COST-BENEFIT ANALYSIS OF PRIORITY HEALTH SYSTEM STRENGTHENING INTERVENTIONS IN GHANA

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Academic Abstract

Ghana is a lower-middle-income country in sub-Saharan Africa with a high incidence of maternal and neonatal mortality. Over the last three decades, Ghana has implemented many interventions aimed at improving maternal and child health. As a result, under-five mortality and neonatal mortality have gone down considerably from 119 per 1000 live births and 41 per 1000 live births in 1993 to 52 per 1000 live births and 25 per 1000 live births as of 2017. Maternal mortality has also declined from 385 deaths per 100,000 live births in 1990 to 310 per 100,000 live births. This reduction notwithstanding, Ghana failed to meet the MDG target of 4/5 reduction of under-five mortality and ¾ reduction in maternal mortality by the close of 2015.

For Ghana to achieve the desired levels of maternal and child survival rates required in line with the Sustainable Development Goals (SDGs), the implementation of proven interventions with the optimum health benefits is required. We present here estimates of benefits and cost analysis of extending the coverage of three of the top proven health systems strengthening interventions in contemporary Ghana.

The three interventions that were analysed in this study were the Ghana Essential Health Intervention Program (GEHIP) implemented in Northern Ghana, the NEWborn Health INTervention Study (NEWHINTS) undertaken in the middle belt of Ghana and the provision of access to Emergency Obstetric and Neonatal care (EmONC). We estimated the costs and benefits of hypothetical scenarios where coverage of these interventions would be increased from their current levels to 100% of the rural population of Ghana. Estimated deaths and morbidity averted were translated into economic benefits and compared with the projected costs, in order to derive benefit-cost ratios.

GEHIP had a benefit-cost ratio of 51, 38 and 37 at 5%, 8% and 14% discount rates respectively. The NEWHINTS trial had a benefit-cost ratio of 28 while the provision of EmONC had a benefit-cost ratio of 5.7, 5.6 and 5.3 for similar discount rates. Thus, the GEHIP intervention had the highest benefit-cost ratio of the three interventions.

Key Words: *Cost-benefits, Maternal and Neonatal health, Health Systems, Ghana priorities*

Policy Abstract

The Problem

Over the last three decades Ghana has invested large amounts of effort in implementing various strategies to reduce maternal and child mortality in the country. Among the key interventions are: Safe Motherhood Program (SMP), Life Saving Skills (LSS) program, Integrated Management of Childhood Illness (IMCI), Community-Based Health Planning and Services (CHPS), User Fees Exemption for Delivery (UFED), Focused Antenatal Care (FANC), National Health Insurance Scheme (NHIS), and Accelerated Child Survival and Development (ACSD). These programs have led to significant improvements in maternal and child health over time. However, Ghana failed to meet the Millennium Development Goal 4 and 5 targets regarding reduction in child and maternal mortality by the end of the year 2015 when the era of the MDGs closed out (United Nations, 2015). Under-five and infant mortality in Ghana decreased from 155 and 77 deaths per 1,000 live births in the year 1988 to 52 and 37 per 1,000 live births in 2017 respectively (Ghana Statistical Service, 2018). While the maternal mortality ratio was reduced from 760 per 100,000 live births in the year 1990 to 310 per 100,000 live births by the year 2017, this ratio is still significantly higher than the MDG 5 target of 190 maternal deaths per 100,000 live births (United Nations, 2015; Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International, 2018).

Ghana failed to meet the required reductions in maternal and child mortality in spite of many initiatives targeted at reducing mortality that have been implemented in the country. There is, therefore, the need to identify and implement additional proven cost-effective interventions with comparatively high impact in order to accelerate improvements in maternal and child health in the country. We present in this paper the benefit-cost analysis of three strategic health systems strengthening interventions that have shown enormous potential for improvement of maternal and child health in Ghana. These interventions are the Ghana Essential Health Intervention Project (GEHIP), the NEWborn Health Intervention Study (NEWHINTS) and Emergency Obstetric and Newborn Care (EmONC).

Intervention 1: Ghana Essential Health Intervention Project (GEHIP)

Overview

GEHIP was a five-year plausibility trial designed to strengthen the health system by promoting the delivery of quality primary health care services. It is best understood as a bundle of related interventions targeting each of the six WHO health system building blocks (World Health Organization, 2010). The specific activities were: improving leadership capacity development, promotion of grass root political and community engagement, information for decision-making, budgeting, logistics, training, and health worker deployment, community-based primary healthcare scale-up and the provision of health services at community locations (Awoonor-Williams *et al.*, 2013; Bawah *et al.*, 2019; Kanmiki *et al.*, 2019).

Implementation Considerations

- Series of training programs for district level health care managers and frontline healthcare providers on leadership, stakeholder engagements for health delivery at the community level, training on how to deal with the lead causes of maternal and neonatal deaths including neonatal resuscitation, WHO recommended care for the newborn (World Health Organization, 2013).
- Mentorship and monitoring support to frontline healthcare providers on how to leverage resources from communities and other stakeholders to improve healthcare delivery and health-seeking
- Flexible funding of up to US$ 0.80 dollar per capita for district-level prioritization of healthcare needs activities
- Community-based low-cost emergency referral system that involved the promotion of facility-based delivery, effective communication and a process of convening community engagement for sustaining social support for referral operations.

Costs and Benefits

Costs

The cost of the GEHIP's intervention is the sum of all six category costs namely the cost of capacity building among human resources for health through trainings and reorientation, the

cost associated with additional health service delivery, the cost related to additional medicines and vaccines, health information, leadership/governance-related expenditures and other costs that mainly involved the program costs of deploying a community-based emergency transport system. Since the GEHIP project was implemented over a three-year period, the total for these categories over the three years is summed up to represent total implementation costs of GEHIP. As GEHIP trial covered 6.8% of Ghana's rural population, these costs were then scaled up to 100% nationwide coverage of the rural population of Ghana, bringing total costs to GH¢ 84.0 million for the year 2018. These costs were then modeled over a six-year period (2018-2023), resulting in a total cost for the six-year period of GHC 159 million at an 8% discount rate.

Benefits

Baseline and end-line survey data from the GEHIP project and comparison districts were used to estimate the incremental health benefits of GEHIP. The difference-in-differences empirical approach was used to estimate the number of newborn lives saved as well as under-five morbidity reductions for two disease conditions (malaria and diarrhea cases).

One of the key impacts of the GEHIP project was a sharp reduction in neonatal deaths over the first three years (Bawah et al, 2019) with declining impacts thereafter. Out of the possible 71,990 expected neonatal deaths over the period 2018-2025, we expect GEHIP would save the lives of 7,551 neonates. Valuing these deaths at Ghana Priorities assumptions value per death averted per year puts the economic value of these averted deaths at GH¢ 5.8 billion.

Also, GEHIP was found to reduce the incidence of diarrhea and malaria among under-fives by 37% and 25% respectively. Using information on the projected number of under-fives in rural Ghana, we estimate the total economic benefits of GEHIP on malaria and diarrhea cases avoided to be GH¢ 295.2 million based on estimates of the total days of illness avoided, hospital treatment cost per case, and productivity loss due to time lost by parent in seeking care for her under-five child. Thus, the total economic value of GEHIP benefit is the sum of economic benefits from mortality and morbidity reduction which is GH¢ 8.3 billion; GH¢ 6.1 billon and GH¢ 5.4 billion, using discount rates of 5%, 8% and 14%, respectively.

Intervention 2: NEWborn Health Intervention Study (NEWHINTS)

Overview

The NEWHINTS intervention involves the training of lay community health workers called community-based surveillance volunteers (CBSV) to identify pregnant women in their communities and to do two home visits during pregnancy and three visits on days 1, 3, and 7 postpartum. The goal is to improve delivery, newborn care practices and care-seeking for mothers and sick newborn babies with an overall aim of reducing maternal and child mortality (Kirkwood *et al.*, 2010).

Implementation Considerations

- Training of Community-based Service Volunteers (CBSV) including periodic refresher trainings
- Monitoring and supervision system at the district level to ensure conformity to guidelines and protocols
- Due to high attrition of CBSVs systems are put in place for periodic/occasional replacement of CBSV
- NEWHINTS intervention works best in places where the community-based health planning and services program (CHPS) is functioning properly
- Improving the capacity of health staff in essential newborn care in health facilities is necessary to ensure optimal benefits from the intervention

Costs and Benefits

Costs

The total cost of this intervention if expanded to cover 100% of Ghana's rural population would be GH¢ 24.9 million per year. This is made up of the summation of six categories of cost items as published by Pitt et al (2016). These are capital cost, human resources, meetings and trainings, supplies, overheads and maternal related cost (the opportunity cost to mothers receiving the intervention) (Pitt *et al.*, 2016).

Benefits

The NEWHINTS intervention was found to reduce neonatal mortality by 8%. This would translate into about 819 neonatal deaths averted per year if scaled up to the rest of rural Ghana. At an economic value of 12,854 per life saved, the economic value of this reduction is estimated at GH¢ 667 million.

NEWHINTS is estimated to reduce not only mortality, but also morbidity. Since we do not have information on morbidity reduction, we estimate an additional 2% reduction in mortality and attribute this to morbidity reduction. These result in economic value of morbidity reduction to be GH¢ 30.3 million. Hence, the total benefits of NEWHINTS intervention is estimated at GH¢ 698 million.

Intervention 3: Emergency Obstetric and Neonatal Care (EmONC)

Overview

Emergency obstetric and neonatal care (EmONC) is known to be a high impact intervention highly recommended for improving maternal and neonatal health outcomes in resource-poor settings (Adam *et al.*, 2005). The provision of Basic (BEmONC) alone is estimated to avert up to 40% of intrapartum-related neonatal mortality and have a significant impact on maternal mortality as well (Lee *et al.*, 2011).

Implementation Considerations

According to the Ghana national standards for EmONC, there should be at least 5 EmONC facilities per 200,000 population. Our cost estimates are based on the estimated number of EmONC facilities required to fill the gap using gap analysis from the 2011 EmONC survey in Ghana (Ghana Ministry of Health, 2011).

Costs and Benefits

Costs

We did not find any prior study in Ghana that has conducted a cost analysis of EmONC provision. Therefore, we rely on an EmONC costing study conducted in Tanzania involving 6 facilities (Mengistu *et al.*, 2019). Ten categories of cost items were specified to make up the total cost of EmONC provision according to the referred study. As per the last Ghana national assessment for emergency obstetric and newborn care survey conducted in 2011, the gap in comprehensive EmONC services is 472 health facilities (Ghana Ministry of Health, 2011).

Drawing from Mengistu et al's EmONC costing of 6 health facilities, and projections over a 15-year period (2018-2032) it would cost a total of GH¢ 835 million at 8% discount rate to fill the national gap in EmONC facilities in Ghana. These cost estimates do not envisage the building of hospitals/facilities from scratch. Instead the analysis takes into account hospitals and other health facilities that already exist but which lack the logistical and human capacity to provide EmONC services. So cost estimates are based on filling this logistical and capacity needs of staff including minor extension/renovation of already existing buildings.

Benefits

The benefit estimates are drawn from Gabrysch et al 2019 which found that EmONC achieves 27% reduction in neonatal mortality. Based on this, the estimated projected economic benefits accruing from neonatal deaths avoided and morbidity reduction by scaling up EmONC to the whole country is GH¢ 5.8 billion.

BCR Summary Table

Interventions	Discount Rate	Benefit (GHS million)	Cost (GHS million)	BCR	Quality of Evidence
Essential primary health care package (GEHIP)	**5%**	**8,341**	**165**	**51**	**Strong**
	8%	**6,149**	**160**	**38**	**Strong**
	14%	**5,450**	**147**	**37**	**Strong**
Late pregnancy and early infancy home visits (NEWHINTS)	**(costs and benefits modeled over one year so discount rate not applicable)**	**698**	**25**	**28**	**Very Strong**
Emergency obstetric and neonatal care (EmONC)	**5%**	**5,778**	**1,012**	**5.7**	**Strong**
	8%	**4,647**	**836**	**5.6**	**Strong**
	14%	**3,186**	**606**	**5.3**	**Strong**

1. Introduction

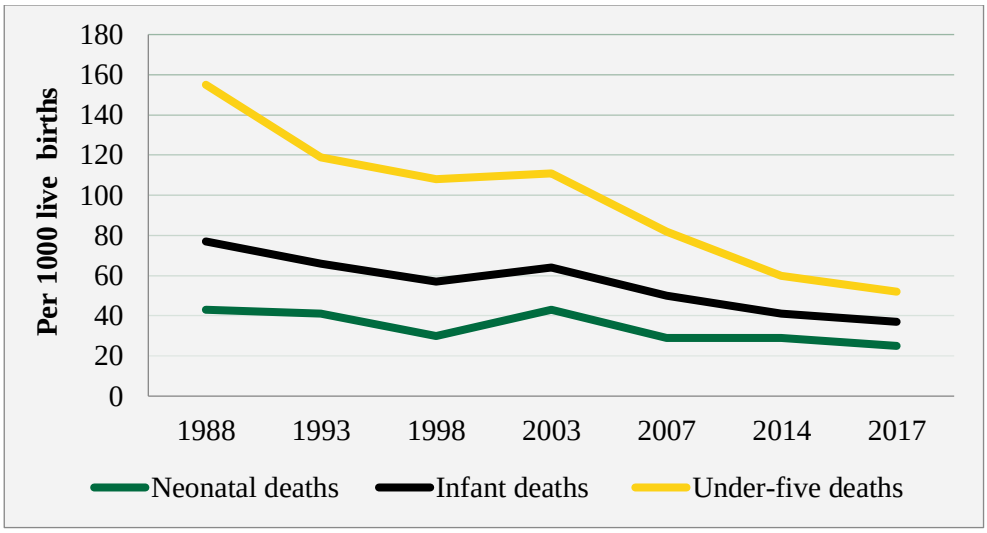
In spite of a global reduction in maternal and child mortality, over 2.7 million neonates still die each year in addition to about 2.6 million babes who are stillborn (Blencowe *et al.*, 2016; Liu *et al.*, 2016). Maternal mortality rate has declined from 385 deaths per 100,000 live births in 1990 to 310 per 100,000 live births (Alkema *et al.*, 2016; GSS and GHS, 2017). However, a majority of these maternal and child deaths occur in low and middle-income countries.

Since the early 1990's Ghana has made a number of efforts aimed at improving maternal and child health. Key among these interventions is the Safe Motherhood Program (SMP). The SMP was launched in 1993 in response to a search for an effective strategy to improve maternal health. It basically provides guidelines for activities related to safe motherhood and strengthening service availability, accessibility, acceptability and capacity building for improving quality healthcare for mothers and newborns (Okiwelu *et al.*, 2007).

The Life Saving Skills (LSS) program was also introduced in the 1990's in Ghana and had at the core of it the development of a manual and training programs with ten modules all aimed at expanding the role of midwives in recognizing and responding to life-threatening emergencies. Other key interventions implemented to improve maternal and child health includes the Integrated Management of Childhood Illness (IMCI), the Community-Based Health Planning and Services (CHPS), User Fees Exemption for Delivery (UFED), the Focused Antenatal Care (FANC), National Health Insurance Scheme (NHIS), Accelerated Child Survival and Development (ACSD).

These interventions among others have contributed to a significant reduction in maternal and child mortality in Ghana during the era of the MDGs. Under-five mortality and neonatal mortality has decreased considerably from 119 and 41 per 1000 live births in 1993 to 52 and 25 per 1000 live births respectively, in 2017 (Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International, 2018). Figure 1 shows the trends in child mortality in Ghana since the year 1988.

Figure 1: Child mortality trend in Ghana 1988-2017 per 1000 live birth



Maternal mortality is however still high at 310 maternal deaths per 100,000 live births (Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International, 2018). Ghana could not meet the MDG target of 2/3 reduction of child mortality and 3/4 reduction in maternal mortality by the close of 2015. In the current SDG era, countries are advised to prioritize child survival programs with proven life-saving interventions in order to achieve the SDG child survival target. Ghana's under-five mortality rate is almost twice the target specified by the SDGs (Ghana Statistical Service, 2017; Liu et al 2016) and therefore it is obvious that the country needs a focused approach to improve maternal and child health indicators.

This paper which is the first of its kind in Ghana is aimed at identifying top proven health systems strengthening interventions with a high impact on child survival and conducting cost-benefit analyses on them. Three strategic health systems strengthening interventions with a high potential for improving maternal and child mortality in Ghana were studied. The Ghana Essential Health Intervention (GEHIP) was implemented between 2010-2015 in a predominantly rural region of Ghana and evidence shows that it lead to high improvements in mortality and morbidity reduction. The second intervention analysed namely the NEWborn Health INTervention Study (NEWHINTS was also implemented in a rural setting of Ghana within the middle belt. It also led to improvements in neonatal mortality reduction. The third intervention - Emergency Obstetric and Neonatal Care (EmONC) also has very high promise for maternal and neonatal mortality reduction. The paper provides policymakers in Ghana the required information to enable them to evaluate and implement the best intervention for improving maternal and child health with the highest benefit to cost ratio.

2. GEHIP

2.1 Intervention Context

Ghana launched the Community-based Health Planning and Services (CHPS) program in the year 2000 as the cornerstone to promote primary health care especially in deprived communities. CHPS itself was based on the Navrongo Community Health and Family Planning Project (CHFP) which tested the hypothesis that deployment of community health nurses to provide door-to-door primary health care services in hard-to-reach communities would overcome the geographic constraints of health care services delivery (Debpuur et al 2002). After almost a decade of implementation of the CHPS program, monitoring of the national scale-up carried out in 2008 revealed that progress had stalled due to fundamental problems in understanding of the concept and other bottlenecks (Binka et al, 2009). To help address the challenges of scale-up of the CHPS, the Ghana Essential Health Intervention Programme (GEHIP) was launched in 2010 to address the systemic issues that affected the scale-up and implementation of the CHPS.

2.1.1 Description of Intervention

GEHIP was a five-year plausibility trial designed to test the hypothesis that a set of health system strengthening interventions with a focus on the WHO health system building blocks including district and sub-district leadership capacity development, promotion of grass root political and community engagement, information for decision-making, budgeting, logistics, training, and health worker deployment, community-based primary healthcare scale-up and the provision of health services at community locations would lead to the improvement in overall health and under-five survival (Awoonor-Williams *et al.*, 2013; Bawah *et al.*, 2019; Kanmiki *et al.*, 2019).

During the GEHIP implementation, frontline workers were trained and equipped to deal with the main causes of neonatal morbidity and mortality. A comprehensive referral service was developed for GEHIP districts that involved the promotion of facility-based delivery, the organization of a communication system, and a process of convening community engagement to sustain social support for referral operations (Patel, Koku Awoonor-Williams, *et al.*, 2016; Awoonor-Williams *et al.*, 2017). GEHIP's interventions were strategically aimed to improve health systems functioning through activities around the WHO health systems building blocks and the provision of flexible funds at the district level to reinvigorate system structures. Table

1 provides the system and operational problems that were identified and GEHIP-specific interventions aimed at addressing those problems.

Table 1: The operational problems that were addressed with particular interventions under GEHIP

Organizational level of intervention	***Type of operational problem to be addressed***	***GEHIP Interventions***
District Health Management Team	*Lack of strategic understanding of the CHPS model*	*Field exchanges and demonstration added to routine leadership training workshops*
	Lack of flexible funding	*Addition of $0.85 per capita per year for three years to the District Common Fund.*
	Lack of evidence-based planning and budgeting	*Provision of a burden of disease-based planning tool.*
District Hospital and Sub-district Health Centers clinical services	*Excess neonatal mortality* *Excess maternal morbidity and mortality*	*Post-natal care for newborns (KMC, other interventions)* *Directly Observed Therapy, Short-course (DOTS)* *Emergency management: Comprehensive Emergency obstetric services to include basic Emergency obstetric care, comprehensive Emergency obstetric services, case management of newborn illnesses, comprehensive emergency referral logistics equipment, and newborn resuscitation training*
Sub-district Health Centers clinical services	*Lack of supervisory support for frontline providers*	*Facilitative supervision training* *Information for decision-making systems reform*
CHPS level interventions	*Lack of functioning information systems* *Lack of field work, community outreach, doorstep services* *Lack of organized program of referral, triage, and community engagement for emergency public health*	*Simplification and reform of clinical recording systems* *Supervisory support for community-based care.* *Comprehensive training in emergency management to include:* *Newborn surveillance and care, including resuscitation training, febrile illness recognition, and other immediate newborn monitoring* *Emergency communication and referral equipment and support.* *Motorcycle ambulance provision.* *Volunteer ambulance driver training and deployment* *Community outreach training* (Source: Bawah et al 2019)

2.1.2 Literature Review

GEHIP as an intervention is a strategic framework for expanding community-based primary healthcare by emphasizing the importance of improving district level leadership capacity for effective systems functioning. The main hypothesis of the GEHIP project was that developing leadership, information for decision-making, budgeting, logistics, training, and community health workers deployment in remote community locations will enhance the provision of health services at community locations and impact on the survival of children (Bawah *et al.*, 2019; Kanmiki *et al.*, 2019). Supportive supervision was provided to systems structures to enhance overall effectiveness. In addition, GEHIP engaged communities to promote the provision of the integrated management of childhood illness regimen promoted by WHO. Frontline workers were trained and equipped to deal with the lead causes of neonatal morbidity and mortality. A comprehensive referral service was developed for GEHIP districts that involved the promotion of facility-based delivery, the organization of a communication system, and a process of convening community engagement for sustaining social support for referral operations (Awoonor-Williams *et al.*, 2013; Patel, Awoonor-Williams, *et al.*, 2016).

2.2 Calculation of Costs and Benefits

The cost and benefit analysis presented here is based on a nationwide scale-up of the GEHIP interventions. GEHIP is a rural intervention and therefore the analysis assumes that the interventions are scaled to cover all of Ghana's rural population. In practical terms, this means a scale-up of GEHIP from 6.8% to 100% of the country's rural population. Even though there are subtle differences in rural populations across the ecological zones of the country, the analysis assumes that the costs can be scaled-up proportionately to the size of the population.

The first year of GEHIP's five-year trial was devoted to project inception activities in preparation for the actual implementation. Implementation costs were expended in 2012, 2013 and 2014. In the analysis that follows we assume that the project will be implemented over three years and after which interventions will stop. However, key system elements of the project that are supposed to be permanent features will be maintained. We therefore, include the incremental costs and benefits of these elements in our calculations.

In terms of the benefits, existing papers have estimated the fertility and mortality effects of the first three years of the project. Bawah et al (2019) estimate a large reduction in neonatal mortality after three years of implementation. Our further interrogation of the data used by

Bawah et al (2019) shows that the neonatal mortality reduction was 9%, 16% and 23% respectively in each of the first three years. We assume that the mortality reduction impact would extend up to five years' post-intervention, allowing additional mortality reductions of 16%, 9%, 5%, 2% and 1% in the ensuing five years.

2.2.1 General Parameters

GEHIP's implementation covered 6.8% of the rural population of Ghana. This study modeled the cost and benefits of the GEHIP on the assumption that the program is scaled up to cover the entire rural population of Ghana. Cost and benefits of nationwide implementation are estimated to be proportional to population coverage. The current neonatal mortality rate in Ghana is 25 per 1000 live births and the targeted (rural) population is 12.6 million, with an estimated number of births in 2018 of just above 1 million. The projected GDP per capita for 2018 is GH¢ 10,379.

2.2.2 Costs

The primary source of data for the estimation of costs comes from Kanmiki et al (2019). Kanmiki et al (2019) is a prospective costing study that analyzed the cost of implementing GEHIP. GEHIP cost data were assembled from GEHIP intervention districts and project records over a three-year period. Five WHO health system building blocks were adopted as cost centers. These were i) the development of health human resources, ii) health service delivery, iii) the provision of medicines & vaccines, iv) health information, and v) leadership/governance building blocks.

Using Kanmiki et al (2019) as the starting point and with additional estimates for a referral package of services that were not factored in Kanmiki's study, we projected the cost of GEHIP for a nationwide coverage of the rural population of Ghana. Using the GDP deflator obtained from the Ghana Statistical Service, we projected cost in 2018 GH¢, amounting to GH¢ 84.0 million. Costs were then projected for an additional five-year period through 2023. For each year, we obtained the equivalent cost of GEHIP for 100% of the rural population of Ghana. Using a 8% discount rate, we estimated that the total cost of implementing GEHIP throughout rural Ghana would be GH¢ 159 million.

2.2.3 Benefits

Bawah et al (2019) estimates that the GEHIP intervention reduced neonatal mortality significantly. That evaluation was carried out three years after the start of the implementation. Using the data from Bawah et al (2019), we estimated that the impact of GEHIP on neonatal

mortality was 12% in the first year, 13% in the second year and 23% in the third year. In our analysis, we assumed that the mortality effect would persist for another five years, with the effects declining each year. We also analyzed the data from Bawah et al (2019) using the difference-in-differences framework to obtain morbidity impact of GEHIP. The analyses show that GEHIP reduced the incidence of malaria by 37% and the incidence of diarrhea by 25%. Benefits were projected form 2018 through 2025.

To calculate total neonatal deaths averted, we first multiplied the crude birth rate with the projected rural population of Ghana to obtain the estimated number of births. We then multiplied the number of births by the current neonatal mortality rate to obtain an estimate of expected neonatal deaths. Assuming implementation commenced in 2018, we estimate that the number of neonatal deaths averted in the years 2018-2025 alone would be 7,551 out of a total of 71,990 deaths expected. Using the value of lives saved as per the Ghana Priorities project assumptions and using discounts rates of 5%, 8% and 14%, we estimated the 7-year benefits of the intervention as a result of neonatal mortality reductions to be GH¢ 8.0 billion, 5.9 billion and 5.2 billion, respectively.

Benefits resulting from reductions in morbidity were estimated based on reductions in the two most common disease conditions of children under five in Ghana (Malaria and Diarrhea). GEHIP project based data shows that GEHIP reduced malaria and diarrhea incidence by 37% and 25% respectively. The most recent Ghana Demographic and Health Survey shows that the incidence of malaria and diarrhea among under-fives is 52 and 22 per 1000 respectively (Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International, 2015). We estimate the expected number of children from rural Ghana that would be affected by these two diseases by multiplying the incidence rates with the number of children under five years.

The number of malaria cases that a scale-up of GEHIP would prevent is based on the 37% incidence reduction found in the original study and is estimated to be 373,034. The number of diarrhea cases prevented is 106,636 based on the 25% incidence reduction found in 2018. The total benefits accruing from reduction in malaria and diarrhea are based on total averted treatment costs and the opportunity cost in the form of lost wages for parents taking their children to receive care. The potential benefits from avoided malaria were computed by multiplying the average economic cost-of-illness of malaria by the estimated number of cases averted. The unit cost is GH¢ 108 and is based on calculations from the malaria paper in the

Ghana Priorities series (Nketiah-Amponsah et al. 2020). Note that this figure accounts for both inexpensive uncomplicated cases and expensive severe cases.

The total benefits from reductions in diarrhea were computed in the same fashion by multiplying the expected number of avoided diarrhea cases by the weighted average of cost of illness for inpatient and outpatient treatment of diarrhea. The details of this calculation can be found in Awuah et al. (2020). The total economic benefits from morbidity reduction over the 6-year period was GH¢ 295.1 million, 275 million and 242.4 million using a discount rate of 5%, 8% and 14%, respectively.

In summary, the economic value of GEHIP's benefits is the sum of the economic benefits from neonatal mortality reduction and the reduction in malaria and diarrhea incidence. This value is GH¢ 8.3 billion, 6.1 billion and GH¢ 5.4 billion for discount rates of 5%, 8% and 14% respectively.

2.2.4 Summary of Cost Benefit Analysis

The benefit cost analysis results are presented in Table 2. At 8% discount rate the benefit-cost ratio is 38, implying that for every one cedi spent on GEHIP, 38 cedis worth of social and economic benefit would be achieved.

Table 2: Summary BCR Table for GEHIP

Discount Rate	Total Cost (GHS million)	Mortality benefit (GHS million)	Morbidity benefit (GHS million)	Total Benefits (GHS million)	BCR
5%	165	8,046	295	8,341	51
8%	160	5,873	275	6,149	38
14%	147	5,207	242	5,450	37

2.2.5 Sensitivity Analysis

The BCR marginally changes to 51 and 37 when we applied discount rates at 5% and 14%. Also, when we halved the neonatal mortality impact a BCR of 26, 20 and 19 are achieved for discounts rates of 5%, 8% and 14% respectively. However, when we increased the mortality reduction rate by 25% a benefit-cost ratio of 63, 48 and 46 is achieved respectively for discount rates of 5%, 8% and 14%. Thus, the BCR of GEHIP was found to be sensitive to changes in discount rates as well as changes in neonatal mortality impact rates.

2.3 Discussion

The huge benefits cost ratio of the GEHIP intervention has important implications for policy review and scale-up. The success of GEHIP cannot be attributed to a single intervention but the entire package of interventions comprising of a combination of leadership and community support for outreach and care, emergency referral services, and expanded coverage of primary care services. This holistic approach is demonstration of a key strategy for saving newborn lives.

The success of GEHIP among neonates, with its package of community-engaged approaches to sustaining emergency referral and providing doorstep post-delivery surveillance, is therefore directly relevant to policy. GEHIP results show that a comprehensive approach to newborn care is feasible, even if care is augmented by community-based nurses.

Mobilizing community action to promote care delivery, with support for essential logistics services, set the stage for GEHIP impact. However, retraining of workers to conduct post-delivery household visits and care for asphyxia, febrile illnesses, and recognition of emergency needs was also important.

The system of frontline care was supported by a corresponding system of community, political, and leadership engagement to marshal resources and sustain primary health care governance. The result was an acceleration of community service functioning and an intensification of access to care that has saved child lives. The task ahead requires policy and action to scale-up GEHIP to the entire rural population of Ghana.

2.3.1 Assessment of Quality of Evidence

The benefits of the intervention are estimated using difference-in-difference estimates from baseline and endline surveys of both intervention and control areas. Costs are based on prospective documentation of project implementation costs. All evidence is from large-scale government-led implementation in Ghana. Therefore, the evidence is assessed as strong.

3. NEWHINTS

3.1 Intervention Context

In rural and remote communities, community health workers are considered essential for newborn care and survival due to their ability to serve as catalysts for community actions as well as to provide healthcare themselves (Kirkwood *et al.*, 2010). Based on successful demonstration of the large impact that community workers have had on child survival in some countries of Asia (Bang *et al.*, 1999; Z. A. Bhutta *et al.*, 2008; Baqui *et al.*, 2009), this approach has been advocated by the WHO and UNICEF as an effective strategy for improving child survival (WHO and UNICEF, 2011).

In line with this and in response to the need for evidence on the feasibility and effectiveness of community-based worker approach for reducing neonatal mortality in the African context, the NEWborn Health INTervention Study (NEWHINTS) was implemented by the Kintampo Health Research Centre (KHRC) of the Ghana Health Service in collaboration with the London School of Hygiene & Tropical Medicine and the Institute of Child Health (Kirkwood *et al.*, 2010). NEWHINTS was implemented in the middle belt of Ghana in seven contiguous districts of the Brong Ahafo Region of Ghana (Kintampo North, Kintampo South, Wenchi, Tain, Techiman, Nkoranza North, and Nkoranza South).

3.1.1 Description of Intervention

This intervention was designed as an integrated package within the primary healthcare system. The core of the intervention was to have trained Community-based Service Volunteers (CBSVs) who were provided with basic logistic support to identify and make visits to pregnant women and their babies to provide counseling-based help aimed at improving maternal and neonatal care. District Health Management Teams (DHMT) played a key role in the design and implementation of this intervention. They played a lead role in the identification and recruitment, supervision and coordination of the CBSVs. Two members of the DHMT in each district were specifically designated with supervising responsibilities for overseeing the activities of each CBSV. To aid their work, a quarterly budget from project funds was provided to cover their participation. In addition, each district-based supervisor was provided with a motorbike with fuel and maintenance costs taken care of by the project.

Home visits by CBSVs

The core element of the intervention was to have CBSVs make five home visits to pregnant women and their babies. Two of the visits were to be made during pregnancy and the remaining three visits after birth specifically during the first week of life of the neonate. Table 3 provides the timing and specific activities carried out by the CBSV at each visit. To ensure effectiveness of these visits, CBSVs were trained to use strategies such as storytelling, counseling and problem-solving approach in delivering their messages. Family members of the pregnant women/mothers were also involved.

Table 3: Specific activities undertaken by CBSV during home visits

Visit No.	**Period of visit**	**Specific activity/massage**
First visit	Early pregnancy	• Encourage antenatal care attendance • Counsel on early care seeking for maternal danger signs • Provide counseling on the need for facility delivery or clean home delivery if facility delivery is not a feasible option. • Discuss and advise on emergency preparedness • Advocate for the use of treated bed net for malaria prevention
Second Visit	3rd trimester	• Counsel on drying, wrapping & breastfeeding immediately after delivery • Advice on delay bathing for at least a day
Third Visit	Day of birth	• Weigh and examine the baby for danger signs - Refer very low birth weight (LBW) & potentially sick babies to the hospital • Encourage exclusive breastfeeding (EBF) • Encourage good thermal care (bath with warm water, dry immediately • and wrap well) • Encourage special care for LBW babies (Skin to skin contact, delay bathing at least 3 days, hygiene, frequent breastfeeding)
Fourth Visit	Day 3 After delivery	• Examine baby for danger signs & refer sick babies • Reinforce advice on EBF, thermal care • Teach newborn danger signs & encourage prompt care-seeking
Firth Visit	Day 7 after delivery	• Assess baby for danger signs & refer sick babies • Reinforce EBF, thermal care, prompt care-seeking • Encourage bed net use and immunisations
Other adhoc visit		• Follow-up visits within 24 hours for referred babies • Visit at 14 days for LBW babies

(Source: Kirkwood et al, 2010)

CBSV Material and Logistics

To aid their work, the CBSVs were provided with a package of materials. These included picture ID cards, waterproof bags and polo shirts branded by the project to enhance the CBSV's credibility. They were also provided with workbooks, counseling assessment cards, tubular weighing scales and slings; digital timers to measure respiratory rates; digital thermometers; cotton rolls and 70% ethanol for disinfecting thermometer; and referral slips. They were also given family cards to record appointments, births, birthweights and referrals and which also have key message reminders. CBSVs with large catchment areas were provided with bicycles to aid their mobility. All these materials were provided to the CBSV to aid their functionality, credibility as well as serve as motivators.

Training & Supervision of CBSVs

CBSVs were trained in two phases. The first phase involved a three-day training focused on the identification of pregnant and newly delivered women in the community, essential newborn care, behavior change communication and the use of counseling cards. They were trained in batches of 30-40 per course. The training was done by NEWHINTS project staff that had themselves been trained by a NEWHINTS clinician (who also earlier on had participated in a UNICEF training of trainees' course). The second phase of training involved coaching CBSVs on weighing, assessing newborn dangers signs and referring and promoting special care for low birth weight neonates.

District level supervisors were deployed with the target of visiting each of their CBSVs at least once a month to directly observe a home visit and to address any issues. Also, supervisors held group meetings with CBSVs within their catchment area every two to three months where the volunteers could share their experiences and discuss their problems. There were also meetings held with community leaders to provide them feedback and stimulate interest in the intervention.

CBSVs Incentives

A monetary incentive, equivalent to $5 was given every month to each CBSV in order to keep them motivated. This amount was also found to be sustainable. It was distributed to CBSVs during monthly supervisions. Health staffs at hospitals within the NEWHINTS intervention area were provided with training in essential newborn care. This became necessary owing to identified inadequacies in the capacity of these facilities in providing essential newborn care.

Before the initiation of the intervention, various fora were organized to sensitize stakeholders on the aims, objectives and operations modalities of the intervention. In particular, healthcare workers at the various facilities in the intervention districts were briefed. Also, through community durbars and meetings, community leaders and members were sensitized in order to have their buy in and full cooperation. For the purposes of the experimental design, the whole area was mapped and divided into supervisory zones. A total of 98 zones in all were then further grouped. Forty-nine zones received NEWHINTS intervention while the remaining 49 served as control.

3.1.2 Literature Review

The predominant direct causes of neonatal mortality in low and middle-income countries are asphyxia, birth injuries, complications during preterm and infections (diarrhea, sepsis, tetanus, pneumonia) whiles indirect causes such as hypothermia and low birth weight are all well identified (Lawn *et al.*, 2008; Kirkwood *et al.*, 2010). The link between maternal health and neonatal outcomes has also been well established (Bhutta *et al.*, 2005). In most rural and remote settings in developing countries, postnatal care for mothers and neonates is either not available or is of poor quality, and is particularly pronounced when deliveries occur at home. Thus, community level healthcare interventions are required in remote and rural setting particularly those focused on improving maternal and newborn care practices at the family level (Kirkwood *et al.*, 2010). It is estimated that 15-32% of neonatal deaths can be prevented through the promotion of basic practices such as clean home delivery, hygienic cord care, thermal care and exclusive breastfeeding and early care seeking for illness (Darmstadt *et al.*, 2005).

Several studies have demonstrated that deploying trained lay community workers leads to substantial reductions in neonatal mortality and impacts on maternal health as well (Bang *et al.*, 1999; Z. Bhutta *et al.*, 2008). Indeed research from Asia show that trained lay community health workers deployed to do three home visits within the first week of life to promote key newborn care practices and identify and refer sick babies can reduce neonatal deaths by up to 60% (Baqui *et al.*, 2008; Kumar *et al.*, 2008; Z. Bhutta *et al.*, 2008). This wealth of evidence has become the basis on which low and middle-income countries have since 2009 been exhorted by WHO and UNICEF to adopt home visit strategy for newborns in a bid to improve maternal and newborn care (WHO and UNICEF, 2011).

The NEWHINTS study in Ghana achieved 8% neonatal mortality reduction rate (Kirkwood *et al.*, 2013). Although this appears quite modest compared with the level of reductions seen in

parts of Asia, it is to be understood that the context and the prevailing mortality rate play a key role in the level of reduction that can be achieved. For instance, Ghana already implemented the community-based health planning and services (CHPS) initiative in the year 2000 as a national policy which had home visits by trained community resident health workers as a core component (Nyonator, 2005; Wells Pence *et al.*, 2007). NEWHINTS actually built on existing community-based volunteers engaged by CHPS by providing them with additional training, logistics and supervision to enable them to provide a focused attention on prenatal and postnatal home visits (Pitt *et al.*, 2016). Although at the time of the NEWHINTS trial, CHPS might not have been well functioning in the areas of implementation, traces of CHPS could have offset some of the effect on mortality observed by the NEWHINTS intervention.

3.2 Calculation of Costs and Benefits

The costs and benefit calculations are based on project level information that was published by the researchers involved in the NEWHINTS intervention. We included cost estimates for mothers since NEWHINTS project researchers adopted a health systems perspective without including estimates of cost incurred by mothers in receiving care. Cost data were assembled from Pitt et al (2016), however, as that data was collected in the year 2009, the GDP deflator was used to project costs for the year 2018. NEWHINTS implementation originally covered 6.15% of Ghana's rural population. These analyses modeled costs and benefits for 100% coverage of Ghana's rural population.

3.2.1 General Parameters

Table 4 presents the general parameters employed in the benefit-cost modeling. As per the latest maternal health survey conducted in Ghana, the neonatal mortality rate is 25 per 1000 live births, while the crude birth rate is 31 per 1000 people in rural Ghana. Assuming a 100% coverage of the rural population, an estimated 409,448 births would be expected and an estimated 10,236 neonatal deaths. The NEWHINT intervention would have the potential to save a total of 819 lives.

Table 4: General Parameters Applied in Modeling NEWHINTS Cost and Benefits

General Parameters	2018 year
Neonatal mortality rate (per 1000 live births)	25
Crude birth rate per 1000 people (Ghana, rural)	31
Projected target population	12,589,896
Births per year	409,448
Neonatal deaths	10,236
Reduction in neonatal mortality in 3 years by NEWHINTS	8%
Neonatal deaths avoided by NEWHINTS	819
YLLs avoided per death	63
Value per YLL	12,854
Projected GDP per capita	10,379
VSL to GDP per cap ratio	44.75

3.2.2 Costs

The total cost of NEWHINTS intervention, if expanded to cover 100% of Ghana's rural population was estimated to be GH¢ 24.8 million. This is a summation of six categories of cost items as published by Pitt et al (2016) with costs converted to 2018 GH¢ and then expanded to 100% of the rural population. These are capital costs, human resources, meetings and trainings, supplies, overheads and maternal related cost (Pitt *et al.*, 2016). Table 5 provides the estimated cost categories and percentage of cost attributable to each category. Based on a projected coverage of 410,000 births per year, this implies a cost of GH¢ 61 per mother which is reasonably aligned to other counseling style interventions in the Ghana Priorities series (see for example, breastfeeding promotion GH¢60 and complementary feeding promotion GH¢28 in Aryeetey, Nkegbe, Issahaku and Wong, 2020).

Table 5: Percentage cost per category

COST Categories	Cost at 2018 (millions GH¢)	Percentage Attribution (%)
Capital cost	3.2	12.9
Human Resources	15.9	63.9
Meetings & trainings	0.7	2.9
Supplies	1.4	5.5
Maternal cost	3.2	13.0
Overheads	0.4	1.8
Total	24.8	100.0

3.2.3 Benefits

Information on the benefits of NEWHINTS came from the study by Kirkwood et al (2013) who used a randomized control trial to evaluate the impact of NEWHINTS on neonatal survival. Results show that NEWHINTS achieved an 8% reduction in neonatal mortality. Based on the crude birth rate in rural Ghana, and the neonatal mortality rate from the last maternal health survey conducted in Ghana, this translates into 819 neonatal deaths averted. Based on an economic value per life saved of 12,854 the total value of these lives saved is estimated to be GH¢ 667.9 million.

NEWHINTS is estimated to have the same impact on morbidity. Based on the Global Burden of Disease study (2017), which puts the rate of neonatal morbidity at 9.5%, the total number of disability days NEWHINTS would avoid is 2,975. This results in economic benefits of GH¢ 30.3 million. Hence the total benefits of NEWHINTS intervention is estimated at GH¢ 698.2 million.

3.2.4 Summary of Cost Benefit Analysis

The cost of a nationwide rural scale-up of NEWHINTS is estimated to cost GH¢ 24.8 million, and generate economic benefits of GH¢ 698.2 million. The Benefit cost ratio is therefore 28, meaning that every cedi spent on NEWHINTS will yield 28 cedis worth of social and economic benefit.

Table 6: Summary BCR Table for NEWHINTS

Annual Cost	Annual Benefit	BCR
24.8m	698.2m	28

3.2.5 Sensitivity Analysis

The study carried out some sensitivity analysis mainly by varying the neonatal mortality rate using rates of two regions (Greater Accra and Volta region) of Ghana. These two regions have two extremes in neonatal mortality; Greater Accra with the lowest rate at 19 deaths per 1000 live births and Volta region with the highest neonatal mortality rate in Ghana (33 deaths per 1000 live births). The objective was to see how sensitive the benefits of the NEWHINTS intervention were based on the mortality rates of different regions.

The results of the sensitivity analysis are presented in Table 7. It can be seen that the benefits of NEWHINTS are sensitive to variations in the neonatal mortality rate. Using a neonatal mortality rate of 19, benefits from NEWHINTS decreased to GH¢ 698 million and a BCR of 28. Using the neonatal mortality rate from the Volta region, led to a benefit cost ratio of 37.

Table 7: Sensitivity analysis using different neonatal mortality rates

	Neonatal mortality rate	**Benefits**	**BCR**
National	25	698,184,580	28
Greater Accra region	19	537,898,921	22
Volta region	33	911,898,793	37

3.3 Discussion

Although the NEWHINTS intervention achieved a modest reduction of 8% in neonatal mortality over a three-year period, this would result in saving the lives of about 819 neonates and economic benefits of GH¢ 698 million with a high benefit cost ratio of 28 if scaled up to all rural parts of Ghana. According to Pitt et al 2016, the NEWHINTS home visits intervention has a 95% chance of being highly cost-effective if implemented in rural settings with neonatal mortality rates of 30 or more deaths per 1000 live births (Pitt *et al.*, 2016). The NEWHINTS strategy targets a set of neonatal disorders which account for a low proportion of newborn deaths in areas of lower mortality rates, therefore, where neonatal mortality rates are already low, the added benefit of NEWHINTS intervention will most likely be low (Pitt *et al.*, 2016).

The application of NEWHINTS to the entire rural region of Ghana is feasible given that the health system structure is fairly similar across Ghana. Since Ghana has already adopted the Community-based Health Planning and Services (CHPS) as a national strategy for primary

healthcare delivery (which includes home visits by trained healthcare providers who also reside in the community they serve); it might be redundant to push for a NEWHINTS approach.

3.3.1 Assessment of Quality of Evidence

Evidence for analyzing the cost and benefits of this intervention came from a randomized control trial and prospective data collected from project records. In addition to author owned estimates and projections. Based on the rigorous nature of the methods and computations, the quality of evidence is assessed to be very strong.

4. EmONC

4.1 Intervention Context

Ghana still faces major challenges with regards to reducing maternal and neonatal mortality and morbidity. Access to EmONC interventions has been identified as a key strategy for improving maternal and neonatal health outcomes (Ghana Ministry of Health, 2011). Emergency Obstetric and Neonatal Care (EmONC) provision is crucial for reducing neonatal and maternal mortality. Providing EmONC requires trained health workers, medical equipment, essential medicines and supplies (Mengistu *et al.*, 2019). This entails committing adequate resources and capacity building.

4.1.1 Description of Intervention

EmONC provision in Ghana requires infrastructure upgrades that include buildings or renovating existing buildings to ensure the availability of operating theatres, maternity wards, laboratory facilities. It also involves providing equipment, essential EmONC supplies, medicines as well as capacity building for clinical and non-clinical staff in EmONC skills for delivering emergency care to mothers and neonates (Mengistu *et al.*, 2019).

4.1.2 Literature Review

The government of Ghana with support from various development partners has over the years implemented various maternal and newborn healthcare programs at all levels in the country. In spite of all these efforts, maternal and neonatal mortality is still high (Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International, 2018). Many research efforts have contributed to understanding and documenting the maternal and child health situation in the

country; prominent among the issues highlighted is the quality of healthcare services provided to mothers and neonates from pregnancy through postnatal care (Nesbitt *et al.*, 2013).

Therefore, there is an urgent need to strengthen the quality of maternal and newborn care services so as to reduce the high maternal and newborn mortality in Ghana. Improving the capacity of health facilities to provide EmONC services has gained prominence as an effective strategy for addressing high maternal and child mortality (Manasyan *et al.*, 2013). The majority of maternal and neonatal deaths and long-term childhood neurological disorders are due to obstetric complications, which include sepsis, hemorrhage, preeclampsia/eclampsia, and prolonged and obstructed labor (Khan *et al.*, 2006). Access to safe and effective obstetric and neonatal services (EmONC) is important for preventing morbidity and mortality (Khan *et al.*, 2006; Manasyan *et al.*, 2013).

During the last national EmONC survey conducted in Ghana, a total of 1,268 facilities were surveyed, 3 of which were Teaching hospitals, 9 were Regional hospitals, 273 were District and other hospitals, 518 were Health centres, 161 Health clinics, 165 Maternity homes and 139 CHPS Compounds (Ghana Ministry of Health, 2011). Facilities were classified as basic EmONC if they provided 7 basic EmONC signal functions in the last three months and comprehensive EmONC if they provide all 9 EmONC signal functions. Table 8 presents the signal functions used in the classification of EmONC during the last national survey.

Table 8: EmONC signal functions use for classification

BASIC SERVICES	**COMPREHENSIVE SERVICES**
(1) Administer parenteral antibiotics	Perform signal functions 1-7 plus
(2) Administer uterotonic (e.g. parenteral oxytocin)	(8) Perform surgery (e.g.) caesarean section
(3) Administer parenteral anticonvulsants for pre-eclampsia and eclampsia (e.g. magnesium sulphate)	(9) Perform blood transfusion
(4) Manual removal of placenta	
(5) Removal of retained products (e.g. manual vacuum extraction, dilatation and curettage)	
(6) Perform assisted vaginal delivery (e.g. vacuum extraction)	
(7) Perform basic neonatal resuscitation (e.g. with bag and mask)	

(Source: Ghana Ministry of Health, 2011)

Facilities that did not meet these criteria were classified as non-EmONC facilities (Ghana Ministry of Health, 2011). The UN guidelines recommend that there should be a minimum of 5 EmONC facilities for every population of 500,000 people, with at least one of them providing comprehensive EmONC care. In Ghana, based on the population distribution, a more rigorous approach has been applied with the guidelines recommending a minimum of 5 EmONC facilities per 200,000 population, with at least one of them providing comprehensive EmONC care (Ghana Ministry of Health, 2011). With this mind, there should be 485 Basic facilities and 121 Comprehensive facilities. However, the last EmONC assessment found only 13 Basic facilities (leaving a gap of 472 facilities) and 76 Comprehensive facilities (leaving a gap of 45 facilities). It was therefore recommended that more existing healthcare facilities should be improved and strengthened to be capable of providing EmONC services so as to meet the national standards on EmONC.

4.2 Calculation of Costs and Benefits

We did not find any previous study from Ghana that had done a costing analysis of the cost of EmONC so we relied on a study from Tanzania which assessed the cost of setting up 6 facilities to be fully EmONC functional. The last EmONC survey conducted in Ghana was in 2011; this survey estimated that based on the population of Ghana and the current existing facilities, there was a gap of 472 EmONC health facilities. Estimates on the costs of nationwide scale-up of EmONC facilities are based on this gap and the costs of establishing EmONC facilities from Mengistu et al 2019 (the Tanzania study). Estimates of benefits use Gabrysch et al. (2019), which assessed the impact of EmONC on neonatal mortality in Ghana.

4.2.1 General Parameters

The general parameters used are similar to the first two interventions. We used the crude birth rate in rural Ghana (33 per 1000 population) and the projected rural population of 12.6 million to estimate the projected births per year. The current institutional delivery rate in rural Ghana is 68% of all deliveries therefore; the number of deaths that a scale-up of EmONC facilities would be capable of influencing (all things being equal) is a function of the neonatal mortality rate (25 per 1000 live births in Ghana), the projected births per year and the percentage of facility deliveries. We estimate cost and benefits over a 15-year period. Based on Gabrysch et al. (2019) who did a secondary analysis of data from two randomized control trials in the middle belt of Ghana over a nine-year period, improvement in EmONC facilities was estimated to lead to an increase of 1.1% of facility deliveries within the first year (Gabrysch *et al.*, 2019).

We assume that successive years after the first year would have a growth in facility delivery of 1.015% annually over the previous years.

4.2.2 Costs

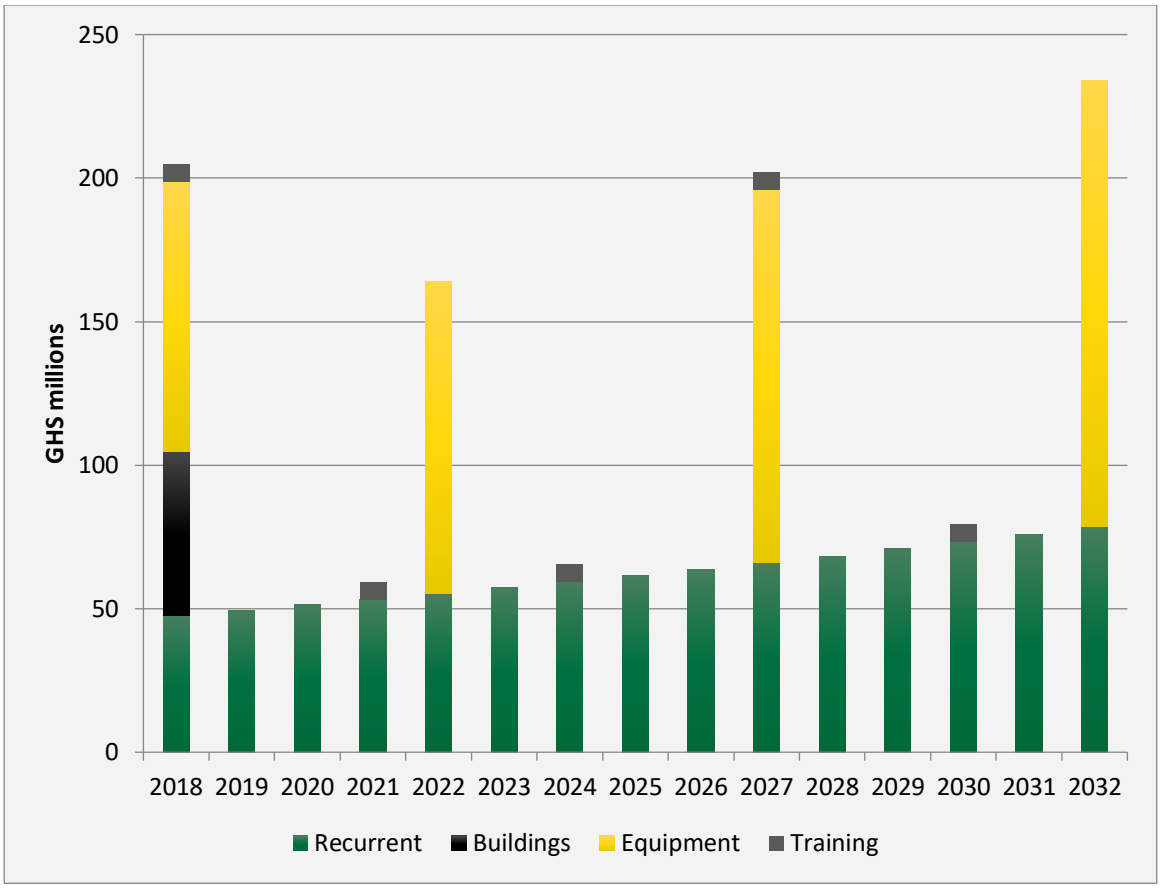
Cost estimates came from Mengistu et al (2019), which estimates the cost of operating 6 EmONC facilities in Tanzania. Expanding EmONC to the recommended levels in Ghana would not imply full construction costs from scratch. This is because the study envisages the use of already existing health facilities which lack the required logistics and/or human capacity to provide EmONC however. The costs therefore are primarily for scaleup involving improving on this existing facilities much like Mengistu et al's study from Tanzania. Four categories of cost items were identified: building construction costs, cost of equipment, training of health workers and recurrent cost items. The total cost of all this is equivalent to 2.6 million in 2018 GH¢. Table 9 provides the cost breakdown in 2018 GH¢ for the first year.

We project these costs over the next 15 years (from 2018-2032) – see Figure 1. We assume that, equipment would be replaced every 5 years, new buildings would be put up once every 30 years, EmONC trainings would take place every 3 years while recurrent cost would be incurred every year. A real cost inflator factor of 0.04 is applied for successive years as a cost growth index.

Table 9: Cost estimates for EmONC scale up for 2018

Cost Items/Categories	**Cost estimates for 2018**
Equipment	94,017,867
Buildings	57,059,329
Training	5,979,602
Recurrent	47,710,660
Total costs	204,767,457

Figure 1: Cost of scaling up coverage of EmONC in facilities across Ghana



Total cost for the 15-year projection period amounted to GH¢ 1.1 billion, GH¢ 838 million and GH¢ 606 million, using 5%, 8% and 14% discount rates, respectively.

4.2.3 Benefits

We identified and applied two important sources of evidence on the benefits of EmONC in this analysis. First, a 2011 systematic review by Lee et al, found that EmONC provision led to a 40% reduction in intrapartum neonatal mortality. A study that was conducted in Ghana by Gabrysch et al. (2019), estimated that EmONC achieved a 27% reduction in intrapartum neonatal mortality.

Using Lee et al's 40% reduction in neonatal mortality and morbidity, and a value of GH¢ 12854 per death averted, total benefits accruing from mortality reduction over the 15 year period is GH¢ 12.2 billion while benefits accruing from morbidity reduction is GH¢ 832.4 million. Thus the total benefits at 8% discount rate is GH ¢ 6.9 billion.

However, using Gabrysch et al's reduction of 27%, the total benefits accruing from EmONC from both mortality and morbidity reductions is GH¢ 4.6 billion for 8% discount rate.

4.2.4 Summary of Cost Benefit Analysis

Table 10 provides a summary of the cost benefits analysis of EmONC scale-up in Ghana using the two approaches discussed above. The approach using Lee et al. had comparatively higher benefit cost ratios compared to estimates using Gabrysch et al. At a discount rate of 8%, estimates using Lee et al yielded a benefit-cost ratio of 8.3 while estimates using Gabrysch et al. produced a ratio of 5.6.

Table 10: Summary BCR Table for EmONC

Approach 1 (Lee et al 2011)	**Costs (millions, cedi)**	**Benefits (millions, cedi)**	**BCR**
5%	1,012	8,631	8.5
8%	836	6,943	8.3
14%	606	4,760	7.8
Approach 2 (Gabrysch et al 2019)	**Costs**	**Benefits**	**BCR**
5%	1,012	5,778	5.7
8%	836	4,647	5.6
14%	606	3,186	5.3

4.2.5 Sensitivity Analysis

The benefit-cost ratio of EmONC was found to be sensitive to varying neonatal mortality rates of reduction. At 8% discount rate while Lee et al neonatal mortality reduction rate of 40% yielded a BCR of 8.3, Gabrysch et al's 27% neonatal mortality reduction rate yielded a BCR of 5.6. A similar pattern is observed for discount rates of 5% and 14%. Thus the benefit-cost ratio of EmONC is sensitive to neonatal mortality reduction rates. However, the benefit cost ratio is not significantly sensitive with varying discount rates when a constant mortality reduction rate applied.

4.3 Discussion

Our analysis of cost and benefits yielded a fairly positive benefit-cost ratio for scaling up EmONC. It shows that at 8% discount rate using Lee et al. 2011 estimates of benefits, EmONC would achieve 8.3 cedis for every one cedi investment in EmONC. These have important implications for policy review and implementation. The benefits accruing from EmONC could even be higher if Ghana achieves 100% health facility delivery.

The quality of obstetric and neonatal care delivery is very fundamental for the survival and health of mothers and newborns; therefore, it is important that urgent steps to be taken to improve EmONC provision in Ghana.

4.3.1 Assessment of Quality of Evidence

This analysis has relied on initial cost estimates from Tanzania whose economy and health system might be slightly different. Estimates of benefits came from two high quality sources, Lee et al. (2011) which is a systematic review with relatively high quality of evidence and Gabrysch et al. (2019) which is a cluster-randomised controlled trial conducted in the middle belt of Ghana. We therefore assess the overall quality of the assessment as "Strong".

5. Conclusion

Our analysis has aimed to apply the best available evidence in assessing the benefits and cost of the three interventions. Our estimates show that the three interventions present a wide range of benefit-cost ratios with GEHIP presenting the highest benefit-cost ratios followed by NEWHINTS and then EmONC.

Strengthening primary healthcare through the GEHIP package of interventions is estimated to avert a total of 7,551 neonatal deaths in addition to averting 1,609,250 malaria cases and 670,389 cases of diarrhea among under-five children within the 7 years period of our projection. GEHIP also has other benefits including the uptake of family planning services (Phillips *et al.*, 2019) which could impact on fertility reduction in the long term, generating even more benefits.

Further, strengthening primary health care through the scale-up of NEWHINTS was found to avert 819 neonatal deaths and 3,121 neonatal yearly lives lost averted within one year of implementation. Strengthening primary healthcare through scale up of EmONC will avert a total of 6,666 neonatal deaths and 28,486 neonatal yearly lives lost averted within 15 years of implementation.

The evidence as presented on the three interventions has enormous relevance for policy deliberations. A careful study of the interventions reveals that GEHIP has an element of NEWHINTS as well as EmONC within its package of interventions - an element of community mobilization and deployment of resident community health workers with a range of responsibilities including home visitation of pregnant women and newborns. Also, capacity

building of health workers on essential newborn care as well as the provision of medical supplies and logistics which are at the core of EmONC intervention are well featured within GEHIP package of interventions. The analysis indicates that a multipronged approach to dealing with the current high maternal and neonatal mortality in Ghana should be pursued. The evidence shows that GEHIP package of interventions encompasses a multitude of essential strategies for dealing with the problem.

BCR Summary Table

Interventions	Discount	Benefit (millions cedi)	Cost (millions cedi)	BCR	Quality of Evidence
GEHIP	5%	8,341	165	51	Strong
	8%	6,149	160	38	
	14%	5,450	147	37	
NEWHINTS	All rates	698	25	28	Very Strong
EmONC	5%	5,778	1,012	5.7	Limited
	8%	4,647	836	5.6	
	14%	3,186	606	5.3	

Notes: BCR for EmONC is based on Gabrysch et al (2019) impact information

BCR Summary Table with annualized values

Interventions	Discount	Annualized Benefit (millions cedi)	Annualized Cost (millions cedi)	BCR	Quality of Evidence
GEHIP	5%	1,291	26	51	Strong
	8%	1,070	28	38	
	14%	1,175	32	37	
NEWHINTS	All rates	698	25	28	Very Strong
EmONC	5%	557	97	5.7	Limited
	8%	543	98	5.6	
	14%	519	99	5.3	

Notes: BCR for EmONC is based on Gabrysch et al (2019) impact information

6. References

Adam, T. *et al.* (2005) 'Cost effectiveness analysis of strategies for maternal and neonatal health in developing countries', *BMJ*, 331(7525), pp. 1–6.

Alkema, L. *et al.* (2016) 'Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group', *The Lancet*. Elsevier, 387(10017), pp. 462–474. doi: 10.1016/S0140-6736(15)00838-7.

Aryeetey et al. (2020) 'Cost Benefit Analysis of Priority Health System Strengthening Interventions in Ghana

Awoonor-Williams, J. K. *et al.* (2013) 'The Ghana essential health interventions program: a plausibility trial of the impact of health systems strengthening on maternal & child survival', *BMC Health Services Research*, 13(2), p. 1.

Awoonor-Williams, J. K. *et al.* (2017) *Making the System Work: Developing Emergency Public Health Systems (Part B)*. Accra, Ghana: UNICEF.

Awuah et al. (2020) 'Cost benefit analysis for faecal sludge management interventions in Ghana' *Ghana Priorities*, Copenhagen Consensus Center

Bang, A. T. *et al.* (1999) 'Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India.', *Lancet*, 354(9194), pp. 1955–61.

Baqui, A. *et al.* (2008) 'Effect of community-based newborn-care intervention package implemented through two service-delivery strategies in Sylhet district, Bangladesh: a cluster', *Elsevier*. Available at: https://www.sciencedirect.com/science/article/pii/S0140673608608351 (Accessed: 5 October 2019).

Baqui, A. H. *et al.* (2009) 'Effectiveness of home-based management of newborn infections by community health workers in rural Bangladesh.', *The Pediatric infectious disease journal*, 28, pp. 304–310. doi: 10.1097/INF.0b013e31819069e8.

Bawah, A. A. *et al.* (2019) 'The child survival impact of the Ghana Essential Health Interventions Program: A health systems strengthening plausibility trial in Northern Ghana', *PLOS ONE*. Edited by B. Kamath-Rayne. Public Library of Science, 14(6), p. e0218025. doi: 10.1371/journal.pone.0218025.

Bhutta, Z. *et al.* (2008) 'Implementing community-based perinatal care: results from a pilot study in rural Pakistan', *SciELO Public Health*. Available at: https://www.scielosp.org/scielo.php?pid=S0042-96862008000600013&script=sci_abstract&tlng=fr (Accessed: 5 October 2019).

Bhutta, Z. A. *et al.* (2005) 'Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence', *Pediatrics*. American Academy of Pediatrics, 115(2 Suppl), pp. 519–617. doi: 10.1542/peds.2004-1441.

Bhutta, Z. A. *et al.* (2008) 'Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make?', *The Lancet*, pp. 972–989. doi: 10.1016/S0140-6736(08)61407-5.

Blencowe, H. *et al.* (2016) 'National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis', *The Lancet Global Health*. Elsevier, 4(2), pp. e98–e108. doi: 10.1016/S2214-109X(15)00275-2.

Darmstadt, G. *et al.* (2005) 'Evidence-based, cost-effective interventions: how many newborn babies can we save?', *Elsevier*. Available at: https://www.sciencedirect.com/science/article/pii/S0140673605710886 (Accessed: 17 October 2019).

Gabrysch, S. *et al.* (2019) 'Does facility birth reduce maternal and perinatal mortality in Brong Ahafo, Ghana? A secondary analysis using data on 119 244 pregnancies from two cluster', *Elsevier*. Available at: https://www.sciencedirect.com/science/article/pii/S2214109X19301652 (Accessed: 29 November 2019).

Ghana Ministry of Health (2011) *National Assessment for Emergency Obstetric and Newborn Care*. Available at: http://www.mamaye.org.gh/sites/default/files/evidence/Ghana EmONC National Report final 2011.pdf.

Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International (2015) *Ghana Demographic and Health Survey 2014*.

Ghana Statistical Service (GSS); Ghana Health Service (GHS); ICF International (2018) *Ghana Maternal Health Survey 2017*. Accra. Available at: https://www.dhsprogram.com/pubs/pdf/FR340/FR340.pdf.

GSS and GHS (2017) *Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF. 2017. Ghana Malaria Indicator Survey 2016. Accra, Ghana, and Rockville, Maryland, USA: GSS, GHS, and ICF*.

Kanmiki, E. W. *et al.* (2019) 'Cost of implementing a community-based primary health care strengthening program : The case of the Ghana Essential Health Interventions Program in northern Ghana', *PLOS ONE*, 14(2), pp. 1–15.

Khan, K. *et al.* (2006) 'WHO analysis of causes of maternal death: a systematic review', *Elsevier*. Available at: https://www.sciencedirect.com/science/article/pii/S0140673606683979 (Accessed: 25 October 2019).

Kirkwood, B. R. *et al.* (2010) 'NEWHINTS cluster randomised trial to evaluate the impact on neonatal mortality in rural Ghana of routine home visits to provide a package of essential newborn care interventions in the third trimester of pregnancy and the first week of life: trial protocol', *Trials*, 11(1), p. 58. doi: 10.1186/1745-6215-11-58.

Kirkwood, B. R. *et al.* (2013) 'Effect of the NEWHINTS home-visits intervention on neonatal mortality rate and care practices in Ghana: a cluster randomised controlled trial.', *Lancet (London, England)*, 381(9884), pp. 2184–92. doi: 10.1016/S0140-6736(13)60095-1.

Kumar, V. *et al.* (2008) 'Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: a cluster-randomised controlled trial', *Elsevier*, 372(1151), p. 59. Available at: https://www.sciencedirect.com/science/article/pii/S014067360861483X (Accessed: 18 October 2019).

Lawn, J. E. *et al.* (2008) 'Four million neonatal deaths: counting and attribution of cause of death', *Paediatric and Perinatal Epidemiology*, 22(5), pp. 410–416. doi: 10.1111/j.1365-3016.2008.00960.x.

Lee, A. C. *et al.* (2011) 'Care during labor and birth for the prevention of intrapartum-related neonatal deaths: a systematic review and Delphi estimation of mortality effect', *BMC Public Health*, 11(Suppl 3), p. S10. doi: 10.1186/1471-2458-11-S3-S10.

Liu, L. *et al.* (2016) 'Global, regional, and national causes of under-5 mortality in 2000–15: an updated systematic analysis with implications for the Sustainable Development Goals', *The Lancet*. Elsevier, 388(10063), pp. 3027–3035. doi: 10.1016/S0140-6736(16)31593-8.

Manasyan, A. *et al.* (2013) 'Assessment of Obstetric and Neonatal Health Services in Developing Country Health Facilities', *American Journal of Perinatology*. Thieme Medical Publishers, 30(09), pp. 787–794. doi: 10.1055/s-0032-1333409.

Mengistu, T. *et al.* (2019) 'Cost of providing emergency obstetric care in Tanzania's Kigoma region', *The International Journal of Health Planning and Management*, p. hpm.2820. doi: 10.1002/hpm.2820.

Nesbitt, R. C. *et al.* (2013) 'Quality along the Continuum: A Health Facility Assessment of Intrapartum and Postnatal Care in Ghana', *PLoS ONE*. Edited by E. Szyld. Public Library of Science, 8(11), p. e81089. doi: 10.1371/journal.pone.0081089.

Nketiah-Amponsah et al. (2020), '*Cost Benefit Analysis of Priority Health System Strengthening Interventions in Ghana*

Nyonator, F. K. (2005) 'The Ghana Community-based Health Planning and Services Initiative for scaling up service delivery innovation', *Health Policy and Planning*, 20(1), pp. 25–34. doi: 10.1093/heapol/czi003.

Okiwelu, T. *et al.* (2007) 'Safe motherhood in Ghana: Still on the agenda?', *Elsevier*. Available at: https://www.sciencedirect.com/science/article/pii/S0168851007001273 (Accessed: 21 October 2019).

Patel, S., Koku Awoonor-Williams, J., *et al.* (2016) 'Benefits and Limitations of a Community-Engaged Emergency Referral System in a Remote, Impoverished Setting of Northern Ghana.', *Global health, science and practice*. Johns Hopkins University- Global Health. Bloomberg School of Public Health, Center for Communication Programs, 4(4), pp. 552–567. doi: 10.9745/GHSP-D-16-00253.

Patel, S., Awoonor-Williams, J. K., *et al.* (2016) 'Benefits and limitations of a community-engaged emergency referral system in a remote, impoverished setting of northern Ghana', *Global Health: Science and Practice*, 4(4), pp. 552–567.

Phillips, J. F. *et al.* (2019) 'The fertility impact of achieving universal health coverage in an impoverished rural region of Northern Ghana', *Gates Open Research*. F1000 Research Limited, 3, p. 1537. doi: 10.12688/gatesopenres.12993.1.

Pitt, C. *et al.* (2016) 'Cost and cost-effectiveness of newborn home visits: findings from the NEWHINTS cluster-randomised controlled trial in rural Ghana', *Lancet Global Health*. Available at: https://www.sciencedirect.com/science/article/pii/S2214109X15002077 (Accessed: 4 October 2019).

United Nations (2015) *Millennium Development Goals*. Available at: http://gh.one.un.org/content/unct/ghana/en/home/global-agenda-in-ghana/millennium-development-goals.html (Accessed: 17 October 2019).

Wells Pence, B. *et al.* (2007) 'The effect of community nurses and health volunteers on child mortality: The Navrongo Community Health and Family Planning Project', *Scandinavian Journal of Public Health*, 35(6), pp. 599–608. doi: 10.1080/14034940701349225.

WHO and UNICEF (2011) 'Joint Statement on home-based care of newborns:Home visits for the newborn child: a strategy to improve survival: World Health Organization.', *WHO*. World Health Organization. Available at: https://www.who.int/maternal_child_adolescent/news_events/news/2009/09_07_08/en/ (Accessed: 5 October 2019).

World Health Organization (2010) *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies*. Available at: https://apps.who.int/iris/bitstream/handle/10665/258734/9789241564052-eng.pdf (Accessed: 2 October 2019).

World Health Organization (2013) *WHO Recommendations on Postnatal Care of the Mother and Newborn, WHO Recommendations on Postnatal Care of the Mother and Newborn*. World Health Organization. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24624481 (Accessed: 2 October 2019).

GHANA PRIORITIES

The Ghanaian economy has been growing swiftly, with remarkable GDP growth higher than five per cent for two years running. This robust growth means added pressure from special interest groups who demand more public spending on certain projects. But like every country, Ghana lacks the money to do everything that citizens would like. It has to prioritise between many worthy opportunities. What if economic science and data could cut through the noise from interest groups, and help the allocation of additional money, to improve the budgeting process and ensure that each cedi can do even more for Ghana? With limited resources and time, it is crucial that focus is informed by what will do the most good for each cedi spent. The Ghana Priorities project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country.

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