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Malawi three district evaluation: Community-based maternal and newborn care economic analysis

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Abstract

Malawi is one of few low-income countries in sub-Saharan Africa to have met the fourth Millennium Development Goal for child survival (MDG 4). To accelerate progress towards MDGs, the Malawi Ministry of Health's Reproductive Health Unit - in partnership with Save the Children, UNICEF and others – implemented a Community Based Maternal and Newborn Care (CBMNC) package, integrated within the existing community-based system. Multi-purpose Health Surveillance Assistants (HSAs) already employed by the local government were trained to conduct five core home visits. The additional financial costs, including donated items, incurred by the CBMNC package were analysed from the perspective of the provider. The coverage level of HSA home visits (35%) was lower than expected: mothers received an average of 2.8 visits rather than the programme target of five, or the more reasonable target of four given the number of women who would go away from the programme area to deliver. Two were home pregnancy and less than one, postnatal, reflecting greater challenges for the tight time window to achieve postnatal home visits. As a proportion of a 40 hour working week, CBMNC related activities represented an average of 13% of the HSA work week. Modelling for 95% coverage in a population of 100,000, the same number of HSAs could achieve this high coverage and financial programme cost could remain the same. The cost per mother visited would be US$6.6, or US$1.6 per home visit. The financial cost of universal coverage in Malawi would stand at 1.3% of public health expenditure if the programme is rolled out across the country. Higher coverage would increase efficiency of financial investment as well as achieve greater effectiveness.

Keywords: cost, economic, maternal, community, community health worker, health promotion, health surveillance assistants, home visit, Malawi, newborn

Key Messages

- The Malawi Community Based Maternal Newborn Care (CBMNC) package involved national scale up of five home visits implemented by the national multi-purpose extension worker (Health Surveillance Assistant (HSA)) but coverage level of home visits (35%) was lower than expected, with only 11% of mothers receiving a postnatal home visit within three days after birth.
- The main cost drivers of the programme were related to the HSA-fixed costs and especially training (63% of total).
- The cost per mother/child pair for this package standardized to 100 000 population at 95% coverage is US$6.1. Increased coverage could be achieved at similar running costs and would make the package more efficient and much more cost-effective, and should be feasible as is currently 13% of the HSA time.
- The programme cost for national scale up would be $0.23 per capita, or 1.2% of public health expenditure per capita.

Introduction

Malawi is one of a few low-income countries in sub-Saharan Africa considered to have met the fourth Millennium Development Goal (MDG) for child survival (MDG 4) (UNICEF 2014) (Kanyuka *et al.* 2016) despite challenges, including poverty, high population growth rate, HIV/AIDS, and the world's highest estimated preterm birth rate (Box 1) (Blencowe *et al.* 2012, Save The Children, 2011; van den Broek *et al.* 2003; van den *et al.* 2005; Dayrit *et al.* 2011)

In the decade between 2000 and 2010, under five mortality after the first month of life in Malawi declined by 7.1% per year and maternal mortality by 6% per year on average (Zimba *et al.* 2012). However, progress in reducing mortality during the neonatal period (the first 28 days of life) has been slower, estimated at 3.5% per year. Nevertheless, this reduction in neonatal mortality is still higher than the regional average (Starrs 2014). Now >44% of under-5 mortality globally is concentrated in the first month of life, amounting to almost 2.8 million newborn deaths each year (Starrs 2014).

To reduce maternal and neonatal mortality in Malawi and accelerate progress under MDGs 4 and 5, the Malawi Ministry of Health's (MOH) Reproductive Health Unit (RHU)—in partnership with Save the Children, UNICEF and others, in 2007 designed a Community Based Maternal and Newborn Care (CBMNC) package and integrated it into the existing community-based system (Callaghan-Koru *et al.* 2013). The CBMNC package, comprising of high-impact interventions for mothers and newborns linked to community mobilization and health system strengthening activities, was designed to both improve and increase the coverage of key maternal and neonatal practices. The package is delivered through the existing cadre of Community Health Worker (CHW), the Health Surveillance Assistants (HSAs), within the context of the Essential Health Package (EHP) (Mueller *et al.* 2011; Bowie and Mwase 2011) and the Accelerated Child Survival Development (ACSD) Strategy for Integrated Management of Childhood Illness (IMCI) framework in Malawi.

In addition to designing a package of key interventions, the CBMNC programme aimed to demonstrate effective implementation at scale, and measure the incremental costs of implementation. This article presents the results of the costing component of this intervention.

Box 1. Malawi at a glance

	Malawi
Total population 2014	16,695,253
Millennium Development Goal Progress	
Improve Child Survival (MDG4)	Met
Improve Maternal Health (MDG5)	Not met
Child and newborn mortality data	
Number live births (2015)	665,000
Neonatal mortality rate per 1000 live births (2015)	22
Annual number of newborn deaths	14,000
Mortality rate per 1000 live births for children under-5 (2015)	64
Annual number of child deaths under-5	40,000
Health system (2007-2014)	
Number of nurses & midwives (2009)	4,800
Nurses & midwives per 10,000 (2007-2013)	3.4
Skilled* attendant at birth	87%
Antenatal care coverage**, >1	97%
Antenatal care coverage**, at least x4	46%
PNC for mothers, within 2 days (2013-2014)	75%
Under-fives with suspected pneumonia receiving antibiotics	46%
Overseas Development Assistance (ODA) 2010	
ODA (US$) to 0-5 year olds from all donors	2,624,502

Context Community Care: Primary outreach system is a national, centrally recruited cadre of paid Health Surveillance Assistants (HSAs), within the context of the Essential Health Package (EHP) and the Accelerated Child Survival Development (ACSD)

Data sources: *Population data (The World Bank); Skilled attendant at birth, <5s receiving antibiotics; ANC coverage & number of nurses and midwives per 10,000 (World Health Statistics 2015, WHO); neonatal and under-five mortality (UN Interagency Group for Child Mortality Estimation 2015); number of nurses and midwives (WHO- Data by country); annual live births and PNC coverage (Countdown to 2015-2015 Profile); ODA (Pitt 2012 & Hsu 2012 using OECD data)*

Note: *number of nurses and midwives and PNC are for the most recent year*

** Doctor, nurse or midwife*

***Percentage of women (aged 15–49) attended by any provider*

Objectives of the costing study

1. To quantify the additional cost of introducing maternal and newborn home visits in the community-based services delivered by HSAs
2. To quantify the time implications for HSAs of delivering this new package
3. To quantify the time and financial implications of increasing the percentage of mothers in the community in the study area who are visited as part of the CBMNC project, standardising findings to a 100,000 population
4. To assess the feasibility of such scale-up in the context of other demands on HSAs, and in terms of affordability

Methods

Malawi is a small landlocked country with one of the lowest per capita incomes (Gross National Income per capita (GNI) is $340) (The World Bank 2012) in the world, as well as extremely low human resource density (Malawi National Statistical Office 2011, Zimba *et al*. 2012).

The evaluation of costs was undertaken in three "intervention areas" located in three districts: Chitipa in the Northern Region, Dowa in the Central Region, and Thyolo in the South (the project covered large areas, rather than the entirety of the three districts). The Ministry of Health selected one district from each region for implementing the programme based on their interest, their progress in implementing ACSD/IMCI, and the representation of child and neonatal mortality parameters.

Community-based maternal newborn care cadre and recruitment

HSAs are multi-purpose extension workers already employed full time by the local government with six weeks pre-service training and were given an additional day in-service training to conduct five home visits for each mother and child pair: three home visits during pregnancy (one per trimester) and 2–3 within the first week after birth (on day 1 for those who had home births and on day 3 and 8 for all births). HSAs were also trained in community mobilization and tasked with forming a community-based action committee or "Core Groups" to facilitate dialogue and action around maternal and newborn health issues.

While the programme had both a community-based component and a health facilities component, this paper focuses on the community-based programme.

During pregnancy home visits, HSAs counselled women on facility-based births, birth planning, the identification of danger signs and immediate newborn care. During postnatal home visits, HSAs were trained to measure the newborn's weight and temperature, check for signs of infection and refer if necessary, observe breastfeeding, and counsel the mother and caregivers in newborn care (namely the identification of danger signs). Details of the content of the home visits are outlined in Table 1. The set-up and evaluation of the CBMNC package was undertaken between 2007 and 2011, this is outlined in Figure 1.

HSAs were not providing curative care at home for women and newborns, but referring to a facility. Facility-based health workers'

Table 1. Details of the activities undertaken during the three Community Based Maternal and Newborn Care (CBMNC) home visits

Pregnant women: counselling inclusions

Visit 1 (1st trimester, if possible)	Visit 2 (2nd trimester)	Visit 3 (3rd trimester)
• Early antenatal including IPTp, ITN, TTV • Minor ailments of pregnancy & management / care seeking • Good nutrition • Hygiene and rest • Danger signs of pregnancy • Ascertain HIV status	• Early recognition of danger signs and prompt care seeking • Birth preparedness and complication readiness • Subsequent visits for ANC including IPTp, ITN, TTV • PMTCT	• Care seeking for skilled attendant at birth • Clean delivery / Clean delivery kit • Early initiation and exclusive breastfeeding (EBF) • Newborn warmth, asphyxia management, skin-to-skin, delaying first bath • PMTCT and AFASS feeding options • Family planning • Common newborn and maternal danger signs

Postnatal visits

Day 1 Visit (Home delivery)	Day 3 Visit (Both facility and home delivery)	Day 7 Visit (Both facility and home delivery)
• Attachment and positioning • Early initiation and EBF • Warmth /skin to skin / delay first bath • Hygiene, cord care / skin care • Support PMTCT when necessary • Examine newborn & identify: danger signs or low birth weight babies & refer • **Mother** • Early identification of danger signs and refer • Good nutrition • Hygiene • Rest	• Attachment and positioning • EBF • Vaccinations • Hygiene, cord care and skin care • Warmth, skin-to-skin care • Examine newborn & identify: danger signs or low-birth weight babies & refer • Encourage postnatal check at a health facility on day 7 • **Mother** • Early identification of danger signs and refer • Good nutrition • Hygiene • Rest	• Attachment and positioning • EBF • Vaccinations • Hygiene, cord care and skin care • Warmth, skin-to-skin • Examine newborn & identify: danger signs or low birth weight babies & refer • Subsequent weekly visits for low birth weight babies • **Mother** • Early identification of danger signs and refer • Good nutrition • Hygiene • Rest • Encourage U/5 and family planning at 6 weeks

IPTp – Intermittent preventive treatment in pregnancy; ITN – Insecticide treated net; TTV – Tetanus toxoid vaccine; PMTCT – Prevention of mother to child transmission; AFASS – Acceptable, Feasible, Affordable, Sustainable and Safe; U/5 – Under-five.

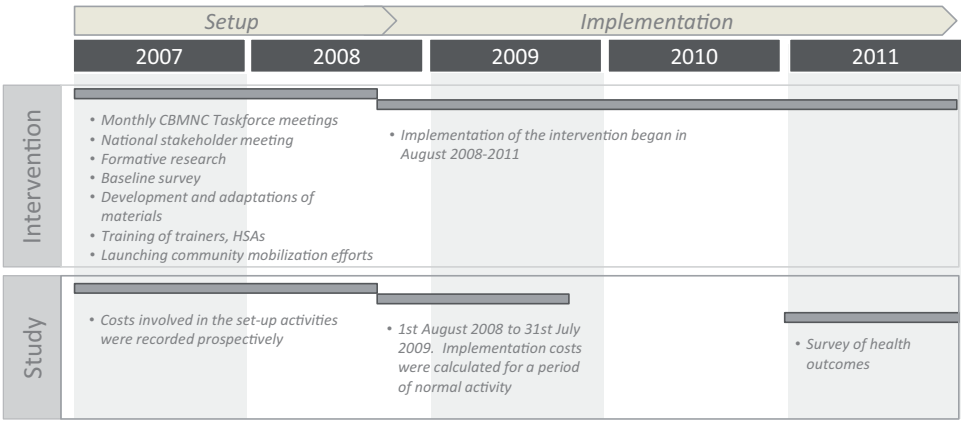

Figure 1. Community Based Maternal and Newborn Care (CBMNC) time period

newborn care skills were reinforced through in-service training in the Integrated Maternal and Newborn Care (IMNC) training package which covered quality of care at birth and care of small and sick newborns, e.g. kangaroo mother care (KMC) and sepsis case management. Additional training and supervision were provided through Malawi's National Health System. "Master Trainers", trained at the national and district levels, conducted trainings for health workers and HSAs. Furthermore, the programme also aimed to strengthen the supervisory and support capacity of the HSAs' immediate supervisor: "Environmental Health Officers".

Data collection

We collected and analysed financial and economic costs using an adapted version of the Microsoft Excel-based Cost of Integrated Neonatal Care (COIN) tool (Daviaud *et al.*, 2017). Financial data was extracted from the Save the Children Malawi project accounts, the District Health Finance Office and UNICEF and economic data (donated items) were valued at market price in 2015 US$. The evaluation covered the years 2007 and 2008 for design and set-up. The year of implementation studied was 2009, during which the time use survey was carried out.

We obtained data on time allocated to the programme by SNL staff through one-to-one interviews while the allocation of HSA and HSA supervisors' time was collected using self-reported forms. A total of 60 HSAs were sampled, 20 HSAs per district. To account for the variation of workload and time spent preparing the visits, the 20 sampled included 10 newly trained and 10 more experienced in delivering the CBMNC package.

Community-based activity data for HSAs, the number of mothers visited, the number of pregnancy and postnatal home visits, were obtained from the project routine information system.

Analysis

We analysed the additional financial costs, including donated items which would not be donated in a routine set-up, incurred by the CBMNC package from the perspective of the provider (Malawi Ministry of Health, Save the Children and UNICEF or other partners at the district level) and have therefore excluded household costs such as transport costs (Abiiro *et al.*, 2014), and foregone production due to time spent on visits. We also excluded research-related costs.

The COIN care tool was used to map the resources for the design, set-up and implementation of the programme and to facilitate data collection. The resources were identified according to the phase of the project (e.g. design, set-up or implementation) and the type of activity (e.g. community mobilization, home visits, training, supervision) and further categorized by (personnel, capital costs, non-staff costs). Design costs (design of the programme, of training and of materials) were treated as "one-off" costs, which will not be incurred again if the programme is rolled out to other districts as opposed to set-up and implementation costs which will take place in each new district. We annualised according to the life of the programme (three years) with the exception of training courses which were annualised on the basis of 1.5 years to reflect the cost of refreshers and training of new recruits. Items that were estimated to last over a year were recorded as capital equipment and annualised based on the expected number of useful life years using straight-line depreciation. The cost of donated items (e.g. weighing scales), was valued at current market price. Costs were adjusted for inflation, using the Consumer Price Index and converted to 2015 US dollar prices, with US$ 1 = Kwacha 456.8 (Oanda, 2015).

We defined "Total Additional Financial Cost" as design costs (capital + recurrent) + set-up costs (capital + recurrent) + one year implementation recurrent costs. We calculated the additional financial cost per activity (defined as the annualised set-up + implementation cost). In order to assess sustainability, we calculated the cost of the programme as cost per capita (total population), which was then expressed as percentage of current public health expenditure per capita. Finally, to inform scale up, fixed costs per HSA and variable costs were calculated to assess the impact of higher coverage on average cost per home visit.

We included a sub-analysis of costs associated with personnel with the objective of capturing (if any) the additional costs of remuneration incurred by the programme and to quantify the additional time spent by HSA and supervisors on the programme. Some SNL staff were recruited for setting up and running the programme. No other additional staff were appointed specifically for the programme, and existing SNL or Government staff did not receive extra payment or incentives for carrying out CBMNC activities. The HSAs and their supervisors are part of the public health workforce, already on a government payroll. Before the start of the programme, HSAs were conducting community visits (e.g. for water and sanitation). Home visits were thus another activity in addition to their current duties, conducted during their regular work hours, without incurring overtime. As no additional payments or benefits were granted to the HSA, their salary was not included in the analysis.

Table 2. Incremental financial costs for the Community Based Maternal and Newborn Care programme according to phase of implementation

	Pre-implementation				Implementation	Annualised costs excluding design
	Total costs		Annualised costs ($)			
	Design	*Set-up*	*Design*	*Set-up*	Recurrent (1 year)	Set-up & Recurrent implementation ($)
Community	*5 770*	*182 687*	*1 260*	*132 912*	*55 096*	*188 008*

The time use of HSAs and HSA supervisors was monitored to inform scale-up decisions. Data on HSAs time use was obtained from 46 HSAs, for a total of 258 home visits, of which 53% were conducted in rural areas. The self-reporting forms recorded an estimate of the time that HSAs spent for preparing the home visit, the length of the journey to the household, the time in the home and time on meetings. Supervisors' time use was monitored for a period of one month. Data were obtained from 15 out of 21 supervisors with self-reporting forms. The self-reporting forms recorded an estimate of the time that supervisors spent preparing for the supervision visit, the length of the journey to the site, the duration of the supervision visit, the number of sites visited, the mode of transport and the distance travelled. In addition, information was recorded on other activities if they were performed during the same day as the supervision visit.

In order to assess the time and financial implications of moving closer to the programme targets, we modelled three scenarios of scale-up analysis under the following assumptions.

Scenario 1: Target coverage and target number of home visits. We modelled a 95% coverage of pregnant women in the study population with the target number of visits (five) per mother and child pair, keeping the same number of HSAs.

Scenario 2: Increased coverage, CHW workload and therefore efficiency. We modelled varying coverage (50%, 70% and 95%) with an average of four visits per mother and child for the same study population and same number of HSAs. Whilst the target number of visits is five, it is likely that some women will travel to family for the delivery, thus not be available for postnatal visits.

Scenario 3: Standardization to a population of 100,000. We standardized Scenario 2 by applying it to a total population of 100,000 using Malawi's crude birth rate. We kept the same ratio of HSAs to total population.

Cost-effectiveness thresholds

We estimated the reduction in the neonatal mortality rate (NMR) that the intervention would need to have achieved to be considered cost-effective. As the maximum cost per DALY averted that national, regional, and global decision makers would consider cost-effective in Malawi is unknown, we considered four different thresholds. The first two thresholds are "attractive" (< $150/DALY averted) and "very attractive" (< $25/DALY averted) (World Bank 1993)[1]. The third and fourth thresholds are linked to Malawi's per capita gross domestic product (GDP): "cost-effective" (< GDP per capita) and "very cost-effective" (< 3 times GDP per capita) (World Health Organization 2012)

1 Originally expressed in 1993 US$. For the exercise they are inflated to 2015 US$values ($41 and $247 respectively)

We estimated the protective effectiveness (PE, i.e. % reduction in the NMR) that the CBMNC intervention would need to have achieved to be considered cost-effective for a given threshold, T, as follows (Pitt *et al.* 2016):

$$PE = \frac{C_t}{N*NMR_c*T*\ \frac{1}{d}*(1-e^{-Ld})}$$

Where:

C_t is the total cost of the CBMNC intervention (costs related to increased service utilization are not included); N is the number of live births in the intervention area: 34 000 (number of expected pregnant women in the intervention area as a proxy for the number of births, from SNL survey); NMR_b is the neonatal mortality rate in a control area: 27 deaths per 1000 live births (Zimba *et al.* 2012); T is the ceiling threshold indicating the maximum cost per DALY averted that would be considered cost-effective; d is the discount rate: 3% (Drummond *et al.* 2005); and L is the life expectancy of the country: 59 years (WHO 2016).

This approach has two main assumptions. First, we assume that the intervention only affects neonatal mortality and has no substantive effects on morbidity. In a similar intervention in Bangladesh, it was estimated that including morbidity only changed the DALY estimate by 0.6% (Shillcutt *et al.* 2013), so this is reasonable. Second, we have only included the costs of implementing the intervention, and have not included any costs for additional health service utilization that may have resulted from the intervention.

Results

A total of 533 HSAs were involved in the implementation of the demonstration project in the three districts, with seven supervisors in each district. The number of expected pregnancies per HSA varied significantly between districts: from 78 in Chitipa, to 57 in Thyolo and 64 in Dowa. The actual number of pregnancies seen by each HSA in the year ranged from 17 in Thyolo, 35 in Chitipa and 22 in Dowa (Supplementary Web Annex C - Table 1).

The coverage of the CBMNC programme (expressed as number of mother and child pair visited at least once as a percentage of expected pregnancies in the study population) was an average of 35% weighed by population size, from 29% in Thyolo, to 34% in Dowa and 46% in Chitipa.

A total of 33 001 programme-related home visits were carried out during the year. Most home visits were antenatal (73%), from 68% in Chitipa, 66% in Dowa to 83% in Thyolo. As an average, a mother and child pair visited had 2.8 home visits, approximately 2 of them were antenatal and less than one was postnatal. The average number of home visits per HSA per week ranged from 2 in Chitipa, 1.1 in Thyolo and 1.2 in Dowa, an average of 1.3 visits per week across districts.

The total additional financial cost of the programme, non-annualised, is US$243 553 of which US$5,770 for design costs, US$182 687 for set-up costs and US$55 096 for one year Implementation (Table 2).

During the design phase, the main cost drivers were project staff for the planning of the programme (33%), overheads, meetings and consultancies for the preparation of the training and materials. Annualised design costs stood at $1,260. In the set-up phase, 97% of the expenditures went on training HSAs. The average training cost per HSA (non-annualised) was $331, 73% of which was for HSAs' allowances. Annualised set-up costs stood at $132 912. Implementation costs for the one year monitored amounted to $55 096. The largest cost driver (82%) was transport; this high share is due to the fact that the salaries of HSAs and supervisors were already paid by the government, hence not included in the additional costs. Management/support by project staff represented 7% of costs, supplies 5%, meetings 3% and overhead 3% (Figure 2).

Combining annualised set-up and implementation cost, the cost per mother visited was $15.8 and per home visit $5.7. Supervision represented 12% of costs. Extrapolated to cost per capita total population ($0.25), the additional financial costs of the programme amounted to 1.3% of per capita public health expenditure.

Health surveillance assistants (HSA) use of time

The **total time** required to perform a home visit, including preparation time and displacement, varied greatly from a minimum of 20 min to a maximum of 4 h and 45 min. On average, the total time was 1 h and 34 min (median of 1 h 29 min). Estimates varied according to the districts (Table 3).

The **contact time** during the home visits lasted 49 min on average across districts (median of 45 min). Chitipa registered the shortest median duration at 30 min and urban Thyolo recorded the longest median duration at 59 min. The longest visit lasted 2 h and 40 min; and the shortest only 7 minutes. The data suggest that more experienced HSAs took more time in performing a home visit.

The median for the **preparation time** was 12 min across districts, ranging from a median of 10 min in Chitipa to a median of 20 min in Thyolo. The longest preparation time registered was two hours. Recently trained HSAs (total of 79 out of 97) dedicated more time to prepare for the home visits compared to more experienced colleagues in Chitipa and Thyolo. The data in Dowa refer only to newly trained HSAs.

Travel time across districts and areas, considering all possible means of transport (walking, bicycle, motorbike, ambulance, bus and car) ranged from a median of eight minutes in urban Chitipa to a median of 29 min in urban Dowa, with a median across districts of 20 min (average of 29 min). The longest travelling time was recorded in Chitipa at three hours. The bicycle was recorded as the most popular means of transport for HSAs. On average, bicycles were estimated to be used 75% of the time for CBMNC-related activities.

The average total home visits time was added to supervision time and meetings related to the CBMNC programme to reflect the average weekly time spent on the programme by the HSA. As a proportion of a 40 h working week, CBMNC related activities represented an average of 13% of the HSA working week. The scale-up results section looks in more details at the implications of target coverage on HSAs time on the CBMNC programme.

During the same day of the recorded home visit, 48% of HSAs performed other tasks, ranging from antenatal clinic, under five clinic, water and sanitation activities, immunisations, community meetings and registering women of child bearing age.

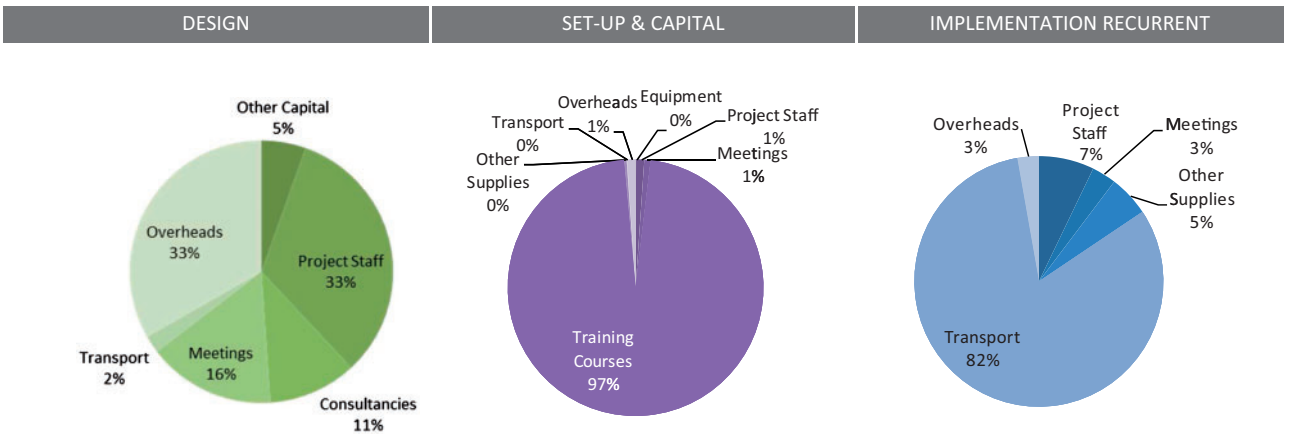

Figure 2. Distribution of the input costs by phase—design, set up and implementation

Table 3. Length of time HSAs spend on home visits (by activity per visit and number of visits/total hours per week) and the programme (by activity type per week)

HSA Time on Home Visits	Median Time per Home Visit (Minutes)				Avg. Home Visits/ Week per HSA	Home Visit Hours per Week per HSA
	Travel	*in Home*	*Preparation*	*Total*		
	20	45	24	89	1.3	1.9

Time on the Programme Per HSA	Avg. Actual Hours per Week			Avg. Total Hrs / Week on Programme	Actual Time as % of Maximum
	Home Visits	*Admin & Meetings*	*Identification of new Pregnancies*		
	1.9	3.2	Not known	5.1	13%

Supervision

Supervisors are generally senior HSAs, but in some cases they are reported being Assistant Environmental Health Officers (AEHO) or Environmental Health Officers (EHOs). On average, during the one month monitoring period they visited 10 sites (median of six).

On average, the preparation time was estimated at 15 min (median at 12) per site supervised, travel time was estimated to last just over a half hour per site (median at 25), and the actual supervision to be just over three quarters of an hour (median at 43 min).

On average, supervisors reported they spent just over seven hours per month for the actual supervision (median at 6 h 43 min). In addition, they spent 2 h 11 min a month preparing for the supervision visit (median at 1 h 25 min), and 2 h 45 min for travel (median at 3 h 1 min). However, the average masks a wide range of time use. As Table 3 shows, the time spent on preparation varies from 30 min to over 6 h, travel time varies from 39 min to over 18 h, and the length of the supervisory visit varies from 1 h 15 min to almost 21 h. This great difference in length of time is due to the fact that some supervisors only visited three sites per month and others over 20.

The vast majority of supervisors (87%) performed other tasks during the same day they had the supervision visit. These activities included a nutrition clinic, water and sanitation (e.g. well inspection), growth monitoring, out-reach, checking village register and general admin/office work. The majority of supervisors (73%) used a motorbike, or a combination of motorbike and bicycle and four used only bicycles.

Scale-up analysis

If Scenario 1, where 95% of expected pregnant women in the study population received the target number visits (5), was implemented with the same HSAs, each HSA would make an average of 6.3 visits a week (up from the observed 1.3) and combined with time on meetings, would spend 13 h a week on the programme (up from the observed five hours), representing 31% of their working time (Table 4). The cost of the programme would remain the same as no supplies were dependent on the number of mothers (Supplementary Web Annex Table C2).

If, as in Scenario 2, mothers received an average of four visits by the same HSAs, for 50% coverage, each HSA would make an average of 2.7 visits a week, and spend seven hours a week on the programme or 18% of their working time. For 95% coverage these values would increase to five visits a week, 11 h on the programme or 27% of HSA's working time. The programme cost would remain the same with the same number of HSAs. The cost per mother visited would be $11.1 and $2.8 per home visit for 50% coverage. At 95% coverage these costs would be $5.8 and $1.5, respectively (Table 4).

Standardizing Scenario 2 to a total population of 100 000 (Scenario 3), the number of HSAs would stand at 71. The number of expected pregnancies per year would be 4,010, using the country's crude birth rate of 40.1 per 1,000 total population (United Nations 2013), lower than the crude birth rate of the study population which stood at 45.2 (Callaghan-Koru *et al.* 2013). For 50% coverage, each HSA would make an average of 2.4 visits a week, and spend under seven hours a week on the programme or 17% of their working time. For 95% coverage these values would increase to 4.5 visits a week, 10 h on the programme or 25% of HSA's working time. The cost per mother visited would be $12.5 and $3.1 per home visit for 50% coverage with a programme cost of $25 026. For 95% coverage, the programme cost would remain the same with the same number of HSAs. The cost per mother visited would be $6.6 and

Table 4. Costs for actual package and efficiency package to scale up, at varying coverage levels

	Actual	Scenario 1: Package as per study design	Scenario 2: Increased CHW workload & varying coverage			Scenario 3: Standardisation to 100,000 total population			
	Average number of achieved visits	Target visits	Average 4 visits			Average 4 visits			
Coverage	Achieved	Target	Variable			Variable			
% of potential mothers visited	35%	95%	50%	70%	95%	50%	70%	95%	
Number of visits per mother	2.8	5		4			4		
Number of mothers visited	11 877	32 274	16 987	23 781	32 274	2 005	2 807	3 810	
Total home visits	33 001	161 372	67 946	95 124	129 097	8 020	11 228	15 238	
Number of HSAs	533	533		533			71		
Number of mothers per HSA/year	22	61	32	45	61	28	40	54	
Visits per HSA/week	1.3	6.3	2.7	3.7	5.0	2.4	3.3	4.5	
% CHW time on programme	13%	31%	18%	22%	27%	17%	20%	25%	
Supervisors Full Time Equivalent (FTEs)	7.3	7.3		7.3			1.0		
Cost per mother	$15.83	$5.83	$11.07	$7.91	$5.83	$12.48	$8.92	$6.57	
Cost per home visit	$5.70	$1.17	$2.77	$1.98	$1.46	$3.12	$2.23	$1.64	
Programme cost	$188 008	$188 008	$188 008	$188 008	$188 008	$25 026	$25 026	$25 026	
Programme cost per capita total population	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Public Health expenditure per capita	19.91								
Programme cost as % Public Health expenditure per capita	1.3%								

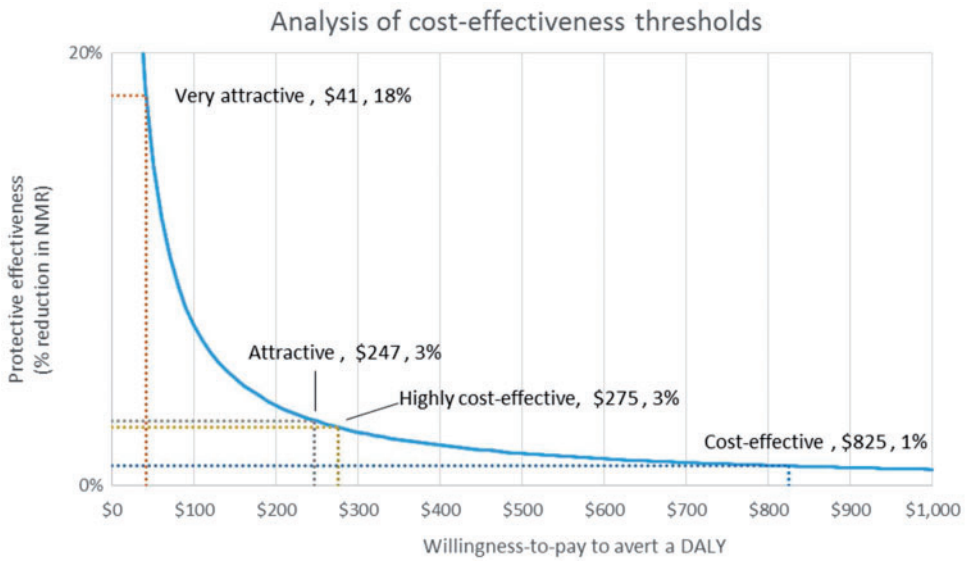

Figure 3. Analysis of cost-effectiveness thresholds

$1.6 per home visit. The additional financial costs of the programme would amount to 1.3% of per capita public health expenditure (Table 4).

Analysis of cost-effectiveness thresholds

As Figure 3 shows, the CBMNC intervention would be considered cost-effective if it reduces the NMR by at least 1%. It would be considered highly cost-effective, or attractive, with a reduction of NMR of at least 3%. An NMR reduction of at least 18% would make this intervention very attractive.

The percentages of reduction in NMR for different cost-effectiveness thresholds appear possible and achievable, given similar interventions in the country (Colbourn *et al.* 2015) and elsewhere (Prost *et al.* 2013). These findings should be considered cautiously, as we were not able to include the additional costs of health service utilization, however, they indicate that this is a promising intervention.

Discussion

Malawi is widely recognized as a low income African country that is on track for MDG 4 and now making increasing progress in reducing maternal mortality (under MDG 5) as well as scale up of HIV and TB interventions for MDG 6. Several analyses have attributed these successes particularly to the role of the extension public health service, which is largely dependent on the HSAs (Zimba *et al.* 2012). Yet HSAs are increasingly loaded with tasks and adding further tasks, especially time intensive ones such as home visits during pregnancy and in the postnatal period, requires careful consideration. This was the government's concern in scaling up CBMNC, particularly around HSA time use and sustainability, not just the financial cost. To our knowledge, this is the first detailed timing study of HSAs in various differing districts and certainly the first study examining the incremental cost and feasibility of HSAs undertaking more tasks. Programmatic, financial and political sustainability are all crucial to long-term effect, sustainability and institutionalisation.

However, the coverage level of HSA home visits of 35% was lower than expected, with only 11% of mothers receiving a postnatal home visit within the recommended 3 days after birth: mothers received an average of 2.8 visits rather than the programme target of five, or the more reasonable average of four given the number of women who would go to deliver away from the area and therefore not be available for postnatal visits. Within the recorded home visits, approximately two were antenatal and less than one postnatal. It is widely recognized that from a supply side pregnancy visits are easier to achieve than postnatal and especially early postnatal visits. The low coverage levels may be due to a number of factors (Sitrin, 2013). Firstly, this was a new programme and the costing study took place over a year within the first 18 months of implementation. Time is needed to build community demand for services: women tend to delay the disclosure of their pregnancy status and so timing for three home visits in pregnancy is more challenging if starting later in pregnancy. For postnatal home visits, the majority of women in Malawi (73%) now deliver in health facilities, but are discharged early, therefore, requiring communication with HSAs. Indeed for the women who notify their HSA with a mobile phone, coverage of CBMNC was much higher. Household survey findings showed that less than one-third (31%) of mothers informed the HSA of the birth, and 44% of these mother and child pairs received one or more home visits from the HSA within the first week compared to only 5% of newborns where the HSA was not contacted.

It is likely that the work load of HSAs who are multi-purpose workers and with many competing tasks (water and sanitation activities, under five clinic, immunizations and community meetings) makes the timeliness of PN visits more challenging than for example for the Female Community Health Volunteers (FCHVs) in Nepal who are based in each community, serve smaller catchment areas and focus on MNCH outreach services only (Sitrin *et al.* 2013). However, HSAs on average spent an estimated 5 h a week on the programme. If the target number of visits for the target number of mothers (95%) was achieved, the HSA would spend about 13 h a week on the programme (10 h for four visits, with 95% coverage). This time may be significant especially since there is a tendency for HSAs, who are recruited centrally, to live outside their catchment areas. Slightly less than half (47%) of the 110 HSAs interviewed resided within their catchment areas and 54% spent three or fewer

days in their assigned community during the previous week, placing additional pressure on achieving. The main reasons for not living within their catchment area given by HSAs were lack of housing (51%) and following a spouse (20%). Not surprisingly, community-based activity levels were higher among those HSA living within the community and these HSAs were also more likely to reach mothers earlier in their pregnancy and newborns within three days of delivery compared to those who resided outside their catchment areas. HSAs that live outside their communities tended to spend 2–3 days per week on average in their catchment areas and would spend considerably more time on travel to complete home visits. The lack of housing mentioned by HSAs could be at least partially addressed through community mobilization efforts.

The share of mothers who received at least one home visit (coverage of the programme) varied substantially across districts: 29% in Thyolo, to 34% in Dowa and 46% in Chitipa. Such variations could be due to a difference in size of catchment areas, Dowa and Thyolo have larger catchment areas on average per HSA compared to Chitipa, and so while Chitipa was reporting lower absolute numbers, higher coverage was more achievable. Finally, implementation was decentralised and certain districts tend to implement programmes better than others for example related to district and facility-level leadership capacity, support for programme, relative accessibility of the population and underlying socio-cultural beliefs. The education level varied between the three districts, with Chitipa literacy level being higher compared to the other two districts (Malawi National Statistical Office 2011).

HSAs are multi-purpose workers and this is an important consideration in planning. HSAs could perform different tasks with improved efficiency and give more attention to economies of scale, like combining activities that can be performed in the same village, thus saving travel time. This would require additional housing and focus on HSAs living in their community. Combining different tasks in the same village in the same day cannot always be done, as for example home visits (especially if pregnancy visits) and vaccination have to be done at a specific time. An approach to enhance HSAs performance could be to provide performance-based incentives for example a monetary reward if the full package is delivered to the mother and the child as a performance-based approach currently under pilot study in Malawi, but this would add expenses and complexity. As well as the challenges in the HSA supply of visits, the demand aspects for home visits are also critical. Finally, improving supervisory and monitoring systems, as well as communication between households and HSAs may be important factors to increase performance.

Financial sustainability is a critical consideration. The additional cost per mother in the study (excluding salaries and bicycles already paid by the government) was US$ 16. It is high compared to the estimated annual running cost of US$ 6.75 in 2015 US$ per infant using volunteers, for a MaiMwana project in Mchinji district, which focused only on the breastfeeding counselling, identifying pregnant women and providing five home visits during pregnancy and postnatally (Lewycka *et al.* 2013). In the CBMNC programme, cost per mother is mainly driven by the HSA training and running cost and by the efficiency (number of mothers visited by HSAs). CBMNC includes care for the women, notably postnatal family planning, as well as much broader newborn care than breastfeeding counselling alone. As no supplies are delivered to mothers and children, the CBMNC is a direct function of the number of HSAs. The number of HSAs is determined by wider considerations than the programme. Annualised set-up and implementation additional costs stand at $352.7 per HSA (Supplementary Web Annex Table C2). 63% of this amount is due to training costs, 73% of which are for HSA's allowance. Reducing training costs (e.g. adding this to pre-service) and increasing coverage (hence the number of mothers per HSA) and number of visits, whilst raising time concerns, would decrease the cost per mother.

Despite this relatively high cost, given a public sector health expenditure per capita standing at just under $19.9 in 2015, the additional cost of the programme expressed in cost per capita total population would represent 1.3% of this amount. If the same average ratio of total population per HSA is maintained, scaling up CBMNC throughout the country would represent 1.3% of the public health budget. An increase in coverage and efficiency would require an improvement in notification systems, supervision and monitoring and attention to lower health system levels (district, health facility), including enforcing requirements for HSAs to reside in their catchment areas.

Political sustainability is also critical. The government is also grappling with significant macroeconomic challenges, foreign exchange shortages and its temporary suspension from the IMF (International Monetary Fund 2014).

There are some data limitations. For example the study sample for the HSAs' time use study was small, with information from only 46 out of the 60 sampled HSAs, and the self-completion forms may affect reliability, notably underestimation of non-contact time, including non-productive time (Mangham-Jefferies *et al.* 2014; Bratt *et al.* 1999). Whilst supervision time was monitored through self-completion forms as well, the time of the programme co-coordinator was not. The effect of the programme on facility attendance could not be assessed due to data limitations in Health Management Information System (HMIS) facility activity data. Numbers of mothers visited and home visits recorded through the HMIS was lower than those extrapolated from a survey carried out after the end of the monitoring period. The second limitation relates to the timing of the study, which took place shortly after programme implementation, a picture of a more mature programme could provide more representative information. However, these limitations are unlikely to affect significantly the results and modelling of scale-up.

Policy and programme recommendations

This study shows that while the CBMNC package has potential for impact and seems to have strong national ownership and momentum, there are key actions that need to be considered based on this data.

Further investigate the low coverage of the HSA home visits and develop strategies to increase this coverage

The recent household survey confirmed relatively low coverage. Our cost analysis shows that an increase in coverage would not increase overall programme cost, which with the current distribution of HSAs, would stand at 1.3% of public health expenditure if the programme is rolled out throughout the country. Higher coverage would increase the efficiency of financial investment as well as greater effectiveness. Increased coverage is dependent on a combination of demand and supply factors. Supply solutions to consider include pay for performance as discussed above, or task-sharing. For example, in Ethiopia volunteers identify pregnant mothers and provide home visits with education, leaving more time for the health extension workers (HEWs) to cover selected home visits, including the crucial postnatal visit within two days after birth (Mathewos *et al*, 2017). Increased demand could involve a number of approaches and is important in the context of competing and increasing demands on HSAs' time, and family's roles in contacting HSAs are crucial in

achieving higher postnatal care (PNC) coverage. However, our HSA time use study and other data do not fully answer the question of whether HSAs are already overloaded or if with better time management, incentives and community support, they could achieve higher coverage within the constraints of the current system. We recommend additional formative work and timing studies of other HSA tasks to see if they are already at a time saturation point, in which case targeting most at risk pregnancies and babies may be considered, such as young mothers and preterm babies, noting Malawi has the world's highest estimated rate of preterm birth (Blencowe *et al.* 2012). Adding more HSAs could increase coverage but would have financial implications. Factors other than workload also affect coverage and require further study. Reaching newborns and mothers soon after delivery requires timely participation of the community and health facilities to notify the HSAs that a baby has been born. HSAs also need to be residing close enough to the communities they serve to allow them to conduct the home visits at a reasonable time cost (if they are spending a large proportion of their time in transit they are less likely to attempt visits).

Strengthen routine data tracking to monitor this coverage so that it can be continuously improved

In order to strengthen the efficiency and effectiveness of this programme, routine data collection and use is essential. In the last years, substantial progress has been made to reach consensus on a set of CBMNC programme indicators that track coverage of HSA home visits during pregnancy and after delivery and to design associated registers and reports for HSAs and health facilities. This revised system has been rolled out and the indicators are included within the national HMIS of Malawi (available online since 2013 through DHIS2). However, reporting rates remain low (just 20% of expected CBMNC reports received between January and June 2014 in DHIS2) and more work is needed to operationalize the system in terms of data management and capacity building for data use across all levels.

Conclusion

Community-based care services are an important component of the continuum of care especially around the time of birth, both in rich and resource poor countries. The Sustainable Development Goals underline the need for a movement to end preventable maternal, newborn and child deaths as well as stillbirths (Starrs 2014). Global and national ownership of the Every Newborn Action Plan reflects that progress is increasingly contingent on improving newborn survival and Malawi is also launching their own ENAP in July 2015. In Malawi, HSAs who initially covered environmental health services, have now become responsible for the maternal and newborn home visit programme, and also recently for integrated community case management for under 5s (iCCM) and Prevention of Mother to Child Transmission (PMTCT) of HIV/AIDS programme. While these multiple programmes could work together in identifying pregnant women, time pressures for the HSA may pose a challenge to the full development of each programme, and may explain the low coverage of the CBMNC programme. This study has highlighted time as a resource, and quantified the time implications of achieving high level coverage especially for the postnatal visit.

Supplementary data

Supplementary data are available at *HEAPOL* online.

Ethical considerations

The evaluation of the CBMNC package in these 3 districts was granted initial ethical approval by the Malawi National Health Sciences Review Committee (NHSRC) on August 30, 2007. Oral informed consent was obtained from all survey respondents. Ethical review and approval was provided by the Malawi National Health Sciences Research Committee (protocol number 473)."

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