| Afghanistan[52] | \$48.52 |
| Nigeria[179] | \$26.08 |
| Pakistan[180] | \$29.94 |
| Uganda[23] | \$76.83 |
| Dilation and Curettage (D&C) | |
| Bangladesh[174] | \$0.83 - \$2.87 |
| El Salvador[26] | \$94.35 |
| El Salvador[181] | \$111.32 |
| Ghana[182] | \$23.22 |
| India[60] | \$52.43 |
| Mexico[22] | \$158.31 |
| Nigeria [183] | \$31.09 |
| Nigeria[182] | \$47.72 |
| Nigeria[44] | \$110.28 |
| Vietnam[184] | \$8.16 |
| Electrical Vacuum Aspiration (EVA) | |
| Pakistan[185] | \$60.87 |
| Manual Vacuum Aspiration (MVA) | |
| Bangladesh[186] | \$9.72 |
| China[42] | \$64.65 |
| El Salvador[26] | \$82.27 |
| El Salvador[181] | \$99.70 |
| Ghana[182] | \$15.96 |
| Mexico[22] | \$103.30 |
| Nepal[187] | \$12.32 |
| Nigeria[183] | \$34.67 |
| Nigeria[182] | \$23.37 |
| Nigeria[44] | \$108.49 |
| Vietnam[184] | \$8.29 |
| Medical Abortion (MA) | |
| China[42] | \$49.12 |

| | |
|--------------|---------|
| Ghana[182] | \$9.12 |
| India[60] | \$14.68 |
| Mexico[22] | \$75.95 |
| Nigeria[182] | \$34.07 |
| Nigeria[44] | \$97.16 |
| Vietnam[184] | \$13.70 |

Table 9: Abortion Complication Care Costs

| | |
|-------------------------------------|------------|
| Shock | |
| Ethiopia[38] | \$41.30 |
| Mexico[22] | \$1,773.24 |
| Uganda[50] | \$57.03 |
| Sepsis | |
| Ethiopia[38] | \$42.02 |
| Mexico[22] | \$2,368.25 |
| Uganda[50] | \$57.17 |
| Uterine Evacuation | |
| Ethiopia[38] | \$24.64 |
| Uganda[50] | \$50.28 |
| Cervical/Vaginal Lacerations | |
| Ethiopia[38] | \$119.48 |
| Uganda[50] | \$58.18 |
| Uterine Perforations | |
| Ethiopia[38] | \$159.31 |
| Mexico[22] | \$1,558.18 |
| Uganda[50] | \$135.17 |
| All Complications | |
| Bangladesh[186] | \$50.86 |
| Ethiopia[38] | \$31.92 |
| Ghana[188] | \$51.50 |
| Ghana[46] | \$66.35 |
| Ghana[182] | \$25.55 |
| Malawi[46] | \$33.85 |
| Mexico[22] | \$231.29 |
| Nigeria[168] | \$60.51 |
| Nigeria[182] | \$29.55 |
| Pakistan[189] | \$91.12 |
| Uganda[46] | \$63.49 |

Table 10: Newborn Care Costs (USD 2012)

| Treatment of Premature and Low Birth-Weight Newborns | Country | Per Infant Treated | Per Bed Day |
|--|------------|--------------------|-------------|
| Monthly Kangaroo Care at a Tertiary Hospital[190] | Brazil | \$1,975.57 | |
| Inpatient costs with Kangaroo Mother Care[191] | Nicaragua | \$1,845.68 | |
| Inpatient costs without Kangaroo Mother Care[191] | Nicaragua | \$2,278.52 | |
| Neonatal Intensive Care Units | | | |
| Inpatient Care[86] | Brazil | \$4,560.74 | \$217.07 |
| Inpatient Care[192] | India | \$103.66 | \$18.53 |
| Inpatient Care[94] | India | | \$213.08 |
| Inpatient Care (Ventilation)[193] | Mexico | | \$91.85 |
| Inpatient Care (No Ventilation) [193] | Mexico | | \$66.40 |
| Inpatient Care for VLBW[125] | Nigeria | \$348.84 | |
| Inpatient Care (Aquaphor)[105] | Bangladesh | \$168.11 | |
| Inpatient Care (No emollient) [105] | Bangladesh | \$125.25 | |
| Inpatient Care (Sunflower Seed Oil) [105] | Bangladesh | \$133.40 | |
| Basic Neonatal Care[55] | Madagascar | \$37.76 | |
| First year of health system costs (normal birth weight)[111] | Mozambique | \$159.39 | |
| First year of health system costs (low birth weight) [111] | Mozambique | \$719.22 | |

Table 11: Childhood Malaria Prevention and Treatment Costs (USD 2012)

| Bed Nets & Distribution | Country | Total Cost | Bed Net Cost |
|---|------------------|--------------------|--------------|
| Insecticide Treated Bed Nets & Distribution[148] | Eritrea | \$13.53 | \$10.67 |
| Insecticide Treated Bed Nets & Distribution[148] | Malawi | \$4.60 | \$3.99 |
| Insecticide Treated Bed Nets & Distribution[148] | Senegal | \$17.45 | \$12.83 |
| Insecticide Treated Bed Nets & Distribution[148] | Tanzania | \$9.30 | \$12.79 |
| Insecticide Treated Bed Nets & Distribution[148] | Togo | \$10.07 | \$7.92 |
| General Malaria Treatment | Country | Per Infant | Per Child |
| Medication: 1 course of Deltaprim[103] | Tanzania | \$5.77 | |
| Medication: 1 course of Deltaprim & Iron[103] | Tanzania | \$7.88 | |
| Screen & Treat[81] | Nigeria | | \$8.11 |
| Treated base on symptoms alone[81] | Nigeria | | \$6.03 |
| Anti-Malarial Medicine Only (CHW)[147] | Ghana | | \$7.63 |
| Anti-Malarials and Antibiotics (CHW) [147] | Ghana | | \$10.10 |
| Total Treatment (Inpt & Outpt)[127] | Ghana | | \$50.48 |
| Total Treatment (Inpt & Outpt) [127] | Kenya | | \$36.92 |
| Total Treatment (Inpt & Outpt) [127] | Tanzania | | \$29.60 |
| Inpatient Treatment of Malaria | Country | Per Child | |
| General Inpatient Care[123] | Kenya | \$84.78 - \$191.88 | |
| Inpatient Medicines[155] | India | \$4.81 | |
| General Inpatient Care[85] | Ghana | \$25.36 | |
| General Inpatient Care (Severe Anemia) [85] | Ghana | \$59.15 | |
| Outpatient Treatment of Malaria | Country | Per Child | |
| General Outpatient Care[85] | Ghana | \$2.66 | |
| General Outpatient Care (Severe Anemia) [85] | Ghana | \$2.71 | |
| Outpatient ACT Regimen[99] | Papua New Guinea | \$34.98 - \$40.60 | |
| Intermittent Preventative Treatment | Country | Per Child | Per Dose |
| IPTi: Incremental Cost[32] | Uganda | \$2.08 | |
| IPTc: RCH Trekking Team (3 Treatments)[157] | The Gambia | \$2.88 | |
| IPTc: Village Health Workers (3 Treatments) [157] | The Gambia | \$1.35 | |
| IPTc: AQ & AS Bimonthly[85] | Ghana | \$9.85 | |
| IPTc: AQ & AS Monthly[85] | Ghana | \$13.65 | |
| IPTc: SP Bimonthly[85] | Ghana | \$7.56 | |
| IPTi: Total cost[138] | Tanzania | | \$24.85 |
| IPTc: Volunteer Health Workers [116] | Ghana | \$3.12 | |
| IPTc: Nurse Delivery of IPTc (3 Treatments) [116] | Ghana | \$3.58 | |

Table 12: Childhood Pneumonia Treatment Costs (USD 2012)

| | Country | Per Inpatient Admission | Per Bed-Day | Per Outpatient Visit | Per Child Treated |
|-----------------------------------|------------|-------------------------|-------------|----------------------|-------------------|
| Inpatient | | | | | |
| General Treatment[123] | Kenya | \$87.05 - \$355.62 | | | |
| General Treatment[156] | Colombia | \$296.49 | | | |
| Public Primary Care Hospital[141] | India | \$172.76 | | | |
| Public Tertiary Hospital[141] | India | \$302.08 | | | |
| Tertiary Hospital [109] | India | \$176.34 | | | |
| Community Hospital[109] | India | \$100.92 | | | |
| Non-VAP Inpatient[119] | Nicaragua | \$3,938.54 | | | |
| Ventilator-Associated[119] | Nicaragua | \$10,094.93 | | | |
| Severe Pneumonia[152] | Bangladesh | \$218.61 | | | |
| Severe Pneumonia[120] | Pakistan | \$229.64 | | | |
| Pneumonia[120] | Pakistan | \$130.14 | | | |
| Outpatient | | | | | |
| Day Care Treatment [152] | Bangladesh | | | | \$140.01 |
| General Treatment[150] | Uganda | | | \$2.19 | |
| General Treatment[141] | India | | | \$8.99 | |
| General Treatment[96] | Pakistan | | | \$32.57 | |
| Private pharmacy [141] | India | | | \$1.02 | |
| Private traditional healer[141] | India | | | \$2.72 | |
| Total Treatment | | | | | |
| General Treatment[134] | Zambia | | \$261.37 | \$58.35 | |
| General Treatment[96] | Pakistan | \$159.88 | | \$40.02 | |
| General Treatment[135] | Brazil | | | | \$100.74 |
| Private Facility[141] | India | \$197.67 | | \$6.14 | |
| Severe Pneumonia[96] | Pakistan | \$430.73 | | \$158.53 | |
| Pneumonia With Sepsis[96] | Pakistan | \$1,248.21 | | \$809.28 | |
| Acute Otitis Media[135] | Brazil | | | | \$45.22 |
| Pneumococcal Meningitis[135] | Brazil | | | | \$2,564.14 |
| Pneumococcal Pneumonia[135] | Brazil | | | | \$841.15 |
| Acute Otitis Media[135] | Uruguay | | | | \$220.58 |
| Pneumococcal Meningitis[135] | Uruguay | | | | \$5,565.87 |
| Pneumococcal Pneumonia[135] | Uruguay | | | | \$2,811.12 |

Table 13: Childhood Diarrhea Treatment and Prevention Costs (USD 2012)

| Total Intervention | Country | Per Child Treated | |
|---|--------------|-------------------|-------------|
| School-Based Deworming Treatment[80] | Uganda | \$0.68 - \$1.51 | |
| Deworming Campaign Separate From CHD[145] | Lao PDR | \$0.30 | |
| Incremental Cost of Adding Zinc to ORS[108] | Tanzania | \$0.63 | |
| Annual Treatment Cost[139] | Vietnam | \$3.38 | |
| Average Cost[91] | South Africa | \$8.41 | |
| Rotavirus Vaccine (Dose & Administration)[97] | Brazil | \$18.60 | |
| Incremental Pentavalent Vaccination[144] | Ethiopia | \$1.53 | |
| Diarrhea Inpatient Treatment | Country | Per Admission | Per Bed-Day |
| Community Hospital[133] | India | \$55.77 | |
| General Inpatient Treatment[136] | Ghana | \$241.17 | \$42.71 |
| General Inpatient Treatment[153] | Kenya | \$147.63 | |
| General Inpatient Treatment[77] | Kenya | 200.51 | |
| General Inpatient Treatment[130] | Indonesia | \$64.27 | |
| General Inpatient Treatment[104] | Bolivia | \$264.79 | |
| General Inpatient Treatment[97] | Brazil | \$348.00 | |
| General Inpatient Treatment[102] | Nicaragua | \$437.00 | |
| General Inpatient Treatment[149] | Thailand | \$143.39 | |
| General Inpatient Treatment[73] | Bolivia | \$32.98 | |
| General Inpatient Treatment[134] | Zambia | | \$94.82 |
| General Inpatient Treatment[156] | Colombia | \$30.55 | |
| General Inpatient Treatment for Rotavirus[139] | Vietnam | \$21.61 | |
| General Inpatient Treatment for Rotavirus[117] | India | \$83.17 | |
| General Inpatient Treatment for Rotavirus[194] | India | \$108.85 | |
| General Inpatient Treatment for Rotavirus[117] | Kenya | \$147.63 | |
| Tertiary Emergency Room Treatment[133] | India | \$23.56 | |
| Tertiary Inpatient Treatment[133] | India | \$103.41 | |
| Tertiary Inpatient Treatment for Rotavirus[122] | South Africa | \$1,336.03 | |
| Oral Rehydration System Only[161] | Philippines | \$16.21 | |
| Oral Rehydration System Only[140] | Ghana | \$61.94 | |
| Oral Rehydration & Antibiotics Treatment[140] | Ghana | \$92.61 | |
| Oral Rehydration System & Zinc Pills[161] | Philippines | \$19.09 | |
| Non-Rehydration/Antibiotics Treatment[140] | Ghana | \$127.28 | |
| Inpatient Medicines Only[155] | India | \$4.81 | |
| Medications and Nondrug Orders[122] | South Africa | \$53.86 | |
| Diagnostic Tests (Rotavirus)[122] | South Africa | \$61.95 | |
| Diarrhea Outpatient Treatment | Country | Per Visit | |
| General Clinic Visit[136] | Ghana | \$17.62 | |
| General Clinic Visit[153] | Kenya | \$9.94 | |
| General Clinic Visit[130] | Indonesia | \$6.64 | |
| General Clinic Visit[73] | Bolivia | \$5.73 | |

| | | | |
|--|------------|----------|---------|
| General Clinic Visit[149] | Thailand | \$21.08 | |
| General Clinic Visit[134] | Zambia | \$31.61 | \$21.88 |
| General Clinic Visit[97] | Brazil | \$14.69 | |
| General Rotavirus Visit[139] | Vietnam | \$0.65 | |
| General Rotavirus Visit[117] | India | \$3.49 | |
| Rehydration Only[140] | Ghana | \$3.67 | |
| Rehydration and Antibiotics[140] | Ghana | \$3.90 | |
| Non-Rehydration/Antibiotics Treatment[140] | Ghana | \$4.14 | |
| Moderate Rotavirus Visit[126] | Kazakhstan | \$32.58 | |
| Severe Rotavirus Visit[126] | Kazakhstan | \$328.17 | |
| Hospital Treatment Visit[133] | India | \$5.09 | |
| Urban Health Center Visit[133] | India | \$2.15 | |
| Emergency Room Treatment[104] | Bolivia | \$17.89 | |
| Community Emergency Room Treatment[133] | India | \$5.04 | |

Table 14: Childhood Meningitis Treatment Costs (USD 2012)

| | Country | Per Inpatient Admission | Per Outpatient Visit |
|---|----------|-------------------------|----------------------|
| General Treatment[96] | Pakistan | \$3,744.62 | \$1,236.66 |
| General Treatment[123] | Kenya | \$380.25-\$583.03 | |
| Public Facility Treatment[141] | India | \$287.99 | \$8.99 |
| Private Facility Treatment[141] | India | \$326.17 | \$7.30 |
| Private Pharmacy Treatment[141] | India | | \$1.02 |
| Private Traditional Healer Treatment[141] | India | | \$2.72 |
| Public Tertiary Hospital Treatment[141] | India | \$507.76 | |

Table 15: Nutrition and Optimal Feeding Support Costs (USD 2012)

| Breastfeeding Support | Country | Per Month | Per Visit | Per woman |
|--|--------------|-----------|---------------------|-----------------|
| Breastfeeding intervention strategy (Mostly Clinic Visits)[154] | South Africa | \$24.92 | | |
| Breastfeeding intervention strategy (Mostly Home Visits) [154] | South Africa | \$48.65 | | |
| Breastfeeding intervention strategy (Exclusively Clinic Visit) [154] | South Africa | \$9.49 | | |
| Peer-counselling: Home Visits[113] | South Africa | | \$37.97 | \$162.55 |
| Peer-counselling: Home Visits[92] | Uganda | | \$31.88 | \$170.44 |
| Peer-counselling: Home Visits[132] | Malawi | | | \$4.97 |
| Micronutrient Deficiencies | Country | Per Year | Per Capita Per Year | Per Beneficiary |
| Sprinkles Fortification Program[131] | Pakistan | | | \$28.94 |
| Infant Iron Supplementation (1-Course)[103] | Tanzania | | | \$3.70 |
| Multiple micronutrient supplementation (Participating)[195] | Peru | \$10.66 | | |
| Multiple micronutrient supplementation (Targeted) [195] | Peru | \$7.28 | | |
| Vitamin A Fortification[82] | AfrE | | \$0.08 | |
| Vitamin A Fortification[82] | SearD | | \$0.08 | |
| Vitamin A Supplementation[82] | AfrE | \$18.18 | | |
| Vitamin A Supplementation[82] | SearD | \$4.10 | | |
| Weekly Iron-Folic Acid Supplementation; Periodic Deworming[160] | Vietnam | \$0.88 | | |
| Zinc Fortification[82] | AfrE | | \$0.04 | |
| Zinc Fortification[82] | SearD | | \$0.05 | |
| Zinc Supplementation[82] | AfrE | \$2.29 | | |
| Zinc Supplementation[82] | SearD | \$1.09 | | |
| Iron Supplementation[146] | China | | \$7.28 | |

| | | | |
|---|----------------|-----------------|------------------|
| Iron Food Fortification[146] | China | | \$0.04 |
| Zinc Supplementation[146] | China | | \$0.03 |
| Zinc Fortification[146] | China | | \$0.01 |
| Nutrition Programs & Counseling | Country | Per Year | Per Child |
| AIN-C Program Recurrent Budget (<2 years old)[71] | Honduras | \$9.69 | |
| AIN-C Program Incremental Budget (<2 years old) [71] | Honduras | \$5.88 | |
| Food Assistance Program (5 Months)[151] | Chad | | \$980.74 |
| Food Assistance Program plus RUSF (5 Months) [151] | Chad | | \$1,484.58 |
| Infant Nutrition Education: Incremental Cost[98] | Peru | | \$10.80 |
| Nutrition Services: Total Cost[98] | Peru | | \$27.12 |
| Vitamin A, Zinc, ORS, Food and Nutrition Counseling[82] | AfrE | \$435.91 | |
| Vitamin A, Zinc, ORS, Food and Nutrition Counseling[82] | SearD | \$520.52 | |

Table 16: Severe Acute Malnutrition Care Costs (USD 2012)

| Severe Acute Malnutrition | Country | Per Child Treated | Per Child Recovered |
|--|------------|-------------------|---------------------|
| Community-based management (Screening & Outpatient)[107] | Bangladesh | \$165.07 | \$180.08 |
| Community-based management (Outpatient)[100] | Malawi | \$157.17 | |
| Community-based therapeutic care[84] | Zambia | \$116.11 | |
| Community-based therapeutic care[83] | Ethiopia | \$180.37 | |
| Inpatient Care Medicines[155] | India | \$4.81 | |
| Malnutrition program (Daily Program)[78] | Indonesia | \$8.80 | |
| Malnutrition program (Weekly Program) [78] | Indonesia | \$6.73 | |
| Inpatient Care Medicines[155] | India | \$4.97 | |
| Inpatient Care[107] | Bangladesh | \$1,344.00 | \$9,153.00 |
| Therapeutic Feeding Center (>=21 days) [83] | Ethiopia | \$368.41 | |

Table 17: Interpersonal Violence Costs (USD 2012)

| | Country | Per Incident |
|---|----------|--------------|
| Medical Cost (Direct only)[112] | Thailand | \$1,062.09 |
| Marginal cost to treat an IPV injury[124] | Ecuador | \$2.00 |

Table 18: Community and Peer Based Maternal Support Costs (USD 2012)

| | Country | Per Newborn | Per Person Exposed | Per Group |
|--|------------|-------------|--------------------|-----------|
| Face to face counseling (CHW)[89] | Bangladesh | | \$0.82 | |
| Group counseling (Women Support Groups) [89] | Bangladesh | | \$0.85 | |
| Mass Media (Music, Street Dramas, TV, Billboards) [89] | Bangladesh | | \$0.61 | |
| Annual cost of volunteer peer counselling[132] | Malawi | \$4.97 | | |
| Annual cost of women's group[132] | Malawi | \$13.09 | \$4.42 | |
| Annual cost of women's group[121] | Nepal | \$41.17 | \$1.37 | \$671.28 |

Table 19: General Child Health Care Costs (USD 2012)

| Inpatient Care | Country | Per Admission | Per Child Treated | Per Bed-Day |
|--|-----------|-------------------|-------------------|-------------|
| General Hospitalization[150] | Uganda | \$409.53 | | |
| General Hospitalization[134] | Zambia | | | \$21.88 |
| Hospitalization (Malaria or Diarrhea)[102] | Nicaragua | | \$459.00 | |
| Private Clinic[87] | Malawi | \$30.92 | | |
| Public Clinic[87] | Malawi | \$12.57 | | |
| Moderate Adverse Drug Reaction[143] | Nigeria | \$171.95 | | |
| Severe Adverse Drug Reaction[143] | Nigeria | \$807.07 | | |
| Outpatient Care | Country | Per Visit | | |
| General Outpatient visit[134] | Zambia | \$3.65 | | |
| General Outpatient visit[88] | Brazil | \$29.05 | | |
| General Outpatient visit[95] | Uganda | \$1.66 | | |
| Outpatient visit at a private clinic[87] | Malawi | \$6.22 | | |
| Outpatient visit at a public clinic[87] | Malawi | \$4.23 | | |
| Outpatient Health Center[150] | Uganda | \$3.73 | | |
| Outpatient Hospital[150] | Uganda | \$2.19 | | |
| Dental Visit[134] | Zambia | \$24.31 | | |
| Child Health Platforms | Country | Per Child Treated | | |
| Child Health Days [128] | Somalia | \$0.99 | | |
| Child Health Days [90] | Ethiopia | \$1.60 | | |
| Child Health Days [90] | Ethiopia | \$1.96 | | |
| Child Health Days - Incremental Deworming[145] | Lao PDR | \$0.04 | | |
| Child Health Days - Total Program[196] | Zambia | \$2.36 | | |
| IMCI Clinical care in IMCI district[118] | Tanzania | \$10.72 | | |
| IMCI Clinical care in IMCI district[95] | Uganda | \$0.99 | | |
| IMCI Clinical care in IMCI district[142] | Tanzania | \$9.90 | | |
| IMCI Clinical care in Non - IMCI district[142] | Tanzania | \$10.51 | | |
| IMCI Total Cost[88] | Brazil | \$21.87 | | |
| Pediatric Treatment in Non-IMCI districts[118] | Tanzania | \$17.25 | | |

Appendix 1 Search terms

Country/Region Terms: "developing countries" OR "developing country" OR "low and middle income countries" OR LMIC OR asia OR africa OR "south america" OR oceania OR "latin America" OR Afghanistan OR Albania OR Algeria OR Angola OR Antigua OR Barbuda OR Argentina OR Armenia OR Armenian OR Aruba OR Azerbaijan OR Bahrain OR Bangladesh OR Barbados OR Benin OR Belize OR Bhutan OR Bolivia OR Botswana OR Brazil OR "Burkina Faso" OR "Burkina Fasso" OR Burundi OR Urundi OR Cambodia OR "Khmer Republic" OR Kampuchea OR Cameroon OR Cameroons OR Cameron OR Camerons OR "Cape Verde" OR "Central African Republic" OR Chad OR Chile OR China OR Colombia OR Comoros OR "Comoro Islands" OR Comores OR Mayotte OR Congo OR Zaire OR "Costa Rica" OR "Cote d'Ivoire" OR "Ivory Coast" OR Djibouti OR "French Somaliland" OR Dominica OR "Dominican Republic" OR "East Timor" OR "East Timur" OR "Timor Leste" OR Ecuador OR Egypt OR "United Arab Republic" OR "El Salvador" OR Eritrea OR Ethiopia OR Fiji OR Gabon OR "Gabonese Republic" OR Gambia OR Gaza OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guiana OR Guyana OR Haiti OR Honduras OR India OR Maldives OR Indonesia OR "Isle of Man" OR Kenya OR Kiribati OR "Lao PDR" OR Laos OR Lesotho OR Basutoland OR Liberia OR Libya OR Madagascar OR "Malagasy Republic" OR Sabah OR Sarawak OR Malawi OR Nyasaland OR Mali OR Malta OR "Marshall Islands" OR Mauritania OR Mauritius OR "Agalega Islands" OR Mexico OR Micronesia OR "Middle East" OR Moldova OR Moldavia OR Moldovan OR Mongolia OR Montenegro OR Morocco OR Ifni OR Mozambique OR Myanmar OR Myanma OR Burma OR Namibia OR Nepal OR "Netherlands Antilles" OR "New Caledonia" OR Nicaragua OR Niger OR Nigeria OR "Northern Mariana Islands" OR Oman OR Muscat OR Pakistan OR Palau OR Palestine OR Panama OR Paraguay OR Peru OR Philippines OR Philipines OR Phillipines OR Phillippines OR Rwanda OR Ruanda OR "Saint Kitts" OR "St Kitts" OR Nevis OR "Saint Lucia" OR "St Lucia" OR "Saint Vincent" OR "St Vincent" OR Grenadines OR Samoa OR "Samoan Islands" OR "Navigator Island" OR "Navigator Islands" OR "Sao Tome" OR "Saudi Arabia" OR Senegal OR Serbia OR Montenegro OR Seychelles OR "Sierra Leone" OR Slovenia OR "Sri Lanka" OR Ceylon OR "Solomon Islands" OR Somalia OR Sudan OR Suriname OR Surinam OR Swaziland OR Tajikistan OR Tadjhikistan OR Tadjikistan OR Tadjhik OR Tanzania OR Thailand OR Togo OR "Togolese Republic" OR Tonga OR Trinidad OR Tobago OR Tunisia OR Turkey OR Turkmenistan OR Turkmen OR Uganda OR Ukraine OR Uruguay OR Vanuatu OR "New Hebrides" OR Venezuela OR Vietnam OR "Viet Nam" OR Zambia OR Zimbabwe OR "Africa, Northern" OR "Northern Africa" OR "North Africa" OR "Africa South of the Sahara" OR "sub-Saharan Africa" OR "subsaharan Africa" OR "Africa, Central" OR "central Africa" OR "Africa, Eastern" OR "Eastern Africa" OR "east Africa" OR "Africa, Southern" OR "southern Africa" OR "Africa, Western" OR "western Africa" OR "west africa" OR "Caribbean Region" OR Caribbean OR "Central America" OR "Panama Canal Zone" OR "French Guiana" OR "Asia, Central" OR "Central Asia" OR "Asia, Southeastern" OR "Southeastern Asia" OR "Southeast Asia" OR "Asia, Western" OR "Western Asia" OR "Far East" OR Borneo OR Brunei OR "Mekong Valley" OR "mekong delta" "Republic of Congo" OR "Congo-Brazzaville" OR "Democratic

Republic of the Congo” OR DRC OR “Congo-Kishasha” OR “Equatorial Guinea” OR “South Sudan” OR “South Africa” OR “Guinea-Bissau”

Cost Analysis Terms: cost* OR “cost analysis” OR economics OR “cost savings” OR “cost of illness” OR “health expenditures” OR “cost effectiveness” OR “economic evaluation” OR “economic analysis”

Abortion Care Terms: “post-abortive care” OR PAC or “post abortion care” OR “manual vacuum aspiration” OR MVA or “surgical abortion” OR “dilation and curettage” OR “D&C” OR “safe abortion” OR “unsafe abortion” OR abortion OR “ectopic case management” OR “ectopic pregnancy management”

Antenatal Care Terms: “antenatal care” or “renatal care” or “pre-natal care” OR “prenatal screening” OR “antenatal screening” OR ANC OR “basic ANC” OR pregnancy OR “tetanus toxoid” OR “safe motherhood” OR “maternal nutrition” OR “antenatal nutrition” OR “multiple micronutrient supplementation” OR “micronutrient supplementation” OR “balanced energy supplementation” OR “folic acid” OR “iron supplement” OR “calcium supplement”

Family Planning Terms: “family planning” or “birth control” or “oral contraception” or “oral contraceptives” or contraception or contraceptives or condom or condoms or “hormonal injection” or “injectable contraceptives” or “surgical contraception” or “intrauterine device” or “IUD” or “implant” or sterilization or “female sterilization” or “male sterilization” or vasectomy or “LAM” or “lactational amenorrhea method” or “natural family planning” or “vaginal barrier” or “vaginal tablets” or “vaginal ring” or “vaginal film” or “other contraceptives” or “female condom” or “diaphragm” or “emergency contraceptives” or “reproductive health” or “birth spacing” or “barrier method” or “hormonal method”

Newborn/Post-Partum Care Terms: Newborn OR “kangaroo mother care” OR KMC OR “skin-to-skin contact” OR “breastfeeding” OR “lactation support” OR “feeding counselling” OR “feeding support” OR “low birth weight” OR “maternal sepsis” OR “newborn sepsis” OR “postpartum hemorrhage” OR “post-partum hemorrhage” OR “postpartum haemorrhage” OR “post-partum haemorrhage” OR eclampsia OR preeclampsia OR “pre-eclampsia” OR “hypertensive disease case management” OR delivery OR birth OR “cesarean section” OR “caesarean section” OR “cesarean birth” OR “caesarean birth” OR “vacuum assisted delivery” OR “forceps assisted delivery” OR “birth attendant”

Childhood Disease Terms: Deworming OR “intestinal worms” OR diarrhea OR diarrhoea OR rotavirus OR “E. coli” OR “gastrointestinal infection” OR “diarrhea management” OR “oral rehydration” OR zinc OR dysentery OR pneumonia OR “pulse oximetry” OR radiographs OR “community case management” OR fever OR malaria OR febrile OR “insecticide treated materials” OR “indoor residual spraying” OR “HiB Vaccine” OR “anti-malarial” OR “antimalarial” OR “anti-biotics” OR “antibiotics” OR pneumococcal OR “acute respiratory infection” OR “streptococcus pneumoniae” OR “HiB” OR “haemophilus influenza” OR “syncytial virus” OR “skin condition” OR “skin conditions” OR “drug resistance” OR “severe disease” OR “growth monitoring” OR screening OR diagnosis OR “rapid diagnostic tests” OR diagnostics OR measles OR “community mobilization” OR “home visitation” OR “community-based

intervention” OR “community-based programs” OR pharmacies OR “social franchise”

Childhood Disease Platforms: (school AND (feeding OR deworming OR malaria OR vaccination OR vision OR hearing)) OR “school based approaches” OR “school-based approaches” OR “school aged kids” OR “school-aged kids” OR “school based control” OR “school-based control” OR “oral health” OR “early child delivery platforms” OR (child AND (campaigns OR platform OR outreach OR “school based” OR “cash transfers” OR conditional OR unconditional)) OR IMCI OR “Integrated Management of Childhood Illness” OR “skin condition” OR “skin conditions” OR “drug resistance” OR “severe disease” OR zinc OR “integrated packages” OR “growth monitoring” OR “vitamin A” OR screening OR diagnosis OR “rapid diagnostic tests” OR diagnostics OR “integrated care” OR measles OR “community mobilization” OR “home visitation” OR “community-based intervention” OR “community-based programs” OR pharmacies OR “social franchise”

Maternal Depression or Caring Terms: (Maternal OR postpartum OR postnatal OR perinatal OR delivery) AND (“care for depression” OR depression OR “routine screening for detection” OR psychoeducation OR “psycho-education” OR “antidepressants” OR “home visit” OR “pre-school support” OR “mental health” OR “mental disorder” OR “care for women” OR “breastfeeding” OR lactation OR “complementary feeding” OR “psycho-social care” OR “food preparation” OR “hygiene practices” OR “home health” OR “caregiver supply” OR “family support” OR “care practice” OR “care for women”)

Intimate Partner Violence Terms: “gender-based violence” OR GBV OR (women AND violence) OR “sexual violence” OR “violence against women” OR “intimate partner violence” OR “intimate male partners” OR “social cost of violence” OR “female genital mutilation” OR fgm OR incest OR rape OR “dowry-related violence” OR “emotional violence” OR trafficking OR “lifetime physical violence” OR “sexual victimization” OR “forced sex” OR “sexually assaulted” OR “sexual assault” OR “sexual trauma” OR trafficked OR “domestic violence” “domestic abuse” OR “sexual coercion” OR “sexually coercive” OR “genital cutting”

Nutrition and Optimal Infant Feeding Terms: “food fortification” OR periconceptual OR “folic acid supplementation” OR “iron supplementation” OR “daily supplementation” OR breastfeeding OR “complementary feeding” OR “counselling and support” OR “infant feeding” OR “home fortification” OR “micronutrient powders” OR “acute malnutrition” OR malnutrition OR “calcium supplementation” OR “nutritional care” OR “lactating women” OR “iodine supplementation” OR “vitamin A supplementation” OR “child nutrition” OR “infant nutrition” OR “maternal nutrition” OR undernutrition OR “under-nutrition”

Appendix 2. Methods Description

| Category of Studies | Total (Percent of Total) | | Study Type | | | | | | | | Methods | | | | Perspective | | | | | Data collection | | | | | Cost Method | | | | | | | |
|--------------------------------------|-----------------------------|------|---------------|-----|-----------------------|-------------|-----------|---------|---------|----------|----------|----------|-------------|---------------|-------------|---------------|----------|------|----|-----------------|----|-----|----|-----|-------------|-----|----|------|----|-----|---|-----|
| | | % | Cost analysis | CCO | Cost-Benefit Analysis | CE analysis | Empirical | Modeled | Patient | Provider | Societal | Modelled | Prospective | Retrospective | Ingredients | Record Review | Multiple | | | | | | | | | | | | | | | |
| Total | 146 | 100% | 89 | 61% | 3 | 2% | 2 | 1% | 52 | 36% | 107 | 73% | 39 | 27% | 5 | 3% | 110 | 75% | 31 | 21% | 28 | 19% | 50 | 34% | 68 | 47% | 78 | 53% | 66 | 45% | 2 | 1% |
| Reproductive/Maternal | 52 | 36% | 40 | 77% | 0 | 0% | 0 | 0% | 12 | 23% | 44 | 85% | 8 | 15% | 5 | 10% | 43 | 83% | 4 | 8% | 0 | 0% | 21 | 40% | 31 | 60% | 26 | 50% | 25 | 48% | 1 | 2% |
| Neonatal | 10 | 7% | 5 | 50% | 0 | 0% | 0 | 0% | 5 | 50% | 9 | 90% | 1 | 10% | 0 | 0% | 10 | 100% | 0 | 0% | 0 | 0% | 4 | 40% | 6 | 60% | 2 | 20% | 7 | 70% | 1 | 10% |
| Nutrition/Optimal Feeding | 21 | 14% | 7 | 33% | 0 | 0% | 2 | 10% | 12 | 57% | 14 | 67% | 7 | 33% | 0 | 0% | 17 | 81% | 4 | 19% | 7 | 33% | 7 | 33% | 7 | 33% | 15 | 71% | 6 | 29% | 0 | 0% |
| Under-Five | 59 | 40% | 35 | 59% | 3 | 5% | 0 | 0% | 21 | 36% | 38 | 64% | 21 | 36% | 0 | 0% | 38 | 64% | 21 | 36% | 21 | 36% | 17 | 29% | 21 | 36% | 31 | 53% | 28 | 47% | 0 | 0% |
| Maternal Depression & IPV | 4 | 3% | 2 | 50% | 0 | 0% | 0 | 0% | 2 | 50% | 2 | 50% | 2 | 50% | 0 | 0% | 2 | 50% | 2 | 50% | 0 | 0% | 1 | 25% | 3 | 75% | 4 | 100% | 0 | 0% | 0 | 0% |

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