Cost analysis of the seasonal malaria chemoprevention project in Katsina state, Nigeria

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Abbreviations

ANC	ante natal clinic
BCC	behaviour change communication
CA	cost analysis
CBV	Community-Based Volunteer
CCG	community care giver
CI	confidence interval
CS Pro	census survey professional
EA	enumeration area
EPI	Expanded Programme on Immunization
FMoH	Federal Ministry of Health
GoN	Government of Nigeria
HF	health facility
HSCL	Health Systems Consult Limited
ICF	informed consent form
LGA	local government area
MC	Malaria Consortium
MDA	mass drug administration
MDG	Millennium Development Goal
MNCH	maternal neonatal and child health
MS Excel	Microsoft excel
NGO	non-governmental organisation
NMEP	National Malaria Elimination Programme
OPD	Outpatient Department
PHC	primary health care
QA	quality assurance
RBM	Roll Back Malaria
SMC	seasonal malaria chemoprevention
SMEP	State Malaria Elimination Programme
SMoH	State Ministry of Health
SSA	sub-Saharan Africa
SuNMaP	Support for National Malaria Programme
UN	United Nations
WHO	World Health Organization

Executive summary

As a result of the seasonal surge in malaria incidence particularly seen in the Sahel region of northern Nigeria, the Bill & Melinda Gates Foundation funded Seasonal Malaria Chemoprevention (SMC) project, which involves the administration of a full treatment course of antimalarial drugs, was implemented in Katsina state. The project aimed at reducing illnesses and deaths attributable to the disease, especially among children under five.

With the project in its second year, a cost analysis was pertinent to determine the financial and economic cost per child to receive a complete course of treatment in all four cycles of SMC drugs in a transmission round. The costing study is to inform project implementers, donors and partners on cost of scale-up to other similar regions.

This costing study was executed taking input of all levels - national, state, local government area (LGA), health facility and community - into consideration. Representative samples were taken at respective levels that required sampling and questionnaires were administered accordingly. Table 1 below shows the results obtained from the study in line with project aim and objectives.

This report presents detailed findings of the SMC cost analysis of SMC implementation which took place in 2 LGAs (Baure & Mashi) in 2013 and 4 LGAs (Baure, Mashi, Mai'adua, Dutsi) in 2014. From the results obtained, findings indicate that the total economic cost was higher in 2014 compared to 2013. This is explained by the fact that the project was scaled up to an additional two LGAs in 2014 and there was an increase in treatment cycles from three cycles of treatment in 2013 to four cycles in the 2014 round. Across both years, the major cost drivers for the project were found to be procurement of drugs and test kits, human resource costs (MC project staff costs), training, technical assistance (TA) costs, opportunity costs and domestic travel costs. These six cost categories contribute about 93.7 percent of the entire SMC project cost in 2013 and 90.6 percent of the entire cost of implementing SMC in 2014.

Cost categories that could benefit from economies of scale include HR, TA, trainings and travel costs.

Using 2014 as a proxy for a fully mature SMC programme with a complement of the recommended four cycles per high transmission season, it costs approximately $3.35 for each eligible child that received at least one complete SMC treatment and $3.77 for each child that received four complete SMC treatments to attain full coverage, not discounting for attrition of children between cycles[1].

In 2013, it cost $3.26 for each eligible child that received at least one complete SMC treatment and $3.98 for each eligible child that received three complete SMC treatments to attain acceptable coverage, not discounting for attrition of children between cycles [1].

[1] To address the limitation presented in tracking individual children between cycles, it was assumed that all children presenting in the cycle with the lowest coverage received SMC treatment across all cycles of SMC.

These results show some reduction in costs when compared with other studies that have determined cost per fully covered child to be approximately $4.58[2] and $3.47[3] for an acceptably covered child using similar delivery mechanisms. These variations could be a result of the differences in the implementation settings, where the studies were conducted in a more controlled study setting and also possibly of the programme scale-up as the number of children reached in this setting was much higher than the ones in the research settings of the comparator study.

Based on the study findings, it is recommended amongst others that cost reduction opportunities are explored by running state based projects to reduce travel and training costs from headquarters and international staff; pooling procurement with other Sahel countries involved in SMC; revisiting the incentive structure for SMC personnel and exploring the possibility of integrating SMC with MNCH initiatives in the country so as to leverage from well-established programmes.

[2] Khalifa A, Bojang et al, PLOS Medicine: Two strategies for the Delivery of IPTc in an area of seasonal Malaria Transmission in the Gambia: A Randomised Controlled Trial; February 1, 2011 DOL:10.13071/journal.pmed.1000409

[3] Conteh L, Patouillard E, Kweku M, Legood R, Greenwood B, et al. (2010) Cost Effectiveness of Seasonal Intermittent Preventive Treatment Using Amodiaquine & Artesunate or Sulphadoxine-Pyrimethamine in Ghanaian Children. PLoS ONE 5(8): e12223. doi:10.1371/journal.pone.0012223

Table 1: Summary of study findings

Study objective	**Results**						
Objective 1 Outline of all financial and economic costs required for design, start-up and actual SMC delivery through the proposed delivery system	**Cost/year**	**Financial costs ($)** Design and start-up costs are fixed for both years		**(Other costs) ($)**		**Total (economic) costs ($)**	**Total number of children reached**
	2013	**Design phase**	120,287.96	**Design phase**	0	1,117,339.61	487,354.00
		Start-up phase	308,096.39	**Start-up phase**	0		
		Service delivery phase	621,071.86	**Service delivery phase**	67,883.40		
		Total	797,709.55	Total	67,883.40		
	2014	**Design phase**	120,287.96	**Design phase**	0	1,518,452.82	1,112,330.00
		Start-up phase	308,096.39	**Start-up phase**	0		
		Service delivery phase	906,768.53	**Service delivery phase**	183,299.94		
		Total	1,761,051.73	Total	183,299.94		

Objective 2a To highlight the main cost drivers for SMC delivery (% allocated to each category)	**Year**	**Percentage contribution by cost category (%)**							
		SMC drugs And test kits	**HR**	**Demand creation**	**Training**	**Monitoring & Evaluation**	**TA**	**Opportunity cost**	**Domestic travels**
	2013	31.3	26.6	0.46	14.1	0.5	10.8	3.5	8.8
	2014	41.2	18.7	1.0	11.4	2.4	7.5	7.0	5.8
Objective 2b To highlight costs which could benefit from (reduce with) economies of scale (i.e. through scale-up)	• Human Resource costs • TA costs • Training costs • Travel costs								
Objective 3 Average economic cost per child for providing a complete round of SMC treatment (three and four cycles of SMC in 2013 and 2014 respectively)	**2013**			**2014**					
	$3.26 (Excluding design, start-up and research related costs)			**$3.35** (Excluding design, start-up and research related costs)					
Objective 4 The economic cost per child fully covered (i.e. child that received all three SMC treatment cycles during 2013 and four complete SMC cycles during 2014 rounds respectively)[4].	**2013**			**2014**					
	$3.98 (Excluding design, start-up and research related costs)			**$3.77** (Excluding design, start-up and research related costs)					

[4] To address the limitation presented in tracking individual children between cycles, it was assumed that all children presenting in the cycle with the lowest administrative coverage received SMC treatment across all cycles of SMC during that years round.

Introduction

Background

Worldwide, malaria is of public health significance with Africa bearing 90 percent of the global burden. Nigeria, Africa's most populous country, carries the greatest malaria load among countries in the world with over 300,000 malarial deaths occurring annually, mostly among women and children under five[5]. Previous WHO recommendations for malaria control in children in endemic areas relied on prompt case management, use of insecticide-treated nets and vector control, none of which proved fully efficacious for controlling the infection[6].

Seasonal malaria chemoprevention was launched in 2012 by WHO as a new intervention against *Plasmodium falciparum* malaria. This intervention, formerly referred to as Intermittent Preventive Treatment in children (IPTc) involves the intermittent administration of full courses of an antimalarial treatment combination during malaria season in areas where the infection is seasonal, to prevent morbidity and mortality from the disease[7].

The Bill & Melinda Gates Foundation funded SMC project implemented in Katsina state aimed at improving health outcomes in the state through increased access to SMC among children. The intervention was implemented with a view to assessing the feasibility, operability and costs of community-based SMC delivery systems. Information generated was to inform the National and State Malaria Control Programmes on what will be needed to scale up SMC across suitable areas of northern Nigeria and other countries in the Sahel region where the malaria transmission season is no longer than four months.

Costing information has been an integral component of public health intervention evaluations as it is vital for management, prioritisation and scaling-up. Although efficacy information is available for key malaria interventions, there is a dearth of information on the resources required for implementation of interventions known to be cost-effective. Consequently, there is a need for data on actual costs of the SMC delivery systems in the Sahel region of Nigeria where malaria transmission occurs seasonally which have not been collected before in northern Nigeria. These costs will provide comparable evidence to other studies of similar nature and will inform recommendations for future design, continuation and scale-up of the SMC initiatives in Nigeria. This cost analysis will also enable Malaria Consortium to gain understanding of the related costs of SMC delivery in northern Nigeria; and will further generate evidence to support the national programme's decision making on its adoption and scale-up.

[5] Morel, Chantal M., Jeremy A. Lauer, and David B. Evans. "Cost effectiveness analysis of strategies to combat malaria in developing countries." Bmj 331.7528 (2005): 1299.
[6] Cost-effectiveness of malaria intermittent preventive treatment in infants (IPTi) in Mozambique and the United Republic of Tanzania. http://www.who.int/bulletin/volumes/87/2/08-051961/en/
[7] WHO Policy Recommendation: Seasonal Malaria Chemoprevention (SMC) for *Plasmodium falciparum* malaria control in highly seasonal transmission areas of the Sahel sub-region in Africa

This report reflects the findings of the costing analysis for the SMC implementation conducted in Katsina state to assess the successes and challenges of the project activities.

Purpose of the analysis

The purpose is to undertake a costing analysis of implementing SMC in four LGAs in Katsina state, northern Nigeria.

Objectives

1. To generate an outline of all financial and economic costs required for design, start-up and actual SMC delivery through the proposed delivery system
2. To highlight
    a. The main cost drivers for SMC delivery (% allocated to each category) and
    b. Costs which could benefit from (reduce with) economies of scale (i.e. through scale-up)
3. To determine the economic cost per child of receiving at least the first dose of all four courses of SMC (acceptably covered)
4. To determine the economic cost per child that received all three doses during the three cycles of 2013 round and four cycles of 2014 transmission season

Coverage

The assignment was conducted in four LGAs of Katsina state (Baure, Dutsi, Mashi and Mai'adua) and the National/country office finance, Katsina state.

Approach and methodology

In this section, a detailed description of procedures carried out to generate results and findings are presented. These include study area description, study design, sample size determination, sampling procedure, data collection and analyses.

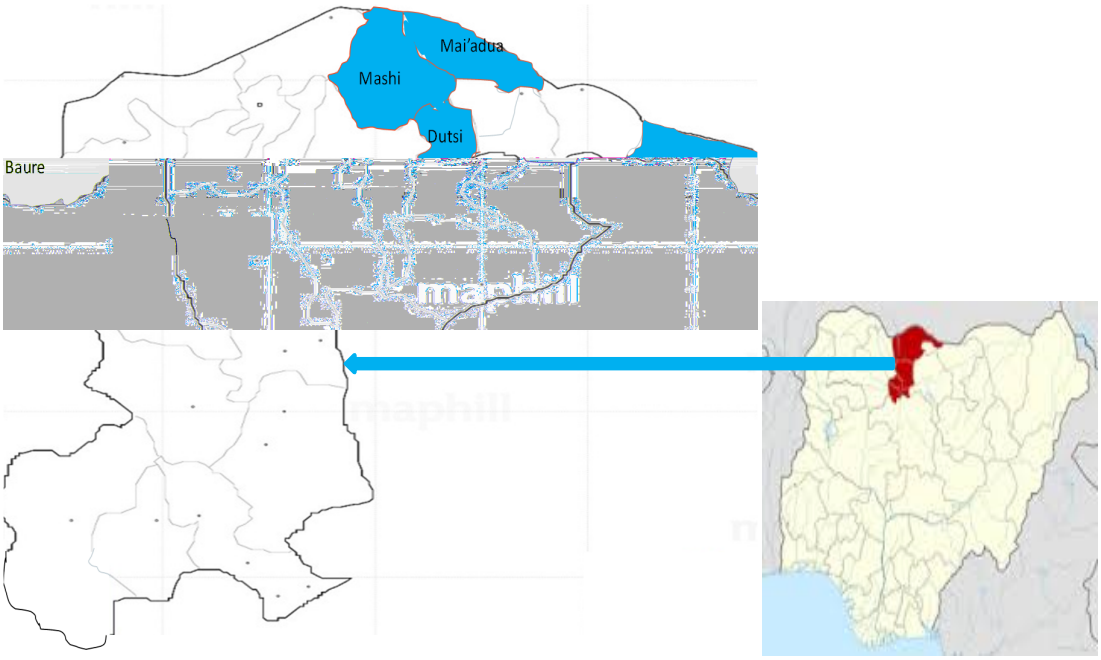
Study area

Katsina state, located in north western Nigeria with geographic coordinates 12°15′N 7°30′E. The state occupies a total area of 24,192km^2 and has a total population of about 5,792,5788 (2006 estimate). The Hausa people, sometimes grouped with the Fulani as Hausa-Fulani, are the largest ethnic group in the state. Katsina state is an agrarian state with agricultural business of farming and rearing of animals constituting the mainstay of its economy.

[8] NPC 2006

The SMC costing activity was carried out in four LGAs in Katsina state. These LGAs were Baure, Dutsi, Mashi and Mai'adua. Baure LGA shares a border with the Republic of Niger. Its headquarters are in the town of Baure in the northwest of the area at 12°50′10″N 8°44′47″E with a population of 197,425 (2006 estimate). Dutsi LGA has an area of 283km² and a population of 120,023 (2006 estimate). Mashi LGA also shares a border with the Republic of Niger. Its headquarters are in the town of Mashi in the southwest of the area at 12°59′00″N 7°57′00″E. Mai'adua LGA has an area of 528km² and a population of 201,178 (2006 estimate).

Figure 1: Map of Katsina showing target LGAs



Study design

Financial and economic cost data was collected across various levels: national, state, LGA, health facility and community levels, to determine the cost of SMC service delivery.

The study relied on secondary cost data provided by the Malaria Consortium (MC) programme finance unit which detailed actual expenditures across specific cost heads. This data set served as the major source of all project costs (financial).

To elicit primary data for other costs not directly expended by the MC programme, a structured questionnaire was developed to collect data from the state, LGA, health facility and community levels. Cost types extracted included in-kind payments by state and Local governments for SMC-related activities and the opportunity cost for all cadres of personnel involved in the programme at those levels.

Literature review

Prior to the commencement of field work, an extensive review of reference materials and project documents available through MC was conducted. Relevant data include SMC delivery guide, MC SMC implementation plan/Community Care Giver delivery model, project reports, health facility listing, CCG line list, expenditure reports including training, procurement and production of BCC materials, etc. Review of the project documents provided an in-depth description of the routine tracking and field assessments of the SMC costing analysis project against set project outcomes and objectives.

In addition, desk reviews and online searches were also carried out to obtain and review secondary data and other relevant background information pertaining to SMC projects in other parts of sub-Saharan Africa.

Similar economic studies of IPTc within the sub-Saharan region were also reviewed to afford the study some comparability.

Sampling procedure

A multi-stage sampling approach was adopted based on the costs data levels that were to be collected.

National level: Data at this level were obtained from MC's financial/spend records. This was made available by the finance manager. The spend record spanned from March 2012 to April 2015.

State level sampling: A census of all identified state level stakeholders involved in the SMC project was carried out. These are the Director Public Health, Director Pharmaceutical Services, Director Planning Research and Statistics (DPRS), the State Malaria Elimination Programme (SMEP) Manager, the Advocacy Communication and Social Mobilisation (ACSM) Manager and the Support to National Malaria Programme (SuNMaP) Manager, the staff of the state health authorities and State Malaria Elimination Programme.

LGA level sampling: All four pilot LGAs where the SMC project was implemented were selected for the study. These are Baure, Dutsi, Mashi and Mai'adua. In each LGA, the LGA team which comprises of the Primary Health Care (PHC) Coordinator, Roll Back Malaria (RBM) focal person, Monitoring and Evaluation (M&E) focal person, health educator and storekeeper/logistician were all interviewed. A total of 20 persons were interviewed at the LGA level.

Health facility level sampling: A total sample of 36 health facilities were selected and used for the study. This sample was estimated using the Optimal Design OD Software (Ver. 1.77). Sample size was calculated with a 95 percent confidence interval and an effect size of 0.8. The total number of health facilities in each LGA made up the sampling frame for that LGA.

Community level sampling: a convenient sample of four CCGs per LGA was used for the study. CCG selection was based on the assumption that they share similar characteristics in terms of paid allowances and had no associated direct costs.

Survey questionnaires

Before the commencement of field work, tools were designed to capture cost data at all identified levels of the value chain: national, state, LGA, health facility and community levels. Tools were pretested in Abuja and adjustments were made based on findings from the pre-test. Finalised tools were shared with MC and approval obtained before use in the field.

Field work

The field work spanned for a period of two weeks. Activities that made up this process include engagement with the stakeholders at the state and LGA levels, interviews of identified state and LGA level stakeholders, recruitment and training of data collectors and supervisors, data collection from health facilities that were selected for the study and questionnaire administration to select CCGs. The sections below give detailed description in the methodologies used in this process.

Engagement with state level stakeholders

At the state, the project team visited the stakeholders to sensitise them and to get their support and permission to conduct the study. This provided a platform for identification of all key individuals to be interviewed. Also, a meeting with stakeholders from the LGA was also conducted to sensitise them and get them ready for the data collection process in the selected health facilities within their LGAs.

Recruitment and training of research team

An initial training was conducted by the Health Systems Consult Limited (HSCL) core team for state team lead and project coordinator at the national level. The SMC project manager attended to observe the training and make contributions on how to improve the entire process. At the state, a step-down training for recruited supervisors and data collectors was conducted. The state malaria focal person attended to ensure local involvement and ownership of the study. The research team recruited at the state had strong prior experiences in data collection for similar studies across the state. Training content included the purpose of and expectations for the survey, familiarisation of participants with survey tools, role play and data quality procedures.

Data collection

State level: Upon identification of the relevant state level stakeholders, interviews were conducted using the survey questionnaire as a guide. Responses were recorded and probe questions were asked to verify the accuracy of responses provided. The list of state level stakeholders interviewed is provided as an appendix in this report.

LGA level: In each of the LGAs visited, the entire LGA team was interviewed using the designed questionnaire as a guide. Responses provided were recorded accordingly.

Health facility level: Upon identification of the selected health facilities, the Head of the health facility (in-charge) was interviewed to get costs associated with this level. CCGs were also interviewed to get their associated opportunity costs.

Supervision and data quality

All completed questionnaires were reviewed by team supervisors in the field prior to data entry. Checks were undertaken for completeness, consistency and identification of erroneous entries. Inconsistencies and errors identified were immediately regularised in the field. At the end of the day, team supervisors reviewed all questionnaires and ensured all completed questionnaires were submitted to the state team lead.

The state team lead randomly reviewed all completed questionnaires as quality assurance (QA) procedure to ensure good quality data had been obtained and provided feedback to team supervisors daily throughout the duration of the field exercise.

Data entry and analysis

An excel database maintained by MC for the SMC project was made available to the study team. Also a data entry platform was developed on Microsoft excel in which clean data from the field was entered accordingly and consolidated with the MC finance database. A process of interpretation of the entries and categorising costs was conducted and clarifications sought where it was difficult to interpret. An implementation logic framework was developed based on materials received from MC that itemised the process involved in SMC design, start-up and delivery stages. Similarly, all input activities were itemised in the logframe for which related costs were collected. Several analysis filters were created to adequately categorise elicited costs according to defined cost categories. These categories are depicted in Table 2 below and the operative definitions detailed in Table 3.

Table 2: Categorisation of costs

Category	Sub-categories
Implementation phase	• Design • Start-up • SMC service delivery
Cost type	• Financial (project costs) • Other costs • Economic costs (total costs)
Cost categories	• Communication • Drug distribution costs • M & E costs • International travel • Overheads • Drugs and commodity procurements • Domestic travel • TA • Training • Opportunity cost • HR

Table 3: Operative definitions for costing terminologies

SMC cost terminology	Operative definition
Design phase	The design phase refers to all activities that were carried out in the project developmental stages. This phase spanned from March 2012 to May 2013, a total duration of approximately 14 months.
Start-up phase	The start-up phase includes all inputs and activities carried out in preparation for the mass drug administration (MDA) cycles. It included overhead activities such as recruitment of project staff, office space acquisition, procurement of office materials and others ancillaries that preceded the actual drug distribution cycles. This phase comes in between the design and service delivery phase and terminates just at the commencement of the first MDA in August 2013.
Service delivery phase	The service delivery phase is described as the phase where the MDA was rolled out in addition to baseline and end line surveys, etc. The service delivery phase is repeated every year with 2013 having three cycles in two LGAs and 2014 having four cycles in four LGAs.
Financial costs	These refer to all costs incurred directly through project activities and its related operations and borne by MC. This includes all costs recorded in MC financial records.
Other project costs	These refer to other project related costs that are borne by non-MC partners including state and LGAs. Also included here are costs borne by health facilities and host communities. These costs were identified from stakeholders at other levels.
Economic costs	These refer to the sum total of all costs - both direct and indirect - that are related to the SMC project. These include the financial and other costs and also other in-kind costs and opportunity costs related to the project.

Other subfilters were applied as well to further subcategorise costs that made out significant proportions of the total costs, e.g. HR costs were also subcategorised to HR costs by MC direct staff and HR costs attributed to ad-hoc staff used during the distribution campaigns and other related activities.

Technical assistance costs were also subcategorised into international TA costs and local TA costs.

Allocation tables and charts were also developed to determine cost drivers of the SMC project.

In determining total economic costs per child either adequately covered or fully covered, three cost types were determined.

a. Total economic cost per child based on all documented costs including design and start-up costs
b. Total economic costs per child based on total costs that discounted costs for research activities
c. Total economic costs per child that discounted design, start-up and research activity costs.

For purposes of comparison with other studies, the analysis utilised the cost type (c), which better compared with the settings used for analysis in the comparator studies.

Results

Literature review

SMC is a relatively new intervention approach recommended in 2012 by WHO in areas with high seasonal transmission of malaria. Current efforts at developing a body of evidence to inform the scale-up of this new public health approach to malaria control has dwelt more on the study areas of delivery methods, effectiveness and impact. The volume of literature on economic analysis of SMC is very limited.

Conteh L, Patouillard E (2008)[9], et al assessed the cost effectiveness of IPTc using either artesunate (AS) + amodiaquine (AQ) administered monthly or bimonthly, sulphadoxine-pyrimethamine (SP) administered bimonthly or placebo delivered by community volunteers in Hohoe, Ghana (Kweku et al, PLoS ONE, 2008). The study showed that economic costs per child who received at least the first dose of each course were lowest for SP bimonthly, followed by AS + AQ bimonthly and then AS + AQ monthly. In this study, AS + AQ administered monthly was the most cost effective regimen due to its substantially higher protective efficacy against clinical malaria.

Costs categories included those of IPTc drugs, training of health personnel and Community-Based Volunteers (CBVs), health personnel staff time, utilities (such as water, gas, electricity and telephone bills), supplies, transport supervision and incentives. In the discussion of the paper, the authors opined that between $8.19 and $14.79 the annual cost of delivering at least the first dose of each course of IPTc under trial conditions is higher than that of other interventions designed to protect children against malaria. However, when the unit costs are scaled up to a district wide level, costs of delivery fall to between $1.86 and $4.33 per child; these costs are within the range of the costs associated with delivering other malaria prevention interventions. In an attempt to better understand the costs of operationalising this intervention on a district-wide scale, the authors modelled scale-up costs (both fixed and variable) and explored potential savings from economies of scale. They determined that as the population increases by more than forty times, the costs fall on average four times. This was inferred to be due to certain fixed costs such as incentives to community-based volunteers and facility-based staff remaining constant regardless of the number of children who receive IPTc. Semi fixed costs such as training, drug delivery and supervision also benefited from economies of scale.

Patouillard E, Conteh L et al (2011)10 carried out a costing study as a component of a community randomised trial designed to assess the effectiveness of IPTc in terms of adherence obtained through

[9] Conteh L, Patouillard E, Kweku M, Legood R, Greenwood B, Chandramohan D. Cost effectiveness of seasonal intermittent preventive treatment using amodiaquine and artesunate or sulphadoxinepyrimethamine in Ghanaian children. PLoS ONE 2010; 5:e12223

[10] Patouillard E, Conteh L, Webster J, Kweku M, Greenwood BM, Chandramohan D. Economic costs of IPTc coverage and adherence under 2 different delivery systems. PLoS One 2011

two different delivery system: a facility-based system, including health facility or Expanded Programme on Immunization (EPI) outreach team and a community-based system by volunteers (Kweku et al, PLoS ONE, 2009). For each of the delivery systems, economic and financial total costs were calculated from the perspective of the health care provider (Ministry of Health). Under the facility-based delivery system, the main economic cost categories were personnel cost for dispensing IPTc to children, supervision cost and cost for delivering IPTc to the distribution points; under the community-based delivery system, the main cost categories were supervision cost, transport cost for delivering IPTc drugs to the distribution points and personnel cost for dispensing IPTc to children. The following economic unit costs are presented and compared across delivery systems: the cost per child "fully" covered; the cost per child "acceptably" covered; the cost per "fully" adherent child; and finally the cost per "acceptably" adherent child. The results showed that the economic cost per child receiving at least the first treatment course of all four cycles was $4.58 when IPTc was delivered by village health workers (VHWs), $4.93 by Outpatient Department (OPD) nurses and $ 5.65 by EPI nurses. The unit economic cost of receiving a full treatment course for all four cycles was $7.56 and $8.51 when IPTc was delivered by VHWs or facility-based nurses respectively. The main cost driver for the VHW delivery was supervision, reflecting resources used for travelling to more remote communities rather than more intense supervision, and for OPD and EPI delivery, it was the opportunity cost of the time spent by nurses in dispensing IPTc. The authors also concluded that IPTc was financially and economically less costly when dispensed by VHWs than by OPD or EPI nurses. The main economic cost driver when IPTc was dispensed by VHWs was supervision, accounting for 32 percent of the total economic cost. The economic cost per child ''fully covered'' was $4.58 when IPTc was delivered by VHWs and $5.27 when delivered by nurses, resulting in an incremental saving of $0.69.

Bojang KA, Akor F (2011)11 conducted a cluster-randomised study assessing the effectiveness of IPTc using sulphadoxine-pyrimethamine + amodiaquine in children aged up to five years when delivered by VHWs or reproductive and child health trekking teams in The Gambia. The results showed that delivery of IPTc by VHWs was less costly in both economic and financial terms compared to delivery by the trekking team. This was in agreement with the study by Patouillard in Ghana which also showed the higher cost-effectiveness of IPTc delivery through VHWs. The study also showed the influence of scale on delivery of IPTc and inferred that this was possible as certain fixed costs such as incentives to VHWs and facility based staff are divided by a much larger number of children and that semi-fixed costs such as delivery mechanisms and supervision also benefited from economies of scale in the Gambia.

Study findings and discussion

The cost analysis results are presented according to the study objectives.

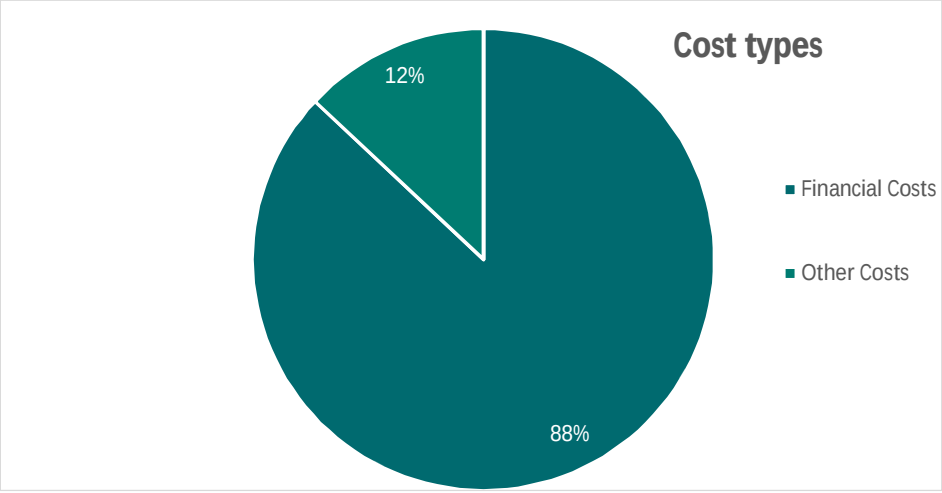
Objective 1: Financial and economic costs required for design, start-up and actual SMC delivery

As shown in figure 2, 88 percent of the total identified costs in 2014 cycle were financial costs while 12 percent were other costs constituting mainly of opportunity costs at state, LGA, health facility and

[11] Bojang KA, Akor F, Conteh L, Webb E, Bittaye O, Conway DJ, Jasseh M, Wiseman V, Milligan PJ, Greenwood B. Two strategies for the delivery of IPTc in an area of seasonal malaria transmission in The Gambia: a randomised controlled trial. PLoS Med 2011;8:e1000409

community levels. This is in keeping with the fact that the SMC project is a relatively new intervention in Nigeria and most activities are donor driven.

Figure 2: Relative distribution of cost types



Costs for project phases

The study also sought to determine financial and economic costs for the various phases of the SMC project. The study categorised activities and related costs into three major project phases - design, start-up and service delivery. The study adopted two classification criteria to be able to categorise activities and costs into specific phases: a) the study reviewed the chronological relationships of events/activities and sorted them in order of occurrence; and b) in consultation with MC, determined which activities fit into which category by either time of occurrence or a fit into chronological bands.

Using the 2014 round as an example of a fully mature programme and assuming that design and start-up costs are fixed costs, table 4 below presents a summary of all financial and economic costs that were required for design, start-up and service delivery in the 2014 programme round.

Table 4: Cost of SMC disaggregated by project phase and cost type

Phase	Cost type		Total ($)
	Financial ($)	Economic ($)	
Design[12]	120,287.96	-	120,287.96
Start-Up[12]	308,096.39	-	308,096.39
Service Delivery[12]	906,768.53	183,299.94	1,090,068.47
Totals	1,335,152.88	183,299.94	1,518,452.82

As shown in the table above, the service delivery phase takes up the highest cost share, 71.8 percent and is the only phase where other project costs were incurred. Other costs in the service delivery phase made up about 17 percent of the total cost incurred at that phase.

Objective 2a: Cost drivers for SMC implementation

The cost analysis sought to determine cost drivers for the SMC project. The utilised cost categories included a mix of standard cost heads and other cost categories reflecting the peculiarities of the SMC implementation in Nigeria. The cost categories are as defined in table 2 above. For the purposes of describing these cost drivers for a fully mature programme, the 2014 round of activities were considered for determining service delivery components of the SMC project while the fixed costs for design and start-up phases were included for completeness. Table 5 below depicts the cost drivers of the SMC project and their relative proportions.

Table 5: Percentage contribution of cost categories to the total economic cost

Cost Category	% cost in 2013	% cost in 2014
	Total number of children covered = 487,354	Total number of children covered = 1,112,330
Communication	0.46%	1.0%
Supervision	0.5%	2.4%

[12] See table 3 above for definitions

Distribution costs	0.2%	0.5%
Meetings	0.5%	0.7%
International Travel	1.1%	0.6%
Overheads	2.0%	3.4%
Procurement	31.3%	41.2%
Opportunity Cost	3.5%	7.0%
Domestic Travel	8.8%	5.8%
TA	10.8%	7.5%
Training	14.1%	11.4%
HR	26.6%	18.7%
Total	**100%**	**100%**

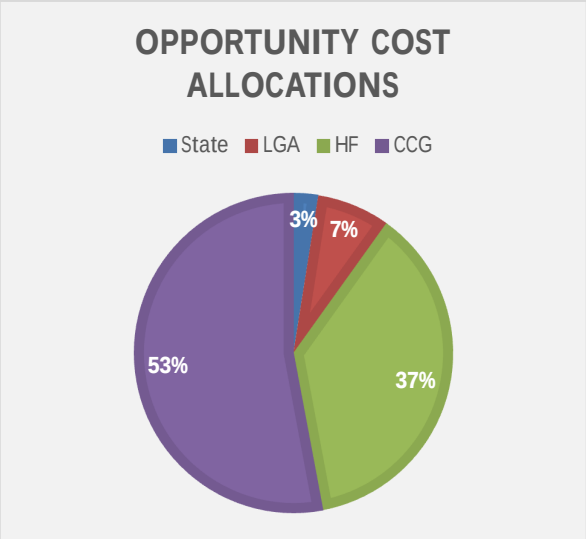
Procurement costs: From the analysis, the cost of procuring drugs, test kits and other related commodities contributed the highest cost proportion of 41.2 percent in 2014 and 31.3 percent of costs in 2013. Drugs procured for MDA include SP/AQ, ACTs and RDTs.

Human resource costs contributed 18.7 percent of costs in 2014 (of which 37 percent were attributed to direct MC staff while 63 percent were attributed to ad-hoc staff used for MDAs and other related activities).

Technical assistance (TA) costs refer to costs of human resources providing support to the MC programme in form of local and international consultants. TA costs contributed 7.5 percent of costs for the SMC project in 2014 as against 10.8 percent in 2013 representing a possible benefit from economies of scale. Of the 2014 costs, 55 percent were for local consultants and 45 percent represented costs for international consultants who were mainly used for the design phase of the project. Payment of professional fees contributed about 92.7 percent of all TA costs. Other costs associated with TA include travels and overhead costs.

Training costs: Training was identified as another significant cost driver in the SMC project. Training costs contributed to 14.1 percent and 11.4 percent of total costs in 2013 and 2014 respectively. This slight reduction also potentially represents a cost type that could benefit from economies of scale.

Figure 3: Opportunity cost allocations



Opportunity costs: These are costs determined from the involvement of field and government personnel in the SMC project. Opportunity costs spanned the several levels of implementation: state, LGA, health facilities and the community (CCG) levels. This cost category contributed 3.5 percent and 7.0 percent of total economic costs for 2013 and 2014 SMC implementation periods respectively. This increase is related to the larger pool of CCGs utilised in the 2014 cycle.

For personnel that received allowances from the MC programme, net opportunity costs were calculated which subtracted the allowance value from the calculated opportunity costs based on the amount of time spent on the MC project. Salary or other earnings were determined for each staff member and validated by payroll documents or estimations for non-formal sector employed personnel. For the community level staff (CCGs) that had a proportion of the sample unemployed, similar proportions were applied to the average calculated net cost and applied to the entire pool of used CCGs during the 2014 round. Figure 3 depicts the relative contribution of opportunity costs from the various levels of participation. 53 percent of opportunity costs determined were contributed by the CCGs; 37 percent by health facility staff; 7 percent by LGA level staff with the state Ministry of Health staff contributing 3 percent.

Cost for operations research and evaluations

Of the total costs of implementing the SMC programme from inception to date, the cost analysis identified that operations research which included formative research, baseline studies, malariometric studies, surveillance studies, case control studies, end-line studies and a costing analysis contributed 18 percent of the total costs ($158,771.36). These are potential costs that could be discounted in future scale-up costs but may be considered when the programme attains its desired scope and scale for impact evaluations to be conducted.

Objective 2b: Costs that benefit from economies of scale

The study attempted to identify costs that could benefit from economies of scale. By definition these cost types are costs that stay fixed or reduce with an increase in size and scale of the SMC project. To review this appropriately, comparison between costs in 2013 and 2014 rounds of MDAS was done. This approach is justified in the fact that the 2014 round was a significant scale-up from the 2013 round in the number of LGAs, the number of rounds and the number of beneficiaries.

The analysis showed that there was a drop in some cost heads in 2014 compared with 2013. These include HR, trainings, TA, domestic travel and international travels. Drop in these cost heads can be explained by the fact that almost the same level of input is required to carry out activities associated with those cost heads. For example, it takes the same number of personnel to travel from the national office to the state to carry out activities at the state level regardless of whether there is an increase in total number of people served. Similarly, with scale-up, costs of TA particularly, the international consultant component decreased in 2014 when compared to 2013. This is explained by the fact that most of the International TA resources were used in the design phase and as the programme matures and is scaled up, this cost component can be discounted.

Project output data

Table 6: Target population versus number of children with SMC administered by LGA in 2013 SMC round (three cycles)

LGA	Number of children targeted	Number of children covered in 2013 round				Average number of children seen during 2013 round by location
		1st cycle	2nd cycle	3rd cycle	4th cycle	
Baure	63,585	51,545	89,208	86,046	N/A	75,600
Mashi	78,238	81,682	88,259	90,613	N/A	86,851
Grand Total	141,823	133,227	177,467	176,659	N/A	162,451
Total number of children that received at least one dose in any SMC cycle[13]			177,467			
Total number received all three doses of SMC in the 2013 round[14]			133,227			

[13] It is assumed that maximum total that received one dose of SMC is equal to the number of children seen.
[14] To address the limitation presented in tracking individual children between cycles, it was assumed that all children presenting in the cycle with the lowest administrative coverage received SMC treatment across all cycles of that years SMC round.

Table 7: Target Population versus number of children with SMC administered by LGA in 2014 SMC round (four cycles)

LGA	Number of children targeted	Number of children covered in 2014 round				Average number of children seen during 2013 round by location
		1st cycle	2nd cycle	3rd cycle	4th cycle	
Baure	63,585	58,094	58,094	89,706	91,196	74,272
Dusti	41,352	35,376	43,897	48,762	45,674	43,428
Mai'adua	57,399	52,895	53,432	53,881	57,399	53,410
Mashi	78,238	100,818	104,847	106,688	111,571	105,981
Grand Total	240,574	247,183	260,270	299,037	305,840	277,091
Total number of children that received at least one dose in any SMC cycle[15]			305,840			
Total number received all four doses of SMC in 2014 round[16]			247,183			

Objective 3: Economic (total) cost per child acceptably covered (2014)

The cost analysis sought to determine the economic cost per child receiving SMC treatment. In 2014, four cycles of SMC were conducted in four LGAs and served as a benchmark for this analysis.

For this cost calculation, the total average number of children seen in each round in 2014 was determined. The total cost of the SMC project in 2014 was also calculated by applying three different cost scenarios.

Scenario A: Total economic cost for SMC delivery including start-up, design and service delivery costs

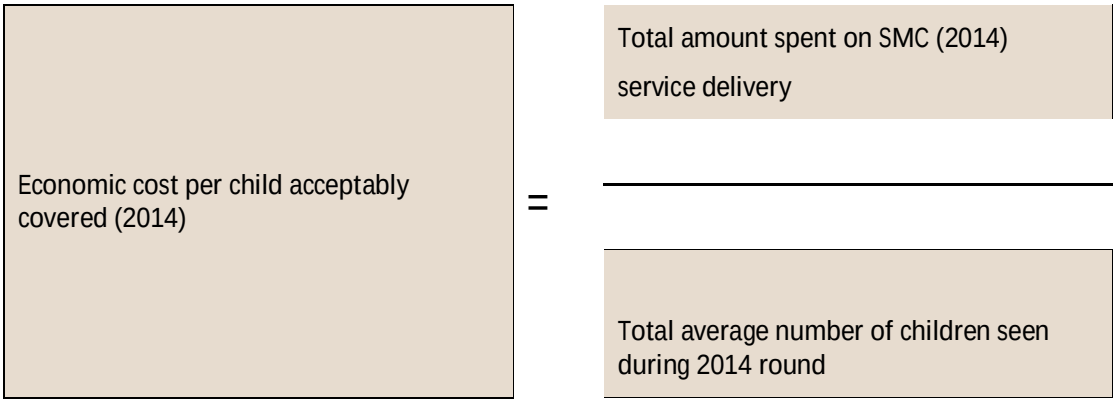
Scenario B: Total economic cost for SMC delivery excluding research related costs

Scenario C: Total economic costs excluding design, start-up and research related costs

[15] See footnotes above
[16] See footnotes above

For each of these cost scenarios, a unit economic cost per child acceptably covered was calculated by dividing each of the economic cost scenarios in 2014 by the number of children that were acceptably covered.

Figure 4: Cost per child acceptably covered in 2014



Derivations from these scenarios are depicted in the table below for 2014.

Table 8: Derivations for different cost scenarios in 2014 SMC round

Scenario	**Total economic cost**	**Economic cost per child (per round of four cycles) acceptably covered (2014)**
Scenario A	$1,518,452.82	$5.46
Scenario B	$1,230,021.11	$4.89
Scenario C	$801,636.76	$3.35

Our literature review shows that similar studies conducted in the region in Ghana[17] and Gambia[18] both discounted research costs and only determined costs of actual service delivery. The two studies also compared different delivery mechanisms against the use of VHWs. This also matched to an extent, the Care Giver group approach utilised in the SMC implementation in Nigeria.

[17] Conteh L, Patouillard E, Kweku M, Legood R, Greenwood B, et al. (2010) Cost Effectiveness of Seasonal Intermittent Preventive Treatment Using Amodiaquine & Artesunate or Sulphadoxine-Pyrimethamine in Ghanaian Children. PLoS ONE 5(8): e12223. doi:10.1371/journal.pone.0012223

[18] Khalifa A, Bojang et al, PLOS Medicine: Two strategies for the Delivery of IPTc in an area of seasonal Malaria Transmission in the Gambia: A Randomised Controlled Trial; February 1, 2011 DOL:10.13071/journal.pmed.1000409

Regarding costs, both study assumptions compared significantly with the assumptions in cost scenario C. For this scenario, the economic cost per child acceptably covered is determined at $3.35. This is comparable with the cost estimates from Ghana which had $3.38 as cost for a child acceptably covered and $3.47 from the study in the Gambia.

Objective 4: To determine the economic cost per child that received all three doses during the three cycles of 2013 round and four cycles of 2014 transmission season

The operational definition here is that a child is deemed "fully" covered if they received all of the three courses in a three-cycle MDA round (2013) and all four courses in a four-cycle MDA round (2014).

Using the cost scenario C described above, the total cost per child that received SMC treatments during all three cycles (fully covered) in 2013 and those that received SMC treatments during all four cycles in 2014 were calculated by dividing the total cost of the project in 2013 and 2014 (discounting design, start-up and research related costs) by the number of children that were "fully" covered.

Figure 5: Cost per child fully covered

$$\text{Economic cost per child fully covered} = \frac{\text{Total amount spent on SMC service delivery}}{\text{Total number of children that received SMC treatments during all cycles in that year}^{19}}$$

Economic (total) cost per child fully covered in 2013

The total cost per child fully covered (i.e. that received all three courses during the 2013 SMC MDA cycle) was found to be $3.98 per child. This was calculated by dividing the total service delivery costs for SMC in 2013 by the total number of children who received the complete three cycles of SMC drugs in 2013[19]. This cost is lower than the costs obtained from the study conducted in Ghana by Conte *et al.* 2009[20] which recorded a cost per child fully covered as $4.58.

[19] To address the limitation presented in tracking individual children between cycles, it was assumed that all children presenting in the cycle with the lowest administrative coverage received SMC treatment across all cycles of that years SMC round.

[20] Conteh L, Patouillard E, Kweku M, Legood R, Greenwood B, et al. (2010) Cost Effectiveness of Seasonal Intermittent Preventive Treatment Using Amodiaquine & Artesunate or Sulphadoxine-Pyrimethamine in Ghanaian Children. PLoS ONE 5(8): e12223. doi:10.1371/journal.pone.0012223

Economic (total) cost per child fully covered in 2014

The total cost per child fully covered (i.e. that received all four cycles during 2014 MDA round) was found to be $3.77 per child. This was calculated by dividing the total costs for SMC in 2014 by the total number of children who received the complete four courses of SMC drugs in 2014.

A true assessment of any potential reduction in costs as the programme is scaled up is difficult because of the variation in implementation scope for the two years with only three cycles in 2013 and four cycles in 2014. Inferences can be drawn based purely on deductions from other studies like the study in Gambia by Khalifa, Bojang et al (2011) which infers that "their study has shown the influence of scale on delivery of IPTc. A smaller study of IPTc delivery by Conteh et al (2010) gave unit costs of village-based delivery more than three times higher than those presented here, even after taking into account differences in costs of IPTc drugs and of treating cases of malaria".

However, it is recommended that this comparison can be done between the planned 2015 MDA round with four cycles and a larger coverage and the 2014 cycle. True costs that benefit from scale might be more visible from such a comparison.

Study limitations

The cost analysis had a few limitations it had to contend with. Primarily, issues with record keeping and inconsistent cost descriptions in the financial database were a big challenge. Future cost analysis will benefit from a standardised approach for cost descriptions for ease of categorisation and subsequent analysis.

Comparing data over two years with differences in scope and relative overlap of start-up phase activities and the 2013 MDA cycle was a challenge. It is recommended that a full four-cycle round be compared with the 2014 cycle for an assessment of cost differences attributable to an increase in the scale of the SMC project.

The monitoring and evaluation system did not have a system of tracking children to determine number of SMC exposure they have had. While record cards are made available during the MDAs, an aggregated analysis of these cards per cycle is not routinely conducted. Data on fully covered and acceptably covered children will need to be analysed after each cycle.

While sample sizes where calculated on the assumption that a fixed incentive package existed for all CCGs and as such variability would be minimal in terms of financial costs to the programme, the study noted significant variability for opportunity costs for CCGs based on their varied backgrounds irrespective of the volunteer status they have. However, discounting opportunity cost from total service delivery costs did not show many differences in unit costs per fully covered child across both 2013 and 2014 cycles.

Recommendations and conclusion

This being a cost analysis, recommendations will be tailored to costs, cost reduction opportunities, sustainability and opportunities for economies of scale. The study did not have the opportunity to assess implementation modalities and as such cannot comment on them.

- With training and other related domestic travel costs accounting for over 14 percent of all costs for service delivery, the programme will do well to explore opportunities for cost reduction by running state level programmes with project staff domiciled in the state where the project is being implemented. This will reduce cost associated with domestic travel, hotel accommodation and per diems.
- Nurturing and sustaining a pool of trained volunteers will also reduce the cost associated with trainings before every MDA round. While training is important for the quality of the work, the scope can better be managed with an experienced pool of SMC volunteers.
- With drugs and test kit procurements accounting for over 50 percent of service delivery costs, there is a huge potential to maximise economies of scale. The programme could explore the options of pooling procurements with other neighbouring Sahel countries where negotiated reductions in price can be achieved.
- The programme will benefit from an improvement in the record keeping system both for financial and programmatic data. A robust M&E plan that institutionalises regular analyses of collected data will be useful. This should be encouraged at all levels at which SMC data is collected and fed into the central database. This is key if cost-effectiveness of the programme will need to be determined in the future.
- As likewise noted in the two reference studies in the region, sustainability of the intervention is a major concern. Reliance on paid volunteers and the several incentives paid to other personnel involved in the SMC work has pros and cons for both the cost and quality of services. If the gold standard is to have local authorities take over this initiative and run it devoid of donor funding, the incentive approach might need to be revisited. Integrating SMC with MNCH services (which utilises community structures and outreaches as a delivery mechanism) might potentially be more sustainable as costs can be shared across programmes. This will however be precedent on an increased body of evidence on SMC cost-effectiveness when compared to other malaria prevention interventions.

Appendices

Appendix 1: List of interviewees

CCG/Community Level

S/n	LGA	Name	Designation
1	Baure	Salisu Aminu	CCG
2	Baure	Hadiza Yusuf	CCG
3	Baure	Jamilu Muntari	CCG
4	Baure	Abdulrahaman Rabiu	CCG
5	Mashi	Murtala Ibrahim	CCG
6	Mashi	Sani Ibrahim	CCG
7	Mashi	Samaila Inusa	CCG
8	Mashi	Kabril Yahaya	CCG
9	Dutsi	Halima Musa	CCG
10	Dutsi	Bilkisu Lawal	CCG
11	Dutsi	Aisha Nasir	CCG
12	Dutsi	Raula Bashir	CCG
13	Mai'adua	Mohammed Lawal	CCG
14	Mai'adua	Umma Mai Kyari	CCG
15	Mai'adua	Aisha Yahuza	CCG
16	Mai'adua	Nura Hamisu	CCG

LGA level

S/n	LGA	Interviewee's Name	Interviewees Designation
1	Dutsi	Abdullahi Haruna	M&E
2	Dutsi	Abdullahi Mohammed	Logistician
3	Dutsi	Dalhatu Aliyu	PHC Coordinator
4	Dutsi	Aliyu Danladi	RBM
5	Dutsi	Salisu Yahaya	Health Educator
6	Baure	Hamisu Adamu	Health Educator
7	Baure	Sidi Mohammed	M&E
8	Baure	Lawal Aminu	PHC Coordinator
9	Baure	Hassana Aliyu	Logistician
10	Baure	Hajara Ibrahim	RBM
11	Mai'adua	Nasir Muazu	Director PHC
12	Mai'adua	Sade Yusuf	Logistician
13	Mai'adua	Magaji Alhassan	Health Educator
14	Mai'adua	Lawal Nasiru	M&E

15	Mai'adua	Hamisu Haruna	RBM
16	Mashi	Suleiman Sani	RBM
17	Mashi	Shuaibu Haruna	Asst PHC Coordinator
18	Mashi	Aminu Abdulwahab	M&E
19	Mashi	Abdullahi Aliyu	Logistician
20	Mashi	Yalati Mohammed	Health Educator

SMOH level

S/n	State	Interviewee's name	Interviewees designation
1	Katsina	Danlami Ibrahim	Acting TMM-SuNMaP
2	Katsina	Bala Mani Mohammed	Asst. Director Pharm Services
3	Katsina	Binta Husseini	ACSM Manager
4	Katsina	Dr Bashir Adamu	SMEP Manager
5	Katsina	Dr Sani Suleiman	DPRS Director
6	Katsina	Dr Abduljelil	Director Public Health

Health facility level

S/n	LGA	Facility Name	Name
1	Mashi	MCH Doguru	Abubarkar Yahaya
2	Mashi	MCH Tamilo	Bala Ibrahim
3	Mashi	MCH Doka	Bashir Habibu
4	Mashi	CHC Mashi	Iliyasu Umar Farouk
5	Mashi	MCH Sonkaya	Hambali Ado
6	Mashi	MCH Tsamiyalalu	Dikko Lawal
7	Mashi	MCH Birnin Kuka	Abulhadi Haruna
8	Mashi	MCH	Rabe Lawal
9	Baure	HC Baure	Hasfat Rabe
10	Baure	HC Taramnawa	Salisu Liman
11	Baure		Salisu Haruna
12	Baure	PHC Yanduna	Abubarkar Auwalu
13	Baure	PHC Garki	Ayuba Yusuf
14	Baure	PHC Maibara	Abdullahi Ibrahim
15	Baure	CHC Bananmutum	Rabe Abdulmumini
16	Baure	PHC Yanmalu	Murtala Mamman
17	Baure	HC Muduri	Mamman Ibrahim
18	Dutsi	MCHC Minawa	Nura Sale
19	Dutsi	MCH Sharanka	Usman Yamel

20	Dutsi		Salisi Yahah Yamel
21	Dutsi	MCHC Madawa	Muhd Idris
22	Dutsi		Babangida Nasiru
23	Dutsi	MDG K/Burtu	Iro Wada
24	Dutsi	MCHC Karawa	Kabir mohammed
25	Dutsi	MCHC Yamel	Mamuda Abubakar
26	Dutsi	MCHC Dutsi	Armaya'u Ahmed
27	Dutsi	CHC Dutsi	Lawal Tijjani
28	Dutsi	MPCH Kayawa	Salisu Amadu
30	Mai'adua	CHC Maigari	Talatu Adamu
31	Mai'adua	MCH Yandi	Nasiru sani
32	Mai'adua	MPCH Koza	Rabe Ahmadu
33	Mai'adua	HC Maiadua	Abdurazak idris
34	Mai'adua	HC Danyashe	Yusuf H
35	Mai'adua	MCHC Bumbum	Badamasi Maigari
36	Mai'adua	MCH Kongolam	Salisu Amadu