
Uganda Newborn Study (UNEST) trial: Community-based maternal and newborn care economic analysis

Elizabeth Ekirapa-Kiracho,^{1,*} Diana Barger,² Chripus Mayora,¹ Peter Waiswa,^{1,3,4} Joy E Lawn,⁵ James Kalungi,^{1,3} Gertrude Namazzi,^{1,3} Kate Kerber,² Helen Owen,⁵ and Emmanuelle Daviaud⁶

¹Department of Health Policy Planning and Management, Makerere University School of Public Health, Kampala, Uganda, ²Save the Children, Washington, DC, USA, ³Iganga-Mayuge Health Demographic Surveillance Site, Uganda Newborn Study, Iganga, Uganda, ⁴Division of Global Health, Karolinska Institutet, Stockholm, Sweden, ⁵Department of Infectious Disease Epidemiology, London School of Hygiene & Tropical Medicine, London, UK and ⁶Health Systems Research Unit, Medical Research Council, Cape Town, South Africa

*Corresponding author. Makerere University School of Public Health, PO Box 7072, Kampala Uganda. E-mail: ekky@musph.ac.ug

Accepted on 16 June 2016

Abstract

The Uganda Newborn Study (UNEST) was a two-arm cluster Randomized Control Trial to study the effect of pregnancy and postnatal home visits by local community health workers called 'Village Health Teams' (VHT) coupled with health systems strengthening. To inform programme planning and decision making, additional economic and financial costs of community and facility components were estimated from the perspective of the provider using the Excel-based Cost of Integrating Newborn Care Tool. Additional costs excluded costs already paid by the government for the routine health system and covered design, set-up, and 1-year implementation phases. Improved efficiency was modelled by reducing the number of VHT per village from two to one and varying the number of home visits/mother, the programme's financial cost at scale was projected (population of 100 000). 92% of expectant mothers ($n = 1584$) in the intervention area were attended by VHTs who performed an average of three home visits per mother. The annualized additional financial cost of the programme was \$83 360 of which 4% (\$3266) was for design, 24% (\$20 026) for set-up and 72% (\$60 068) for implementation. 56% (\$47 030) went towards health facility strengthening, whereas 44% (\$36 330) was spent at the community level. The average cost/mother for the community programme, excluding one-off design costs, amounted to \$22.70 and the average cost per home visit was \$7.50. The additional cost of the preventive home visit programme staffed by volunteer VHTs represents \$1.04 per capita, 1.8% of Uganda's public health expenditure per capita (\$59.00). If VHTs were to spend an average of 6 h a week on the programme, costs per mother would drop to \$13.00 and cost per home visit to \$3.20, in a population of 100 000 at 95% coverage. Additional resources are needed to rollout the government's VHT strategy nationally, maintaining high quality and linkages to quality facility-based care.

Keywords: Community health worker, community-based newborn care, costing, economic, maternal, newborn, Uganda, village health team

Key Messages

- High coverage was achieved in the intervention area of the Uganda Newborn Study (UNEST) with 92% of all pregnant mothers receiving at least one home visit by local community health workers called Village Health Team (VHT) members.
- During the implementation phase the supervisory system was the main driver of costs, a large share of which went to providing incentives to VHTs and supervisors, this in turn may be a reflection of the lack of attrition amongst VHTs witnessed during the study.
- The cost per mother/child pair for this package in a 100 000 population at 95% coverage was \$13.00.
- The UNEST preventive home visit programme (using volunteer VHTs) was very affordable, with additional costs representing only \$1.04 per capita, a mere 1.8% of Uganda's health expenditure per capita. Additional resources are needed to successfully rollout the government's VHT strategy nationally to ensure that high coverage and strong links to quality facility-based care are maintained, as these are prerequisites for effectiveness.

Introduction

Uganda is 1 of 12 low-income countries to have reduced under-five mortality by two-thirds or more (since 1990), meeting the Millennium Development Goal (MDG) 4 for child health in 2015 (UN Inter-agency Group for Child Mortality Estimation 2015) (Panel 1). However, as recently as 2013, despite notable progress since 2000, Uganda was not on track to meet this MDG partly due to slower progress in reducing newborn deaths (Mbonye *et al.* 2012). Over a third of child deaths were amongst newborns, dying in the first 28 days of life, often at home and mostly of preventable or treatable causes (UN Inter-agency Group for Child Mortality Estimation 2014). This policy-to-implementation gap for both maternal and newborn health was the impetus for a number of key policy changes in the mid to late 2000s.

In its Health Sector Strategic Plan II for 2005–10, the Ugandan Government first committed to improving newborn health and included priority newborn interventions within a minimum health service package which would extend coverage of basic services to rural areas (MOH 2005). Uganda's Ministry of Health (MOH) established a National Newborn Steering Committee in 2006 with the mandate of advising on issues of newborn survival. The Steering Committee has overseen rapid changes in policy at both health facility and community levels, and changes to essential drugs and commodities. In their 2012 analysis of the policy change for newborns over the previous decade, Mbonye and colleagues acknowledged the Steering Committee's impact and intersectoral approach, yet identified a number of areas where continued efforts were needed, including greater focus on innovative district-level implementation approaches (Mbonye *et al.* 2012).

The first 24 h after birth are the time of greatest risk for both mothers and babies, when 46% of all maternal deaths and 40% of all stillbirths and neonatal deaths occur (Ronsmans and Graham 2006; Lawn *et al.* 2014). To improve maternal and newborn health in low-resource settings, interventions delivered in packages across the continuum of care, from pre-pregnancy through the postnatal period and from community to facility level, are recommended to maximize contact points, regardless of where they occur, with the health system (Lawn *et al.* 2014). In Uganda, while 94% of women attend at least one antenatal visit, only 48% attend four (or more) as recommended by both the World Health Organization (WHO) and Ugandan Clinical Guidelines (Ministry of Health Republic of Uganda 2012). The rate of facility-based deliveries and postnatal care are steadily increasing in all areas of the country (Uganda Bureau of Statistics (UBOS) and ICF International Inc. 2012) but quality of care remains poor (Waiswa *et al.* 2015a).

Home visits by Community Health Workers (CHWs) together with community mobilization activities have been associated with reduced neonatal mortality and stillbirths in settings with high neonatal mortality and poor access to facility-based health care (Bang *et al.* 2005; Baqui *et al.*, 2008; Bhutta *et al.* 2005; Kumar *et al.* 2008; Gogia and Sachdev, 2010) and have been recommended by the WHO, UNICEF and partners since 2009 (WHO *et al.* 2009). Although these interventions had proven effective in research settings in Asia, evidence of their effectiveness, cost and feasibility at scale in African settings was lacking.

The Uganda Newborn Study (UNEST) was conducted by the Makerere University with support from Karolinska Institute, Save the Children's Saving Newborn Lives programme, and the WHO to investigate the effect of using a national CHW cadre, Village Health Teams (VHTs), to mobilize communities to improve care practices and combined with activities designed to strengthen health facilities' thus improving the quality of maternal and newborn care services. Informed by findings from formative research (Waiswa *et al.* 2008, 2010a,b,c), key stakeholders agreed on three main strategies:

1. To implement home visits during pregnancy and the newborn period by trained and supervised volunteer VHTs;
2. To improve linkages between the community and the health facilities through supervision of health facilities and VHTs;
3. To strengthen health facilities through:
 - a. District-led training of health workers in essential maternal-newborn care practices, effective supply requisition practices, and using data to monitor service levels
 - b. Supportive supervision and mentorship
 - c. A one-off supply of essential medicines, basic equipment and supplies.

The implementation of this integrated package aimed to improve the following maternal and newborn care practices by 20% in 2 years amongst the target population (attending ANC at least four times; skilled attendance at delivery; mothers putting nothing on the cord; newborns managed by skin to skin contact; and mothers and babies who receive postnatal care). Details of primary outcomes are presented comprehensively elsewhere (Waiswa *et al.* 2012) as are the trial's main findings (Waiswa *et al.* 2015b). In short, the home visit package tested in UNEST together with health facility strengthening activities achieved significant improvements in birth preparedness and essential newborn care practices, including breastfeeding, hygienic cord care, and thermal protection practices. The VHTs, selected by their communities and supported through district-led training and supervision, were able to identify and visit

almost all the pregnant women, especially those from the poorest families and those who delivered at home alone or with Traditional Birth Attendants.

In this article, we present the results of the costing component of this study. Our primary aim is to estimate the additional economic and financial cost of the intervention, distinguishing between the community-based intervention and health system strengthening activities. The secondary aim is to model the financial costs of the community-based component under different scale-up conditions to provide a better understanding of the package's implications for the larger health system. We have prioritized the perspective of the provider and therefore have focused the majority of this analysis on the financial costs rather than the economics costs. However, an overall estimate of the economic costs of the programme, accounting for the time spent by volunteer CHWs and existing staff, has been provided to allow for a broader understanding of the cost implications for the programme beyond the financial resources.

Methods

UNEST setting and population

The UNEST was a 3-year trial (2007–11), undertaken in three phases: the design phase, where the intervention was discussed in workshops and reviewed by stakeholders (2007); the set-up (pilot) phase (2008–mid 2009), and full implementation phase (mid-2009–11). The implementation year costed in this study was January 2010 to December 2010. The UNEST study was conducted in the Iganga-Mayuge Health and Demographic Surveillance Sites (HDSS), a member of the International Network for continuous Demographic Evaluation of Populations and Their Health. The HDSS has a total population of ~72 000 in 65 villages. The HDSS is predominantly rural, with only 13 peri-urban villages that form the Iganga Town Council (Waiswa *et al.* 2015a). The study included one district hospital and 19 lower-level facilities, both public and privately operated (Namazzi *et al.* 2015). UNEST was a two-arm cluster randomized control trial, with villages being the unit of randomization. A total of 63 villages of ~1000 people each were randomly allocated, 31 to the intervention and 32 to the control arm, each with an average of two volunteer VHTs, nominated by their communities (Waiswa *et al.* 2015a)

Facility strengthening component

Formative research during the design phase of the trial identified major gaps in care-seeking at health facilities and low quality care (Waiswa *et al.* 2010a). Waiswa *et al.* found health facilities to be ill equipped to offer newborn care as they lacked equipment, drugs, supplies and an effective referral system. Only 44% of facilities were stocked with delivery kits, a mere 4% had neonatal weighing scales, and just 6% had neonatal resuscitation kits (Waiswa *et al.* 2010a). As the aim of this trial was to improve facility attendance for ANC, delivery and postnatal care, a non-randomized facility intervention was designed to ensure that all 20 health facilities in and around the study area were strengthened through a 6-day in-service training of health workers and improved collaboration with the District Health Team (DHT). In addition, all health facilities were provided with a once-off catalytic supply of equipment, medicines, and other clinical supplies, appropriate for the level of care provided, including antibiotics and key equipment: delivery beds, weighing scales, cannulas, hand-held oximeters, electronic and non-electric sterilizers and digital and blood pressure units and supplies nasal gastric tubes, cotton wool, gloves, needles and syringes. The aim of which was to

continuously improve quality of care in addition to providing minimal infrastructure adjustments (Waiswa *et al.* 2015b; Namazzi *et al.* 2015).

Community-based component

The community-based component of the UNEST study consisted of a target of five home visits by VHTs to pregnant women and their babies: two visits during pregnancy and three during the first week after delivery, with extra visits for small or sick newborns. The timing and focus of each visit is summarized elsewhere (Waiswa *et al.*, 2012). The DHT recruited 61 VHTs who were already involved in other programmes being implemented in the HDSS based on their experience with community-based care. All of the 61 VHTs underwent a skills-based training in essential newborn care practices for a 5-day period (Waiswa *et al.* 2012). To facilitate their work, give credibility and motivation, the district provided kits, containing the VHT's picture identity card, a notebook, counselling and screening cards, referral forms, registers, birth preparedness cards, maternal or family child cards for recording appointments, a 'Mama Kit'¹ and a uniform (a T-shirt). VHTs were not paid a salary but received a 'transport allowance' for attending quarterly group meetings and meetings with their supervisors at the health facilities.

Supervision structure

The UNEST supervision structure is summarized in Figure 1. Five VHT leaders called 'Super VHTs' were chosen from the recruited VHTs. They acted as leaders, mobilizers and supervisors for fellow VHTs within their respective parishes. Each Super VHT was responsible for mobilizing 10–12 VHTs. Super VHTs were provided with bicycles to facilitate their work in addition to standard equipment.

Since VHTs link the community to the health facilities, they were assigned to a local health facility for supervision by midwives or other health workers (nurses/nurse assistants) and for referrals. A total of 17 VHT 'Health Worker Supervisors' (HWS) were selected by the DHT from health workers/health assistants at health facilities within the study area. Each supervisor was responsible for three to four VHTs.

HWS were trained for 5 days in both newborn care and resuscitation to aid them in their supervisory roles. A checklist for supervision was developed in line with national standards for newborn care to bolster their supervision skills. It contained expectations, practices, and roles and responsibilities of VHTs during their work. Supervisors held discussion sessions with VHTs at the health facility and conducted directly observed supervision during VHT home visits. The group meeting initially started out as monthly but, as VHTs became more comfortable in their roles, were stepped down to quarterly, at the discretion of the supervisor in discussion with the study team. The HWS, already salaried government employees earning between 450 and 750 000 Ug Shillings (\$216–360) per month depending on whether they were enrolled or registered nurses or midwives, were compensated with an allowance of 10 000 Ugandan Shillings (\$4.80) per Directly Observed Supervision and 15 000 Uganda Shillings (\$7.20) for attending group meetings.

The DHT led by the District Health Visitor (DHV) provided the overarching supervision of the VHTs and facilities in accordance with the existing district health service structure. To facilitate this supervision, UNEST offered additional support to the DHT, including a motorcycle for each district and additional funds for running costs. The key DHT members involved in the programme's implementation received 300 000 Uganda Shillings (\$144) per month as compensation for additional work done beyond their standard

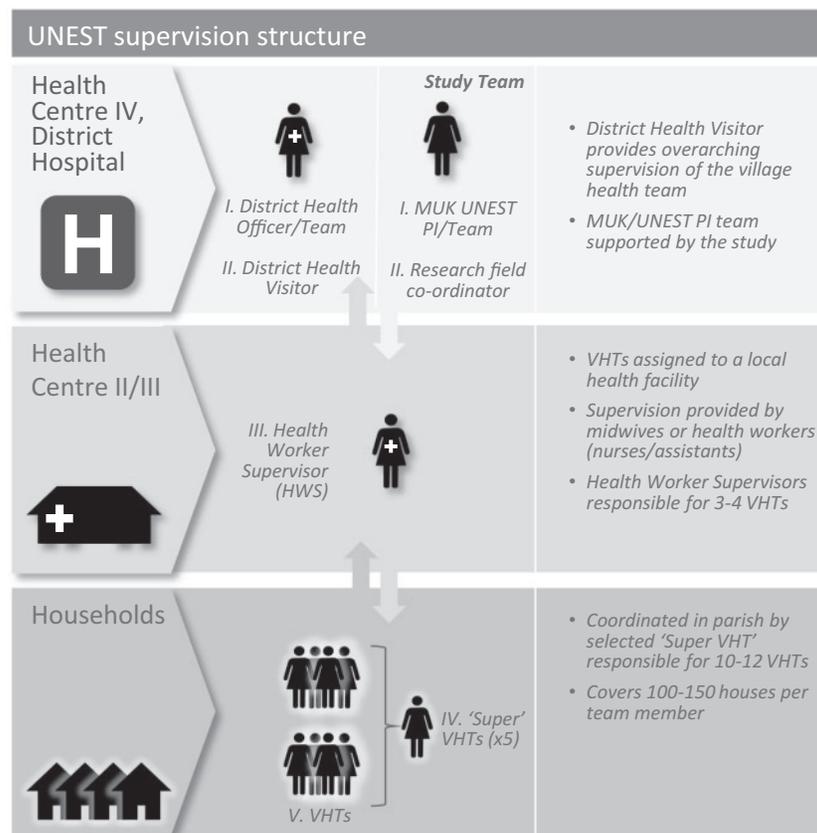


Figure 1. UNEST supervision structure.

workloads and 50 000 Uganda Shillings (\$24) for participating in activities other than VHT group supervision meetings. This stipend therefore supplemented their monthly salary, ranging from 1 to 1.5 million Ug Shillings (\$480–\$720).

Data collection

Three types of data were collected as part of this analysis: cost, activity and time data. We extracted cost data from project records and inputted them into an adapted version of the Excel-based Cost of Integrating Newborn (COIN) Care Tool, designed by the South African Medical Research Council in collaboration with Save the Children, to track the additional costs of newborn health packages at the community level together with their impact on increased facility activity for the multi-country study (Daviaud *et al.* 2010). The methodology of the COIN tool is described in detail elsewhere (see [Supplementary Materials Web Annex, Section B](#)). The COIN care tool aims to facilitate the collection and standardization of economic data by providing a user-friendly Excel-based format, complete with pre-defined yet modifiable categories, validated cells, linked sheets and automatic calculations (e.g. adjustment for inflation). Economic data can be analysed and summarized from different perspectives (e.g. funders or MOH) by those with intermediate knowledge of Excel. However, such analyses are dependent on the quality and availability of routinely collected data in health facilities. To obtain a shadow price for volunteer time, average income in rural areas by level of education was applied based on estimates from the [Uganda Bureau of Statistics from 2009 to 2010](#) (Uganda Bureau of Statistics 2010).

Activity data were collected from the programme's monitoring and evaluation reports, which were compiled by an independent team on a quarterly basis from registries [VHT registries, health facility registries and routine data monitoring (HMIS reports)].

Time spent by the VHT on home visits, travel and other activities (e.g. attending meetings) related to the programme was assessed through a self-reported survey of 18 randomly selected VHTs (29% of total VHTs operating in the intervention villages). Similarly, seven supervisors (38% of total supervisors operating in intervention area) were randomly selected and asked to record time spent on supervision over 1 month.

Analysis

We conducted the analysis of both economic and financial costs from the perspective of the government-run health system, covering design and set-up costs and 1-year implementation. As the focus of this exercise was to determine the additional costs of maternal and newborn home visits and facility strengthening activities, costs already borne by the health system (e.g. HWS salaries) were excluded from the financial costs but included in the economic costs. Research-related expenses were excluded from both analyses. All cost data were adjusted for inflation to 2015 values based on the Consumer Price Index obtained on the site www.tradingeconomics.com and converted from Ugandan Shillings into 2015 US\$ based on the [OANDA: Historical Exchange Rates](#) (Oanda 2015; [Trading Economics 2015](#)).

For both economic and financial costs, we allocated the costs between the two programme components: the community-based intervention (strategies 1 and 2) and the health facility strengthening

(strategy 3). Some expenditures were shared between both programme components and were allocated as follows: the supervisors vehicle was allocated equally across the different phases and components of the programme, overheads, management and administration expenditures were allocated according to the number of Full-Time Equivalents (FTEs) involved in the programme as a proportion of the organization's total FTEs, and utilities were apportioned according to the square metres used by the programme as a proportion of the total area of the organization.

Within each of the two programme components, we used an ingredients approach to estimate the cost per phase of the intervention, defined as design, set-up and capital, and implementation (Drummond *et al.* 2005). 'Design costs' entailed design of the intervention, the development of training and programme manuals and were treated as 'one-off' as they would not be incurred again if the programme were scaled-up to another district. 'Set-up costs' (recurrent and capital costs which would be incurred for each new district) covered the training of trainers, the initial training of health workers and VHTs, printing of stationery, VHT kits, and motorbikes for DHVs and bicycles for super VHTs. Implementation costs covered the running costs during one year of implementation evaluated (2010) at both the community and the health facility level. We have presented the costs associated with each component of the programme separately.

We annualized all non-capital costs, with the exception of training, incurred during the set-up phase of the intervention over the length of the programme: 3 years. Training costs were allocated 1.5 useful life years based on an expert consensus of the estimated average frequency of retraining. For capital items, we estimated the average annual cost of each capital item using straight-line depreciation, dividing the cost of the item in the base year by its expected 'useful life' (Walker and Kumaranayake 2002). The useful life of capital items were applied in a standardized fashion based on COIN Care Tool methodology that is described in detail in Appendix B. We applied at 3% discount rate to capital items consistent with the shadow-price-of-capital approach in the calculation of economic costs.

For the calculation of economic costs, we applied a shadow price equivalent to a portion of the average wage earned by the head of the household in rural Uganda in 2009 to account for the opportunity cost of VHTs volunteering. In 2015 US\$, this amounted to a monthly wage of \$109 or 355, 633 Uganda Shillings per month (Uganda Bureau of Statistics (UBOS), 2009).

Cost drivers in each phase of the intervention were presented as a percentage of total costs in each phase. Unit costs (cost per mother/baby, cost per home visit, fixed costs per VHT and cost per supervisor) were calculated based on the annualized set-up + capital costs and 1-year of running costs, excluding the one-off design costs.

Scale up scenarios modelled

For the community component, different scale-up scenarios were explored to establish the human and financial resource requirements if the programme has achieved full coverage, greater efficiency and were implemented at scale. Cost per mother and cost per home visit were calculated. We assessed the programme's sustainability by expressing the cost of the programme as cost per capita, which enabled the calculation of the programme cost as a percentage of public health expenditure per capita.

1. 'Scenario 1: Full coverage of package as designed (five visits)': We modelled the unit costs assuming that 95% of pregnant

women in the intervention site population (34 444) received all five target home visits.

2. Scenario 2: Increased efficiency for full coverage of a four-visit package': To assess the costs of improved efficiency, we estimated that, being volunteers, each VHT could spend up to 6 h per week on programme activities including home visits. Under these assumptions, VHT would conduct 3.4 as opposed to 1.5 home visits per week and carry out other programme duties. We modelled increased efficiency assuming each mother received the target 5 (Scenario 2a) and a minimum of four visits (two antenatal and two postnatal) at 95% coverage (Scenario 2b).
3. Scenario 3: Standardized to a population of 100 000: We applied Scenario 2 to a population of 100,000 with an estimated number of pregnancies of 4300 per year based Uganda's crude birth rate in 2013 of 43 per 1000 people (World Bank 2014).

Sensitivity analysis

We carried out one-way sensitivity analyses to assess two areas of uncertainty: the coverage of the programme. To assess the coverage of the programme, we assumed 1722 expected pregnancies in the intervention villages, giving programme coverage of 92%. However, endline survey estimates indicated lower levels of coverage; 79% of women reported receiving any type of home visit. To assess the impact of lower coverage of the community-based intervention on unit costs, a sensitivity analysis was conducted by adjusting the number of women covered in the intervention from 1584 to 1360 and the number of home visits from 4772 to 4081, thus holding the average number of visits per mother constant.

Results

Programme coverage

Ninety-two percent of all pregnant women in the intervention area during the intervention period received at least one VHT visit (UNEST 2010). In 2010, the year of implementation under study, VHTs made a total of 4772 home visits, representing an annual average per VHT of 26 mothers and 78.2 home visits (an average of 1.5 home visits) per week per VHT. Each mother covered by the programme received an average of three of the five target home visits, 58.2% were antenatal and 42.8% postnatal visits. 54.3% of the women received two or more VHT visits during pregnancy. Of the 561 women in the intervention arm who had a postnatal visit by a VHT after birth, 228 (40.6%) received their first visit within 24 h of delivery, and about 62.8% within one week of birth. More women who delivered at home were visited by a VHT after birth (73.6%) when compared with those who delivered in a hospital or health facility (59.7%).

Economic and financial costs of the programme

The annualized economic cost of the programme was \$90 402, including design costs, of which 4% went to design, 22% to set-up and, 74% to the programme's implementation (Table 1). The annualized financial cost of the programme amounted to \$83 360 of which 4% (\$3,266) was incurred during the design phase, 24% (\$20 026) during the set-up phase and 72% (\$60 068) during the year of implementation under study. 56% (\$47 030) of the total costs went towards the health facility strengthening whereas 44% (\$36 330) went towards the community-based component. After excluding one-off design costs, the set-up and implementation of

Table 1. Financial and economic costs associated with the UNEST study by phase (design, set-up and implementation) in US\$2015

Cost US\$2015	Pre-implementation					Implementation		Annualized costs excluding design Set-up + Recurrent implementation
	Total costs		Annualized costs (\$)			Recurrent (1 year)		
	Design	Set-up	Design	Set-up community	Set-up facility	Community	Facility	
Financial	7754	44 605	3266	9281	10 744	26 623	33 446	80 094
Economic	8335	47 684	3283	9234	10 840	33 215	33 830	87 119

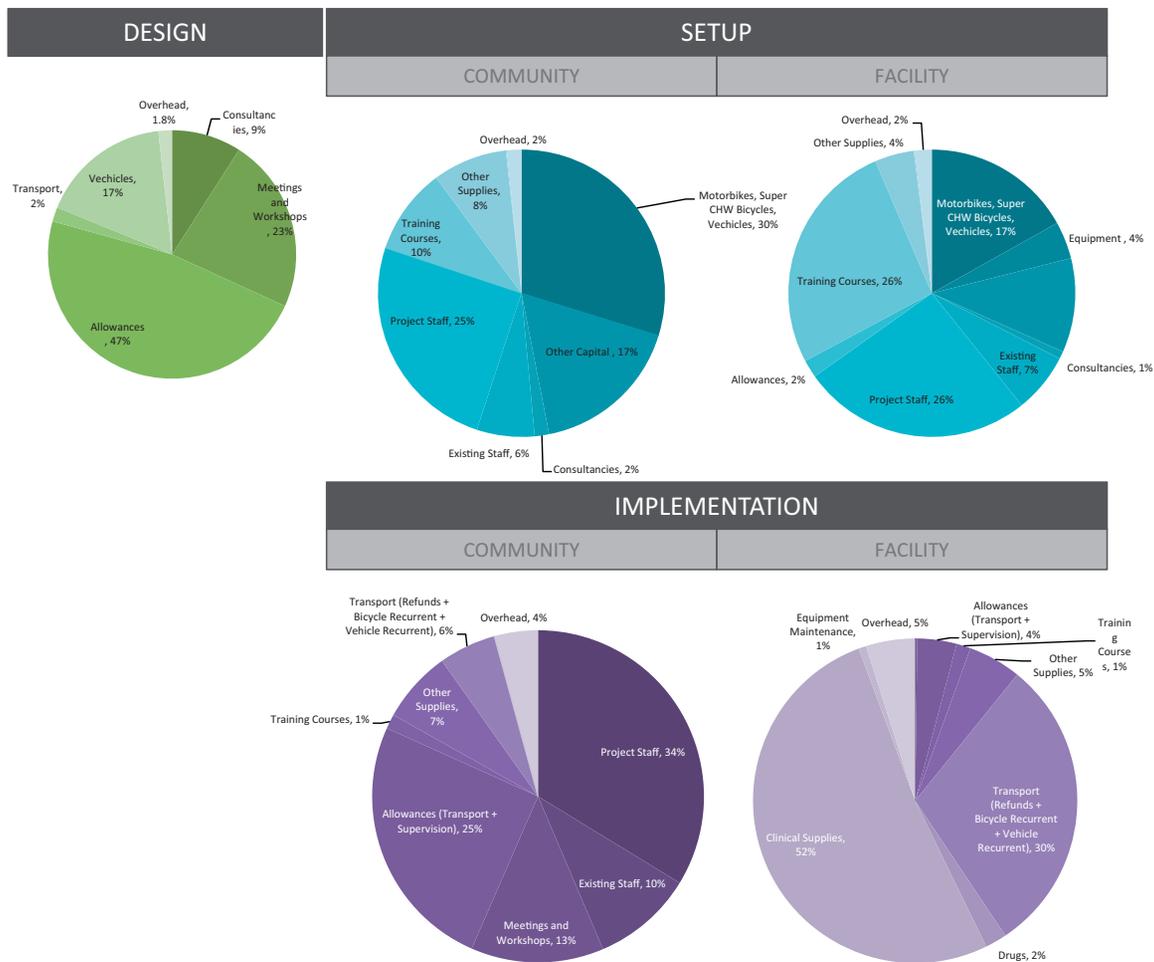


Figure 2. Design, set-up and implementation financial costs for the UNEST (\$US 2015). Design (Figure 2a) Set up Phase (Figure 2b) and implementation (Figure 2c).

the programme amounted to \$80 094 for both programme components (Table 1).

Financial cost drivers in the three phases of programme

Figure 2 presents the main activities for which significant costs were incurred, during each phase of the programme.

The design phase costs comprised mainly costs incurred for meetings and workshops, including allowance paid to attendees, and a vehicle, purchased to help coordinate programme activities, including trips to the field, representing 22 and 17% of costs respectively, incurred during the design phase of the intervention (Figure 2a). The salaries of consultants, hired to design the intervention materials, comprised 9% of the total costs of designing the intervention.

Although facility and community components of the intervention are complementary; the breakdown of costs for the two components

is presented separately for both the set-up phase and the implementation phase. The community-based component, the salaries of those employed by the trial (project staff) (33%) and their means of transport (22%), namely motorbikes for HWS and bicycles for Super CHWs, were the main costs driver during the set-up phase (Figure 2b). For the facility-based component, personnel costs, both project staff (39%) and existing paid staff (8%) and training (30%) were the main cost drivers during the set-up phase.

The drivers of cost during the implementation phase were personnel costs: 34% for project staff and 10% for existing staff, including supervisors’ allowances accounting for 25% of implementation costs and meetings and workshops (13%) for the community based component. Clinical supplies made up the greatest share of total costs (52%) of the facility-based component, followed by allowances for attending meetings (30%), termed ‘transportation refunds’ (Figure 2c).

Table 2. Length of time VHTs spend on the UNEST and home visits, by activity per visit and number of visits/total hours per week

VHTs time on home visits	Median time per home visit (Minutes)			Average home visits/week per VHT	Home visit hours per week per VHT	
	Travel	in Home	Total time			
	32	40	72	1.5	1.8	
Time on the programme per VHT	Average actual hours per week			Average total hours/week on programme	Maximum hours/week on programme	Actual time as % of maximum
	Home visits	Admin & meetings	Identification of new pregnancies			
	1.8	1.4	N/A	3.2	6	53%

Table 3. Annualized fixed and variable costs in the UNEST programme (US\$2015)

(a) Per supervisor			
Supervision annualized costs	US \$2015		
	Total	10% FTE (HWS)	One FTE
<i>Fixed costs</i>			
Vehicle	1828	102	102
Other (Supervisor's manual)	25	1	1
Training	94	5	5
Supplies	115	6	6
Supervision Meetings (Venue, Supplies, Refreshments)	3421	190	190
Supervision Meetings Allowances	6658	370	370
<i>Variable costs</i>			
Transport refunds	144	8	80
Total	\$12, 285	\$682	\$754
(b) Per VHT and per super VHT			
Fixed Costs per VHT and per Super VHT in 2015 US \$(excluding supervision)			
	VHT	Super VHT	
Training	25	25	
Home visit kit supplies	20	20	
Community IEC	8	8	
Bicycle		24	
Total	\$54	\$78	

Time analysis and retention

VHT time

During the implementation year under study, none of the recruited VHTs dropped out. For VHTs, the median time per home visit was 72 min: 32-min travel time, 40 in the home (30 min for the home visit itself and 10 min waiting). On average, each VHT made 1.5 home visits per week (Table 2). There was no significant difference in the time spent by VHTs undertaking antenatal and postnatal home visits. Nor was there a significant difference in the travel time for home visits during dry and wet season. The combined time spent by VHTs on the programme (home visits and administration/meetings) was 3.2 h a week, 53% of the maximum six hours a week that were assumed could be expected of a volunteer.

Supervisor time

The time spent on the intervention by the sampled supervisors was equivalent to 0.1 FTE, or four hours per supervisor per week. 28% (68 min) for supervision, 40% on travel (98 min) and 36% on other meetings linked to supervision (88 min).

Community level unit costs

For the community component, fixed and variable costs per VHT and per HWS, combining annualized set-up and 1-year implementation, are presented in Table 3.

As the supervisory systems was tiered (involving DHV, HWS and Super VHT) many of the costs of supervision, such as training or group supervision meetings, were shared across cadres (Figure 1). Three types of supervision meetings were conducted: 'Group Meetings', facilitated by the DHV, 'VHT Supervision Meetings', between HWS and VHTs at health facilities, and finally, 'Directly Observed Supervision'. The meeting costs represented travel allowances/refunds for all participants and per diems for DHV and HWS. The fixed cost per HW was \$674, covering vehicles, training, supplies and meetings, including allowances for attending meetings; variable costs amounted to \$8 covering transport refunds (Table 3).

The fixed cost per VHT, excluding supervision, amounted to \$54.00, of which \$25.00 went to training and the remaining \$28.00 went to VHT's home visit kit supplies, uniforms and \$8 went to Community Information Education and Counselling materials (Table 3). Super VHTs were equipped with the same supplies but also received a bicycle, costing \$24.00. The fixed costs per Super VHT were therefore \$78.00. The financial cost per mother visited was calculated at \$22.70 and per home visit at \$7.50.

Financial costs of scale-up for the programme

Table 4 presents the actual cost of the UNEST community component in comparison with the required resources to provide five home visits to 95% of pregnant women in the study area (Scenario 1), maintaining the observed levels of VHT activity (1.5 visits per week).

Table 4. UNEST programme actual costs and standardized modelled cost for three scenarios (\$US 2015)

	Actual	Scenario 1: gold standard	Scenario 2: increased CHW workload and efficiency		Scenario 3: standardization to 100 000 total population ^a		
	Average number of achieved visits (3)	Target visits (5)	Five visits (2a)	Four visits (2b)	Single purpose CHW—average four visits per mother		
Coverage	Achieved	Target	Target		Variable		
% of potential mothers visited	92%	95%	95%	95%	50%	70%	95%
Number mothers visited	1584	1636	1636	1636	2150	3010	4085
Number visits/mother	3	5	5	4	4		
Total home visits	4772	8180	8180	6544	8600	12 040	16 340
Number CHWs	61	114	50	40	53	74	100
Number mothers per CHW/year	26	14	33	41	41	41	41
Visits per CHW/week	1.5	1.5	3.4	3.4	3.4	3.4	3.4
% CHW time on programme (maximum 6 h)	53%	53%	100%	100%	100%	100%	100%
Supervisors FTEs	1.8	3.8	1.7	1.3	1.8	2.5	3.4
Cost per mother (\$)	\$22.7	\$34.0	\$20.4	\$18.0	\$16.2	\$14.2	\$13.0
Cost per home visit	\$7.5	\$6.8	\$4.1	\$4.5	\$4.1	\$3.5	\$3.2
Programme cost	\$35 905.0	\$55 555.0	\$33 396.0	\$29,475.0	\$34 842.0	\$42 672.0	\$53 031.0
Programme cost as % Public Health expenditure per capita (\$59.00 per capita)	1.8%	2.7%	1.6%	1.5%	0.6%	0.7%	0.9%

^aCrude birth rate: Country 2013: 43

To achieve the 8180 home visits, 114 VHTs would be required and 3.8 FTE supervisors. The cost per mother would increase from \$22.70 to \$34 and the cost per home visit would drop from \$7.50 to \$6.80.

In Scenario 2a, we assumed that VHT spent 6 h per week on the programme and conducted 3.4 instead of the observed 1.5 home visits per week. Under this 'efficiency package', to achieve high coverage and the target number of home visit (5), only 50 VHT would be required and much less supervision time (1.7 FTE) than in Scenario 1. Assuming VHTs are realistically able to conduct 3.4 home visits per week with an average of one VHT per village instead of the two proposed in the protocol, the cost per mother would drop from \$34 in Scenario 1 to \$20.40 and cost per home visit would decrease from \$6.80 to \$4.71.

In Scenario 2b, the number of visits per mother was reduced from the target five to a more achievable four visits per mother. We adjusted the target number of visits per mother because this is likely to be more sustainable in routine implementation. Under the 'efficiency package' with fewer home visits per mother, only 40 VHTs would be required to achieve 95% coverage of pregnant mothers in the study area. The cost per mother would decrease from \$20.40 in Scenario 2a to \$18.00. The cost per home visit would increase compared with Scenario 2a (from \$4.10 to \$4.50) but decrease compared with the observed levels of implementation by 40%, from \$7.50 to \$4.50.

Table 4 also presents the assumptions of Scenario 2b in standardized population of 100 000 at three levels of coverage (Scenario 3). One hundred VHTs and 3.4 FTE supervisors would be needed to reach 95% of pregnant women with four home visits. The cost of the community-based programme would translate to \$13.00 per mother and \$3.20 per home visit at 95% coverage and represent \$0.53 per capita or 0.9% of average per capita public health expenditure in 2013 inflated to 2015 constant US\$ (World Bank 2013).

Sensitivity analysis

At 79% coverage, the average cost per mother was estimated to be \$26.40 and the average cost per home visit \$8.80.

Discussion

UNEST has demonstrated that VHTs are able to successfully identify and visit pregnant women and newborns at home to promote a number of healthy practices (Waiswa *et al.* 2015b). These findings are consistent with results from South Asian studies elsewhere (Baqui *et al.* 2008; Bhutta *et al.* 2008; Perez *et al.* 2009), although the impact of home visit packages in other African settings has been less clear-cut (Kirkwood *et al.*, 2013) (Daviaud *et al.*, 2017a). Furthermore, UNEST found that home visits benefited poorer families most, with more women in the poorest quintile visited by a VHT compared with families in the least poor quintile, and more women who delivered at home visited by a VHT after birth (73.6%) compared with those who delivered in a hospital or health facility (59.7%) ($P < 0.001$) (Waiswa *et al.* 2015b). Here we estimated the cost per home visit to be \$7.50 and the cost per mother was \$22.70. Under more efficient conditions, costs were modelled to be as low as \$4.50 per home visit and \$18.00 per mother visited based on the intervention population (34 444 people).

The costs of training VHTs and supervisors were low, representing 10% of the total costs for setting up the community component of the programme—lower than all the other examples in this supplement. This is partly due to training being shorter and less intense than in other settings (Daviaud *et al.*, 2017a), a factor which needs to be weighed against the tasks the VHTs are being asked to undertake and their retention, especially when combined with other programmes in the VHT remit such as reproductive and child health. During this study all of the VHTs continued in their posts

throughout the implementation year, despite the fact that it was a volunteer role, contributing to low overall re-training costs. Maintaining these relatively low costs will require a low attrition rate to continue.

The supervisory system involved VHTs supervised by facility-based health workers. The costs associated with supervision represented 16% of the overall annualized costs the programme. The additional 3% workload for supervisors was generally acceptable based on surveying time and opinions of seven supervisors (38% of all supervisors) who were randomly selected (Waiswa *et al.* 2015a). The use of existing staff could help reduce the personnel costs of supervision, although in facilities that are grossly understaffed, high workload may pose an additional challenge. Some higher-level facilities in other districts in Uganda have designated community liaisons that may provide a more realistic link for supervision and training than co-opting existing midwife and nursing staff.

During the implementation phase, the supervision system, encompassed by the cost categories 'meetings and workshops' and 'allowances', represented the greatest share of total costs of the community-based component. The meetings and workshops served several purposes. They were used to reinforce lessons learned in training and identify and work through challenges the CHWs were facing; they were also used to collect reporting forms, used by VHTs to capture key indicators. The directly observed supervision of VHTs done by HWS was also captured under meetings and workshops. These workshops and meetings served a critical function of linking VHTs to health facilities and establishing a rapport with the supervisors. A large share of meeting costs went to providing an incentive to CHWs and supervisors, which is similar to incentive schemes in other examples in this supplement, such as Tanzania's INSIST programme (Manzi *et al.*, 2017). Some volunteer CHW programmes have cited poor supervision and lack of incentives as factors that hampered the success of the programme (Gray and Ciroma 1988; Khan *et al.* 1998). The low attrition witnessed during the UNEST study period may be a reflection of strong links with the supervisory system and the value placed on the VHT role in the community.

UNEST implementation took place concurrently with the revision of the national VHT Strategy, which was finalized in March 2010. As such UNEST was implemented by specifically training the VHTs only on maternal and newborn care though some VHT members had other tasks and training, e.g. malaria, TB and sanitation (Waiswa *et al.* 2015a). Given the wider remit of the VHTs through the national strategy, particularly tasks related to the national roll-out of case management of illness amongst older children (Nalwadda Kayemba *et al.* 2012), the combined workload of all tasks and the time spent undertaking scheduled antenatal and post-natal home visits needs to be considered relative to the benefits. As increasingly more tasks and time are demanded of VHTs, issues of remuneration come to the fore. Studies and reviews have noted the challenge and ethics of maintaining voluntarism as a foundation of the health system (Cherrington *et al.* 2010; Bhutta *et al.* 2011; Singh and Sachs 2013). Although in this study VHT attrition was not a challenge, other volunteer programmes have noted that high attrition can jeopardize success and ultimately contribute to higher costs (Walt *et al.* 1989).

Limitations of analysis

The general limitations and challenges of collection of economic data in these settings, and especially time studies, are discussed in the first article in the supplement (Daviaud *et al.*, 2017a). This analysis

of the cost of the UNEST programme was limited to the provider perspective (i.e. government), thus excluding the costs borne by households and the scope of the study was restricted to the package implemented and thus does not take into account investments in formative research. Finally, design costs were excluded from this analysis based on the assumption that they would not be re-incurred if the intervention were replicated elsewhere. However, to implement the programme successfully elsewhere, it should be acknowledged that certain features of the programme may need to be adapted or re-designed, and therefore some design costs may need to be incurred, though presumably less than presented here within.

Conclusion

The UNEST study has shown that pregnancy and newborn home visits combined with health facility strengthening is feasible and can improve maternal and newborn care practices in a typical rural Ugandan setting (Waiswa *et al.* 2015a). In the national design, maternal, newborn and child health activities are to be carried out by two of the five VHT members in each village. Given that the full complement of VHTs is not available in every village, the scope of activities being carried out by dedicated VHTs includes a wider spectrum of care (beyond maternal and newborn care alone) which may be more challenging to maintain. Using locally recruited, trained VHTs linked to a health facility-based supervision system to deliver home-based preventive care was acceptable and found to be pro-poor. The UNEST study achieved high coverage and the community-based component represented a relatively small proportion of public health expenditure per capita, a mere 1.8%, costing \$1.04 per capita. Of those costs, the largest component was due to supervision, which was incentivized and likely critical to achieving high coverage. Additional resources are needed to support the routine government system, especially to incentivize VHTs and the supervisory system. These inputs will be key to successfully rolling out the government's VHT strategy nationally to ensure that high coverage is maintained and strong links to quality facility-based care are developed. Both are prerequisites for effectiveness and sustainability.

Supplementary data

Supplementary data are available at *HEAPOL* online.

Authors' contributions

Seven authors—E.E.K., C.M., P.W., J.E.L., J.K., N.G. and K.K.—were involved in supporting the implementation of the UNEST programme. E.D. and J.E.L. led the design of the COIN Care Tool and have consistently reviewed and extensively provided input into the draft manuscript. E.E.K., C.M., D.B., H.O. and E.D. undertook the analysis. All authors read, provided substantial input and approved the final article.

Acknowledgements

The authors would like to extend our thanks to the MOH (Uganda) Newborn Steering Committee, Iganga-Mayuge HDSS, and Iganga and Mayuge districts with their managers, health workers and community health workers who implemented the intervention, staff and community members. Additionally, we thank Dr Peter Waiswa, the UNEST Principal Investigator, and all project staff for the support and determination to have this work completed. The authors also express their appreciation for the financial support provided by Saving Newborn Lives of Save the Children USA/Uganda through a grant from Bill and Melinda

Gates Foundation. UNEST also benefited from funding support from Sida/SAREC—Makerere University—Karolinska Institutet Research collaboration grant. Further appreciation goes to the South African Medical Research Council (SAMRC) who financed this supplement to disseminate these outputs.

Funding

This supplement publication cost was supported by the Health Systems Research Unit, South African Medical Research Council. The “Cost of Integrated Newborn (COIN) Care Tool” was developed by the South African Medical Research Council and funded by Save the Children’s Saving Newborn Lives (SNL) programme.

Conflict of interest statement. None declared.

Note

1. A Mama Kit is a package consisting of materials and supplies used by VHTs during their home visits to demonstrate birth preparedness, pregnancy and child care, and how to identify danger signs etc. It contained two baby sheets, cotton wool, mackintosh, cord ties, razor blade, two pairs of gloves and a gauze roll.

References

- Bang AT, Baitule SB, Reddy HM, Deshmukh MD, Bang RA. 2005. Low birth weight and preterm neonates: can they be managed at home by mother and a trained village health worker? *Journal of Perinatology* 25: 572–81.
- Baqui AH, El-Arifene S, Darmstadt GL *et al.* 2008. Effect of community-based newborn-care intervention package implemented through two service-delivery strategies in Sylhet district, Bangladesh: a cluster-randomised controlled trial. *Lancet* 371: 1936–44.
- Bhutta Z, Yakoob M, Salam R, Lassi Z. 2011. *Global Review of Interventions Related to Maternal, Newborn and Child Health (MNCH): What Works and Can be Scaled Up?* Pakistan: Aga Khan University. *Pediatrics*:115(2 Suppl):519–617.
- Bhutta ZA, Darmstadt GL, Hasan BS, Haws RA. 2005. Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence. *Pediatrics*.
- Bhutta ZA, Memon ZA, Soofi S *et al.* 2008. Implementing community-based perinatal care: results from a pilot study in rural Pakistan. *Bulletin of the World Health Organization* 86: 452–9.
- Cherrington A, Ayala GX, Elder JP *et al.* 2010. Recognizing the diverse roles of community health workers in the elimination of health disparities: from paid staff to volunteers. *Ethnicity and Disease* 20: 189–94.
- Daviaud E, Nkonki L, Lawn J. 2010. *Cost of Integrating Neonatal Care Tool: A Tool for Assessing the Incremental Costs of Newborn care within Maternal, Newborn and Child Health Packages for Program and Research Purposes: USER MANUAL.* Cape Town, South Africa: Saving Newborn Lives/Save the Children, Medical Research Council South Africa.
- Daviaud E, Owen H, Pitt C *et al.* 2017a. Overview, methods and results of multi-country community-based maternal and newborn care economic analysis. *Health Policy and Planning* 32: i6–i20.
- Drummond MF, Sculpher MJ, Torrance GW, O’Brien BJ, Stoddart GL. 2005. *Methods for Economic Evaluation of Health Care Programmes*, Oxford: Oxford University Press.
- Gogia S, Sachdev HS. 2010. Home visits by community health workers to prevent neonatal deaths in developing countries: a systematic review. *Bulletin of the World Health Organization* 88: 658–66B.
- Gray HH and Ciroma J. 1988. Reducing attrition among village health workers in rural Nigeria. *Socio-Economic Planning Sciences*, 22(1):39–43.
- Khan SH, Chowdhury AM, Karim F, Barua MK. 1998. Training and retaining Shasthyo Shebika: reasons for turnover of community health workers in Bangladesh. *Health Care Superv.* 17:37–47.
- Kirkwood BR, Manu A, Ten Asbroek AH *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* 381: 2184–92.
- Kumar V, Mohanty S, Kumar A *et al.* 2008. Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: a cluster-randomised controlled trial. *Lancet* 372: 1151–62.
- Lawn JE, Blencowe H, Oza S, *et al.* 2014. Every Newborn: progress, priorities, and potential beyond survival. *The Lancet* 384: 189–205.
- Mbonye AK, Sentongo M, Mukasa GK, *et al.* 2012. Newborn survival in Uganda: a decade of change and future implications. *Health Policy and Planning* 27: iii104–17.
- Ministry of Health Republic of Uganda. 2012. *Uganda Clinical Guidelines: National Guidelines for Management of Common Conditions*. Kampala: Ministry of Health Republic of Uganda.
- MOH. 2005. *Uganda Health Sector Strategic Plan II 2005/6-2009/2010*. Kampala: Ministry of Health.
- Nalwadda Kayemba C, Naamala Sengendo H FAU, Ssekitooleko J *et al.* 2012. Introduction of newborn care within integrated community case management in Uganda. *The American Journal of Tropical Medicine and Hygiene* 87(5 Suppl): 46–53.
- Namazzi G, Waiswa P, Nakakeeto M *et al.* 2015. Strengthening health facilities for maternal and newborn care: experiences from rural eastern Uganda. *Global Health Action* 8: 24271.
- Oanda. 2015. *OANDA: Historical Exchange Rates* [Online]. <http://www.oanda.com/currency/historical-rates/>, accessed 5 October 2015.
- Perez F, Ba H, Dastagire SG, Altmann M. 2009. The role of community health workers in improving child health programmes in Mali. *BMC International Health and Human Rights* 9: 28.
- Ronsmans C, Graham WJ. 2006. Maternal mortality: who, when, where, and why. *Lancet* 368: 1189–200.
- Singh P, Sachs JD. 2013. 1 million community health workers in sub-Saharan Africa by 2015. *The Lancet* 382: 363–5.
- Trading Economics. 2015. *Trading Economics* [Online]. <http://www.tradingeconomics.com>, accessed 5 October 2015.
- Uganda Bureau of Statistics. 2010. *Uganda National Household Surveys Report 2009/2010*. Kampala, Uganda: Uganda Bureau of Statistics.
- Uganda Bureau of Statistics (UBOS). 2009. *Uganda National Household Surveys Report 2009/2010*. Kampala.
- Uganda Bureau of Statistics (UBOS) and ICF International Inc. 2012. *Uganda Demographic and Health Survey 2011*. Kampala, Uganda: UBOS and Calverton, Maryland: ICF International Inc.
- UN Inter-Agency Group for Child Mortality Estimation. 2014. *Levels and Trends in Child Mortality*. New York: UNICEF.
- UN Inter-Agency Group for Child Mortality Estimation. 2015. *Levels and Trends in Child Mortality. In: UNICEF (ed.)*. New York: UNICEF.
- Waiswa P, Kallander K, Peterson S, Tomson G, Pariyo GW. 2010a. Using the three delays model to understand why newborn babies die in eastern Uganda. *Tropical Medicine and International Health* 15: 964–72.
- Waiswa P, Kemigisa M, Kiguli J *et al.* 2008. Acceptability of evidence-based neonatal care practices in rural Uganda - implications for programming. *BMC Pregnancy and Childbirth* 8: 21.
- Waiswa p, namazzi g, kerber k, peterson s. 2015a. Designing for action: adapting and implementing a community-based newborn care package to affect national change in Uganda. *Global Health Action* 8: 24250.
- Waiswa P, Nyanzi S, Namusoko-Kalungi S *et al.* 2010b. I never thought that this baby would survive; I thought that it would die any time’: perceptions and care for preterm babies in eastern Uganda. *Tropical Medicine and International Health* 15: 1140–7.
- Waiswa P, Pariyo G, Kallander K *et al.* 2015b. Effect of the Uganda Newborn Study on care-seeking and care practices: a cluster-randomised controlled trial. 8: 24584.
- Waiswa P, Peterson S, Tomson G, Pariyo GW. 2010c. Poor newborn care practices - a population based survey in eastern Uganda. *BMC Pregnancy and Childbirth* 10: 9.
- Waiswa P, Peterson SS, Namazzi G *et al.* 2012. The Uganda Newborn Study (UNEST): an effectiveness study on improving newborn health and survival in rural Uganda through a community-based intervention linked to

- health facilities - study protocol for a cluster randomized controlled trial. *Trials* 13: 213.
- Walker D, Kumaranayake L. 2002. Allowing for differential timing in cost analyses: discounting and annualization. *Health Policy and Planning* 17: 112–8.
- Walt G, Perera M, Heggenhougen K. 1989. Are large-scale volunteer community health worker programmes feasible? The case of Sri Lanka. *Social Science and Medicine* 29: 599–608.
- WHO, UNICEF, USAID Children S. T. 2009. *WHO-UNICEF Joint Statement on Home Visits for the Newborn Child: A Strategy to Improve Survival*. Geneva: World Health Organization.
- World Bank. 2013. *Data: Health expenditure per capita (current US\$)* [Online], Last accessed 7 February 2014.
- World Bank. 2014. *Data: Crude birth rate* <http://data.worldbank.org/indicator>. Last accessed 7 February 2014.