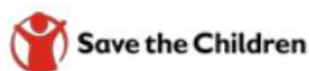**ORIE** Nutrition Research in Northern Nigeria

Cost-effectiveness of the WINNN Programme

Operations Research and Impact Evaluation

Shehzad Ali, Paola Vargas and Sarah Keen

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Oxford Policy Management

Save the Children

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

IDS Institute of Development Studies

UKaid from the British people

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Executive summary

Introduction

Operations Research and Impact Evaluation (ORIE) is led by Oxford Policy Management (OPM) in conjunction with three other UK-based institutions, the London School of Hygiene and Tropical Medicine (LSHTM), the Institute of Development Studies (IDS) and Save the Children UK (SCUK), and four Nigerian partners, the University of Ibadan, Kaduna Polytechnic, Ahmadu Bello University at Zaria (ABU), and the Food Basket Foundation International (FBFI).

ORIE is funded by the Department for International Development of the UK Government and implemented in collaboration with the Government of Nigeria.

This report presents the findings of the ORIE economic evaluation on the cost-effectiveness of the WINNN programme. The aim of this report is to evaluate the cost-effectiveness of the WINNN-supported infant and young child feeding (IYCF) interventions and community-based management of acute malnutrition (CMAM) programme over the WINNN programme duration (2011–2017). The cost-effectiveness of the two interventions is evaluated from both a health services and a societal perspective. The health services perspective evaluates the costs incurred by health service providers in providing the intervention, including in this context costs incurred by WINNN and government. The societal perspective includes in addition costs incurred by health service users (i.e. patients and carers) and other members of society who may be directly or indirectly affected by the intervention (or no intervention).

The audiences for this report are DFID, WINNN, the Nigerian government and civil society stakeholders.

Separate reports provide detailed results of the costing of the WINNN outputs and a Value for Money (VfM) analysis of the overall WINNN programme. These reports complement the cost-effectiveness analysis (CEA) findings in this report and will help provide a more comprehensive view on the VfM question of whether the best possible outcome was obtained with a given budget and with improvements in equity.

The WINNN programme

The WINNN programme is an ambitious £52 million, six-year DFID-funded programme (2011–2017) to improve maternal, newborn and child nutrition in five states in northern Nigeria: Jigawa, Katsina, Kebbi, Yobe and Zamfara. WINNN is implemented by three partners: Save the Children, ACF and UNICEF.

WINNN is designed to deliver three nutrition-specific interventions (micronutrient supplementation, IYCF interventions and a CMAM programme) that evidence has shown are effective and cost-effective, while also supporting effective government coordination and planning for nutrition. The delivery of these interventions through government is expected to build government systems and capacity for implementation, and ultimately to institutionalise them within routine health care systems. This is expected to raise the political profile of undernutrition in Nigeria and to encourage government to support nutrition programmes.

Based on the WINNN logframe, the outputs of the WINNN programme are as follows:

Output 1: Integration of micronutrient intervention into routine primary health services. This output is concerned with the delivery and integration of micronutrient interventions to pregnant women and children under five in routine primary health services.

Output 2: Delivery of effective IYCF interventions in selected states and LGAs in northern Nigeria. This output is concerned with facility and community-based interventions focused on mothers of children under two and pregnant women, to improve IYCF practices through exclusive breastfeeding (EBF), weaning and complementary feeding.

Output 3: Delivery of effective treatment for severe acute malnutrition (SAM) through local health systems in selected states and LGAs in northern Nigeria. This output is concerned with the provision of treatment for SAM via the CMAM programme through integrated primary health services.

Output 4: Strengthening of nutrition coordination and planning mechanisms at national and state level. This output is related to more effective government planning and coordination in nutrition and related sectors at the federal and state levels, as well as building government commitment.

Output 5: ORIE. The fifth output is a consortium independent of the three implementing partners and managed by Oxford Policy Management (OPM). ORIE is responsible for undertaking operations research and assessing the impact and effectiveness of the WINNN programme.

In the interest of simplicity, throughout the report we refer to the second and third WINNN outputs—for which we evaluate cost-effectiveness in this report—as IYCF interventions (Output 2), and the CMAM programme (Output 3).

Cost-effectiveness methodology

CEA involves evaluating the impact of interventions on both costs and outcomes. It answers the question of whether the best possible outcome was obtained with a given budget, which allows decision-makers to compare interventions in terms of VfM. The methodology for the CEA was developed in ORIE's inception phase, in consultation with various stakeholders, including WINNN Implementing Partners (IPs) and DFID, and informed by a focused literature review.

CEA evaluates costs and outcomes in an incremental way, i.e. it evaluates the difference (or increment) in costs and difference in outcomes between a scenario with the intervention under study and a comparator (usually a non-intervention scenario).

For the CMAM intervention, the analysis compares two scenarios. The first is one with WINNN-supported CMAM-related services in focal LGAs (CMAM programme implemented scenario), in which children under five with SAM may have been admitted to CMAM facilities for treatment, received alternative treatment (outpatient or inpatient treatment without therapeutic feeding), or received no treatment/self-treatment. The second scenario (CMAM programme non-implemented scenario) includes children under five with SAM in non-CMAM programme intervention LGAs who may have received alternative treatment, or no treatment/self-treatment.

For the IYCF intervention, the first scenario includes WINNN-supported (facility- or community-based) IYCF-related services in focal LGAs. In this scenario, mothers of children under two may or may not have been exposed to facility- or community-based IYCF counselling. The second scenario includes mothers of children under two in LGAs not supported by WINNN who may or may not have been exposed to IYCF counselling in routine primary healthcare or other non-WINNN programmes. For each scenario pathway, a number of possible child breastfeeding

outcomes can be experienced, such as being exclusively, predominantly or partially breastfed to not being breastfed at all.

The ratio of the difference in costs and difference in outcomes is called the incremental cost-effectiveness ratio (ICER). The ICER represents the additional cost that would be incurred to avert or gain one unit of the outcome measure. The resulting ICER of the WINNN-supported CMAM and IYCF interventions will reveal the optimal alternative (in relation to the comparator), which may be: same cost but more effective than the alternative, less expensive and at least as effective as the alternative, or more expensive while providing additional benefit that is worth the cost. This last scenario is the most common likely outcome of CEA analysis. The ICER is then evaluated against the willingness to pay for gain in one unit of the outcome.

In this report, we calculate ICER ratios for two main outcome measures: disability-adjusted life years (DALYs) and lives saved. These two measures are widely used in economic evaluations of health interventions and are useful for directly comparing VfM in terms of health gain across different interventions. DALYs are primarily a measure of disease burden and combine years of life lost due to premature death and years of life lost due to disability. Lives saved is a measure of the difference between the number of deaths in the comparator scenario minus the number of deaths in the intervention scenario.

The context of the study is five states in northern Nigeria: Jigawa, Katsina, Kebbi, Yobe and Zamfara. The time horizon for the costing covers most of the programme duration (September 2011 to August 2016). The sixth and final year of the programme is not included due to the timing of this report. Various sources of information, including primary data collection and secondary sources, have been used to model the different parameters for the ICER calculation. First, primary results will be presented that are based on data sources and assumptions presented in the methods section. The implementation of the economic evaluation relied on various data sources and assumptions. Primary data was collected by ORIE and secondary sources of information included WINNN programme data and model assumptions based on published literature. Both WINNN IPs and the donor counterpart (i.e. DFID) were consulted in relation to key features of these data collection processes and sources of information.

Findings

Cost-effectiveness of the CMAM programme

From a societal perspective, the cost per child in the CMAM programme implemented scenario was £14.6 while the cost was £1.9 per child in the CMAM programme not implemented scenario. Thus, the cost difference between the two scenarios was £12.6. DALYs per child in the CMAM programme implemented and not implemented scenarios were 30.1 and 29.7 respectively. The proportion of children alive was 81.4% in the CMAM programme implemented scenario compared to 80.3% in the CMAM programme not implemented scenario. Hence, **the ICER for cost per DALY averted was £30.8 ($48.0) and for cost per life saved was £1,138 ($1,778).**

From a health services perspective, the cost per child in the CMAM programme implemented scenario was £12.9 while the cost was £1.5 per child in the CMAM programme not implemented scenario. The difference in costs was thus £11.4. This difference is slightly smaller than the cost difference in the societal perspective given that the health services perspective excludes the costs incurred by community volunteers (CVs) and caregivers. Hence, **the ICER for cost per DALY averted was £27.8 ($43.4) and for cost per life saved was £1,028 ($1,606).**

A sensitivity analysis done on the probability of accessing the WINNN-supported CMAM programme, using estimates from Simplified Lot Quality Assurance Sampling (LQAS) Evaluation of Access and Coverage (SLEAC) coverage surveys, showed improved cost-effectiveness results, although the difference was not substantial: from a societal perspective we calculated a cost per DALY averted of £28.1 ($44.0) and cost per life saved of £1,039 ($1,622), while the figures were £25.2 ($39.4) and £934 ($1,458) respectively from a health services perspective. The difference in cost per DALY is around £3 ($4) cheaper than with the ORIE endline estimates while cost per life saved is around £95 ($150) cheaper. **Thus, the ORIE survey estimates provide more conservative estimates of cost-effectiveness of the CMAM programme compared to using SLEAC estimates.**

Cost-effectiveness of the IYCF interventions

The CEA for the IYCF intervention uses a difference-in-difference (DID) methodology in which the differences in costs and outcomes between the WINNN and non-WINNN intervention scenarios are assessed between baseline (2013) and endline (2016). **The ICER is then calculated as a ratio of the DID estimates of costs and mortality outcomes.**

When using the societal perspective, the cost per mother (i.e. cost per mother reached times the probability of exposure to the IYCF interventions) at baseline was £2.90 and £2.22 for WINNN and non-WINNN intervention areas respectively. Hence, the difference in costs at baseline was £0.69 per mother. At endline, the cost per mother was £8.54 and £4.19 for WINNN and non-WINNN areas respectively. Thus, the difference in costs at endline was £4.35 per mother. As a result, **the DID cost estimate from a societal perspective was £3.66 per mother. When using a health services perspective, the DID cost estimate was £3.15 per mother.**

The predicted mortality at baseline using breastfeeding rates in the Lives Saved Tool (LiST) was the same for both WINNN and non-WINNN LGAs at 116.61 per 1,000 live births. At endline, the predicted mortality was 108.64 in WINNN areas and 113.83 in non-WINNN areas. Thus, **the difference-difference estimate of mortality per 1,000 live births was 5.19 (or 0.00519 deaths averted per live birth) between non-WINNN and WINNN LGAs.**

The ICER for cost per life saved is then calculated as a ratio of the DID cost per mother estimate and the DID mortality outcome. **From a societal perspective, the incremental cost per death averted is £706 ($1,102) and £607 ($947.9) from a health services perspective. As in the case of the CMAM programme, the ICER in the health services perspective is slightly lower due to the exclusion of costs borne by CVs.**

The LiST does not allow calculation of DALYs averted for the IYCF interventions. Thus, we assume 37 DALYs lost per premature death (as in case of the CMAM programme) to convert per life saved to per DALY averted. **We estimate that the incremental cost per DALY averted for the WINNN IYCF interventions is £19.1 ($29.8) from a societal perspective and £16.4 ($25.6) from a health services perspective.** The DALY estimate is based on the assumption that long-term mortality and disability in children who were alive in the IYCF interventions model is similar to those who were alive in the CMAM model after recovering from an episode of malnutrition. This is a conservative estimate (i.e. DALYs experienced by children who were alive in the IYCF interventions model may be under-estimated) given that we expect the SAM condition to have a higher disability weight compared to other conditions affected by suboptimal breastfeeding.

Conclusions

The cost-effectiveness results of the CMAM programme for the WINNN programme compare well with estimates in recent studies of CMAM programmes in northern Nigeria and elsewhere. Using a health services perspective, Wilford *et al*. (2012) estimated an ICER of US$42 per DALY averted and US$1,365 per life saved in Malawi. Similarly, Bachmann (2009) estimated an ICER of US$53 per DALY averted and US$1,760 per life saved in Zambia. From a societal perspective, Puett *et al*. (2013) estimated an ICER of US$29 per DALY averted and US$1,344 per life saved in southern Bangladesh. The lower estimates from southern Bangladesh are so because the model was assumed to be implemented by community workers, meaning that outpatient staff and overhead costs were not included. Finally, Frankel *et al*. (2015) estimated an ICER of US$30 per DALY averted and $1,117 per life saved in a recent study in northern Nigeria. The lower estimates in that case are likely explained by the different methodology used to estimate costs, which produced a lower cost per child treated, and different assumptions around programme coverage and mortality outcomes.

The ICER per DALY averted of £30.8 ($48.0) from a societal perspective and £27.8 ($43.4) from a health services perspective suggest that the WINNN-supported CMAM intervention was 'very cost-effective' using the World Health Organization's (WHO) CHOICE model threshold for cost-effectiveness. The WHO-CHOICE model suggests that if the ICER per DALY averted is below the value of gross domestic product (GDP) *per capita* then the intervention is 'very cost-effective'. The GDP *per capita* of Nigeria in 2015 was $2,617 according to the World Bank (World Bank, 2017); hence, the ICER per DALY averted is 'very cost-effective' in all analyses.

The WINNN-supported CMAM programme is also considered to be cost-effective using other recent cost-effectiveness thresholds in the literature. A recent development in the literature is the cost-effectiveness threshold based on opportunity cost. This country-level threshold was proposed by Woods *et al*. (2016) – the authors combined the GDP *per capita* and the value of a statistical life to propose a threshold to reflect the health opportunity cost. Based on this study, the threshold range for Nigeria is $239 to $1,545. Hence, an intervention that costs more than the higher estimate of $1,545 per DALY averted is considered not cost-effective.

There is a lack of existing ICER estimates in the global literature for similar IYCF interventions, limiting the comparison of the cost-effectiveness of the WINNN-supported IYCF interventions. The studies found in the focused literature review of IYCF interventions calculate cost per beneficiary measures but none of them evaluated long-term outcomes, either in terms of reduced mortality or morbidity.

Using the approximation of 37 DALYs to convert per life saved to per DALY averted for the WINNN IYCF interventions, the **ICER estimates calculated of £19.1 ($29.8) from a societal perspective and £16.4 ($25.6) from a health services perspective suggest that the WINNN-supported IYCF interventions were also 'very cost-effective' using the WHO-CHOICE model threshold**.

Both ICER measures, i.e. the cost per life saved and the cost per DALY averted, are lower for the IYCF interventions than the CMAM programme. This is to be expected, as preventative services such as the IYCF interventions usually represent better VfM and can help to reduce the need for a more expensive treatment. However, the CMAM programme remains very cost-effective and addresses a large disease burden, which brings significant health and economic benefits.

The CMAM and IYCF interventions have much lower cost per DALY averted compared to many other interventions that are competing for the health care budget. For example, the

cost per DALY averted is $117 for family planning programmes, $922 for antiviral therapy (DFID, 2011)and $94 for an integrated prevention campaign focused on diarrhoea, malaria and HIV (Marseille *et al.*, 2014).

Key lessons and recommendations

The principle objective of this CEA was to assess the return on investment of the WINNN interventions, not to develop detailed operational recommendations. ORIE has produced a separate document, the Integrated Evaluation Report of the WINNN programme, which draws on evidence from across ORIE workstreams to fully draw out lessons learned and recommendations targeted toward specific stakeholder groups such as the Nigerian government, donors and programme implementers. The Integrated Report also draws on evidence from across ORIE workstreams to report on WINNN's logframe indicators.

However, a number of important lessons and recommendations do nevertheless emerge from the CEA and are outlined below. In addition to DFID, the WINNN programme and the Government of Nigeria, these will hopefully prove useful to any professionals involved in the design of nutrition-specific and nutrition-sensitive programmes in Nigeria.

Lessons

1) The economic analysis of the WINNN programme has demonstrated that nutrition-specific interventions in Northern Nigeria can be cost-effective.

2) While both interventions were found to be cost-effective, we learnt that high-level programme delivery costs, including those incurred by the WINNN programme, make up a significant proportion of the total programme cost (see ORIE Costing report (2017) for detailed analysis of the programme costs). Funding bodies should work with local governments to assess ways of reducing these costs while building local capacity and transferring programme ownership to state governments to scale up these interventions to the population level.

3) This study has important lessons for future CEAs. ORIE engaged the implementers early in the programme, which allowed for the development of survey tools that were tailored to the evaluation to provide robust data (see Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017 on the effectiveness data). This also allowed investigators to pilot test and improve the data collection methods for within-programme and follow-up data. As a result, compared to other economic studies of nutrition-specific interventions, this evaluation had to make fewer assumptions for the CEA.

4) However, the cost-effectiveness estimates were constrained by the lack of data on health outcomes and particularly long-term ones such as children mortality. This should be planned for in future studies. This study also identified gaps in data in non-intervention areas, such as the type and quantity of care received by children and their outcomes of care – this was overcome by making informed conservative assumptions based on the literature.

5) Cost-effectiveness estimates were also constrained by the lack of long-term data on costs, which should equally be planned for in future studies. Data issues were also encountered in relation to programme-specific costs at state government level, with

data both challenging to obtain and having significant variations in estimates and quality. These issues can be overcome through structured and coordinated efforts between funding bodies and state governments to develop and/or improve programme-specific budgetary reporting mechanisms.

6) Our study found that the cost-effectiveness estimates of nutrition-specific interventions varied based on the perspective of decision-making, and therefore it is important for future studies to plan data collection and present results from both the societal as well as health services perspective.

Recommendations

1) The cost-effectiveness evidence in this study found that both the CMAM programme and the IYCF interventions are cost-effective interventions for improving child health in northern Nigeria. This evidence is consistent with other studies conducted in Nigeria and other countries globally. This provides a basis to recommend that both programmes be considered by policy-makers and funding institutions as interventions that offer VfM in terms of improving child health outcomes.

2) The coverage or exposure rate of the CMAM programme and the IYCF interventions is one of the determinants of cost-effectiveness. While both programmes were found to be cost-effective in this study, the coverage rates of both interventions remain low. The wider literature suggests that higher coverage level is likely to make the interventions even more cost-effective – this is because the fixed costs (such as high-level administrative expenditure) per child tends to reduce with increase in coverage due to economies of scale. Strategies to increase coverage should therefore be pursued by state governments in order to improve the cost-effectiveness of those interventions. Such strategies can include strengthening active case finding through a strong network of CVs, improving the access to IYCF-related services or improving the quality of service delivery.

3) To further improve the cost-effectiveness of the CMAM programme, the programme should also aim to reduce default rates among enrolees, which will improve survival rates in children. While this may require additional resources, the expected health gains in treatment completers will likely outweigh the additional costs.

4) For the scale up of the CMAM programme and the IYCF interventions, resource implications must be considered carefully. This applies to both the resources required at higher-level as well as costs incurred at the level of health facilities and in the community. For instance, WINNN programme costs make up a large proportion of the cost of CMAM and IYCF interventions (i.e. 1/3rd of the total costs in case of the CMAM programme and at least 4/5th in case of the IYCF interventions). Therefore, the state governments should evaluate the budgetary capacity for scaling-up of these programmes.

5) Given the challenges surrounding high-quality data in northern Nigeria, it is important to develop, at least at LGA level, a population-level monitoring and surveillance system on the nutritional status of children, their access to services, short-term treatment outcomes (such as rate of recovery after care and rate of recurrent episodes of malnutrition) and long-term outcomes (including mortality and disability rates), so future evaluations can benefit from robust data.

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List of abbreviations

ACF	Action Against Hunger
ANC	Antenatal Care
CEA	Cost-Effectiveness Analysis
c-IYCF	Community-based IYCF
CMAM	Community-based Management of Acute Malnutrition
CTC	Community-based Therapeutic Care
CV	Community Volunteer
DALY	Disability-Affected Life Years
DFID	Department for International Development
DID	Difference-in-Difference
FANTA	Food and Nutrition Technical Assistance
f-IYCF	Facility-based IYCF
GDP	Gross Domestic Product
HFS	Health Facility Survey
ICER	Incremental Cost-Effectiveness Ratio
IMF	International Monetary Fund
IPs	Implementing Partners
IYCF	Infant and Young Child Feeding
LGA	Local Government Area
LiST	Lives Saved Tool
LNO	Local Nutrition Officer
Logframe	Logical Framework
LTA	Local Technical Assistant
LQAS	Lot Quality Insurance Sampling
MNCHW	Maternal, Newborn and Child Health Week
MUAC	Mid-Upper Arm Circumference
OPM	Oxford Policy Management
ORIE	Operations Research and Impact Evaluation

OTP   Outpatient Therapeutic Programme

PHC   Primary Health Care

PNC   Post-Natal Care

RUTF   Ready-to-Use Therapeutic Food

SAM   Severe Acute Malnutrition

SC   Stabilisation Care

SLEAC   Simplified LQAS Evaluation of Access and Coverage

SNO   State Nutrition Officer

UNICEF   UN Children's Fund

VfM   Value for Money

WHO   World Health Organization

WINNN   Working to Improve Nutrition in Northern Nigeria

1 Introduction

This report presents the findings of the ORIE economic evaluation of the cost-effectiveness of the WINNN programme.

1.1 What is the WINNN programme?

The WINNN programme is an ambitious £52 million, six-year, DFID-funded programme (2011–2017) to improve maternal, newborn and child nutrition in five states in Northern Nigeria: Jigawa, Katsina, Kebbi, Yobe and Zamfara. WINNN is implemented by three partners: Save the Children, ACF and UNICEF.

WINNN is designed to deliver three nutrition-specific interventions (micronutrient supplementation, IYCF interventions and a CMAM programme) that evidence has shown are effective and cost-effective, while also supporting effective government coordination and planning for nutrition. The delivery of these interventions through government is expected to build government systems and capacity for implementation, and ultimately to institutionalise them within routine health care systems. This is expected to raise the political profile of undernutrition in Nigeria and to encourage government to support nutrition programmes.

Based on the WINNN logframe, the outputs of the WINNN programme are as follows:

Output 1: Integration of micronutrient intervention into routine primary health services. This output is concerned with the delivery and integration of micronutrient interventions to pregnant women and children under five in routine primary health services.

Output 2: Delivery of effective IYCF interventions in selected states and LGAs in northern Nigeria. This output is concerned with facility and community-based interventions focused on mothers of children under two and pregnant women, to improve IYCF practices through EBF, weaning and complementary feeding.

Output 3: Delivery of effective treatment for SAM through local health systems in selected states and LGAs in northern Nigeria. This output is concerned with the provision of treatment for SAM via the CMAM programme through integrated primary health services.

Output 4: Strengthening of nutrition coordination and planning mechanisms at national and state level. This output is related to more effective government planning and coordination in nutrition and related sectors at the federal and state levels, as well as building government commitment.

Output 5: The fifth output, ORIE, is a consortium independent of the three IPs and managed by OPM. ORIE is responsible for undertaking operations research and assessing the impact and effectiveness of the WINNN programme.

In the interest of simplicity, throughout the report we refer to the second and third WINNN outputs—for which we evaluate cost-effectiveness in this report—as IYCF interventions (Output 2), and the CMAM programme (Output 3). More detail on the ORIE project is presented in Section 1.2.

Note that the IYCF interventions consist of two component parts: one at the facility level- the f-IYCF component and one at the community level-the c-IYCF component. Similarly, the CMAM programme also consists of two component parts: the treatment received at OTP facilities and treatment received at SC facilities. Throughout this report, the narrative refers to both the interventions as a whole or to its component parts as appropriate.

1.2   What is ORIE?

The acronym 'ORIE' stands for Operations Research and Impact Evaluation. ORIE is responsible for undertaking operations research and assessing the impact of the WINNN programme. It is managed by OPM and consists of two other UK-based institutions – the London School of Hygiene and Tropical Medicine and the Institute of Development Studies – in conjunction with four Nigerian partners: the University of Ibadan, Kaduna Polytechnic, Ahmadu Bello University at Zaria, and Food Basket Foundation International.

The ORIE project is composed of five workstreams as follows:

1. Operations research;

2. Impact evaluation;

3. Economic evaluation;

4. Evidence dissemination and uptake; and

5. Supporting national researchers in nutrition.

The level at which an intervention is focused determines the precise combination of methods used in the assessment of impact of each output of the WINNN programme. The CMAM and IYCF interventions are focused at the level of the LGA while micronutrient supplementation and effective government planning and coordination are focused at the level of the state and federal governments. For interventions implemented at the level of the LGA (i.e. IYCF counselling and the CMAM programme), a quasi-experimental design was used for impact assessment and decision modelling was used for economic evaluation. For other outputs of the WINNN programme, qualitative methods were used.

This report relates to the economic evaluation workstream of the ORIE project, and focuses on the CMAM and IYCF interventions of the WINNN programme. This is because these two interventions have clearly defined and quantifiable outcomes and costs that can be evaluated within an economic evaluation framework.

1.3   What is the aim of the economic evaluation?

The three main objectives of the WINNN cost-effectiveness are:

1. to estimate costs and cost-efficiency measures (cost per beneficiary) of WINNN-supported CMAM and IYCF interventions;

2. to evaluate direct provider-related costs associated to WINNN Output 1 (Integration of micronutrient intervention into routine primary health services) and Output 4 (Strengthening of nutrition coordination and planning mechanisms at national and state level); and

3. to evaluate the cost-effectiveness of the WINNN-supported IYCF and CMAM interventions.

This report responds to the third objective. It brings together costs and outcomes to evaluate the cost-effectiveness of the IYCF interventions and the CMAM programme, i.e. it aims to answer the question of whether the best possible outcome was obtained with a given budget. Separate cost-effectiveness evaluations are conducted for these two interventions to allow decision-makers to separately assess the value of each intervention. **Note that a more overarching analysis of VfM for the WINNN programme (including all its outputs), which also includes coverage of the concept of equity, will be presented as a separate report.**

The present report also includes a summary of the costing results used for this analysis. However, **a more detailed explanation of the costing methods and findings has been delivered as a separate report, which aims to answer objectives 1 and 2 of the economic evaluation workstream.**

As in the costing report, the cost-effectiveness of the CMAM and IYCF interventions is evaluated from a health services and a societal perspective. The health services perspective evaluates the costs incurred by health service providers in providing the intervention, including in this context costs incurred by WINNN and government. The societal perspective includes in addition costs incurred by health service users. (i.e. patients and carers) and other members of society who may be directly or indirectly affected by the intervention (or no intervention).

1.4 Background of the economic evaluation

1.4.1 Stakeholders' involvement

Many stakeholders were involved in the design of each the five ORIE workstreams, including donors, IPs, the Nigerian Federal Ministry of Health and the National Primary Health Care Development Agency.

During ORIE's inception phase, and in order to understand the organisations active in the northern Nigerian nutrition landscape and the pathways between them, a map of the different actors active in this sector and their influence was drawn up by the ORIE team in stakeholder workshops. The workstream designs included the knowledge and main messages emerging from the stakeholder mapping workshop.

Also, as mentioned in the inception report, the designs of all ORIE workstreams were constructed on the basis of ongoing discussion across workstreams, discussions with WINNN IPs, the literature review and the nutrition commitment audit, as well as a review of the literature and evidence specific to each workstream.

The implementation of the economic evaluation relied on various sources of information, from primary data collected by ORIE to secondary sources of information, including WINNN programme data. Both WINNN IPs and DFID were consulted in relation to key features of these data collection processes and sources of information. In addition, throughout the implementation of the economic evaluation there has been a robust process of validation of the main parameters estimated with WINNN programme data, and incorporation of comments received from both WINNN IPs and DFID. Finally, internal and external quality assurance processes were also implemented before this report was finalised to ensure adequacy of methodology and estimations.

1.4.2   Departure from the inception report

The inception report that was produced at the beginning of this evaluation in consultation with various stakeholders constitutes the key document of reference for this analysis (see Annex A for excerpts from Volume I and Volume II of the inception report that relate to the economic evaluation). The inception report was written following consultations with DFID, academics and Nigerian counterparts to ensure that the goals of this evaluation reflected the interests of different stakeholders. There has not been any major departure from the original inception plan. As stated in the inception report (Annex A), the full economic evaluation, which includes a CEA, concentrates primarily on the CMAM and IYCF interventions, which this report has done.

The inception report also outlined the possibility of scoping full costing studies for WINNN outputs 1 and 4. However, this was not implemented in the end due to limitations restricting the ability to scope WINNN contribution on those interventions using a quantitative approach. This is because these interventions are delivered state-wide and nationally (there is no WINNN LGA focus, as there is for the IYCF and CMAM interventions), while they also involve many other IPs and donors, from which expenditure data would have been very difficult to obtain. Thus, it was agreed that this would be outside the scope of the ORIE economic evaluation.

1.5   Scope and structure of this report

The report is organised as follows:

Section 2 will present the overall approach of the economic evaluation as it applies to CEAs of both the WINNN-supported CMAM and IYCF interventions. This will include an introduction to the CEA approach used in the ORIE project, a description of the decision modelling method, an explanation of the rationale for the perspectives taken in the economic evaluation, and a general description of the costs and outcomes included in the analyses.

Section 3 will present the cost-effectiveness of the WINNN-supported CMAM programme. This will include specific descriptions of the decision model used for the analysis, data sources for probabilities, costs and outcomes, and the results of the CEA of this intervention.

Section 4 will present the CEA of the IYCF interventions and will follow the same structure as section 3.

 Section 5 will summarise the main findings, compare our results to other CMAM and IYCF programmes, and include some points for discussion.

Finally, **section 6** provides key lessons deriving from findings as well as some recommendations.

2   Overall approach of the economic evaluation

This section will introduce the overall approach of the economic evaluation, and in particular of the CEA covered in this report. While we have conducted separate CEAs of the CMAM programme and the IYCF interventions, there are several common areas and these are presented in this section. This will be followed by separate sections on the CEAs of the CMAM and IYCF interventions.

2.1   What is CEA?

Economic evaluation can be conducted in the following forms:

1. Cost analysis, which evaluates the cost of delivering an intervention (this is presented in a separate report); and

2. CEA, which brings together both costs and outcomes to allow assessment of the VfM of health care interventions.

In resource-constrained health systems, particularly in developing countries, the allocation of resources between competing interventions requires evidence not only on effectiveness but also on cost-effectiveness. CEA involves evaluating the impact of interventions on both costs and outcomes. This allows decision-makers to compare interventions in terms of VfM to achieve maximum health gains for the population within limited resources.

CEA is the most common method of economic evaluation in the literature (Drummond *et al.*, 2005). This is an incremental analysis, i.e. it evaluates the difference (or increment) in costs and difference in outcomes between the intervention and the comparator (or scenarios A and B) (see Figure 1). The ratio of the difference in costs and difference in outcomes is called the ICER, which represents the additional cost that would be incurred to avert or gain one unit of outcome.

Figure 1:   Overall CEA approach
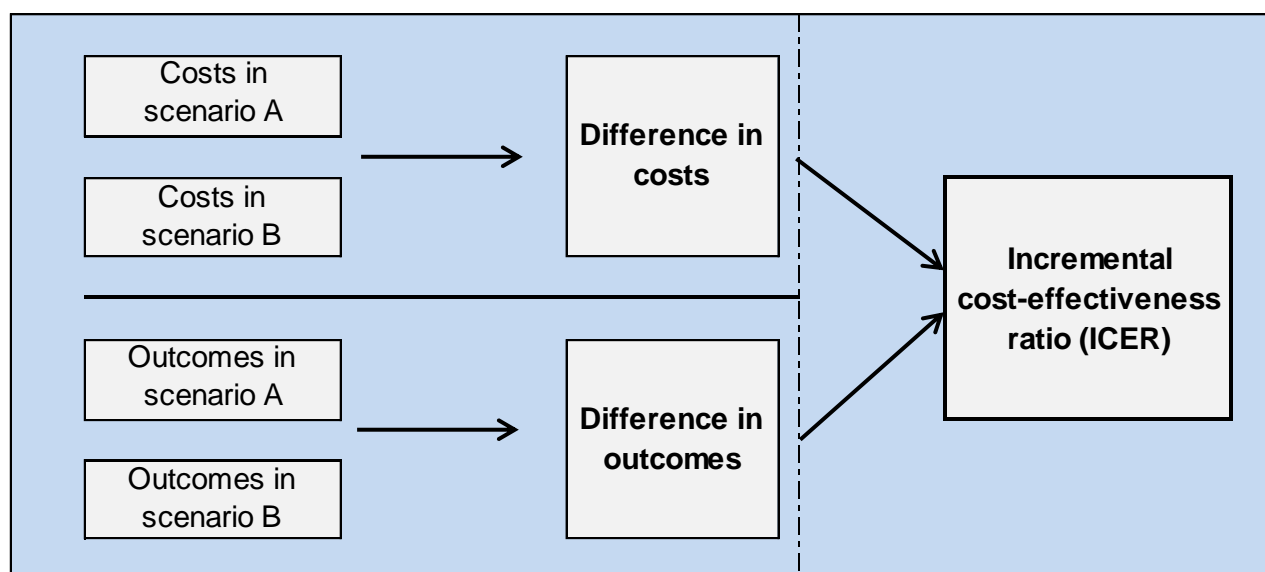
Source: Authors.

The ICER is then evaluated against a cost-effectiveness threshold (discussed later), which represents willingness to pay for an additional unit of outcome. If the ICER is below the threshold then the intervention is considered cost-effective.

The main outputs of the economic evaluation of the CMAM programme are the cost per DALY averted and cost per life saved. The main output of the IYCF interventions evaluation is the cost per life saved due to the IYCF interventions. The DALY outcome is described later in this chapter.

2.2   Use of the decision modelling approach in CEAs

It is common practice in economic evaluations to use decision models to evaluate the cost-effectiveness of interventions (Drummond *et al.*, 2015). Decision modelling is a systematic approach to decision-making under conditions of uncertainty (Briggs *et al.*, 2006). Decision models start by identifying the interventions (or scenarios) being compared. Figure 2 presents a general schematic of a decision tree model. The model starts from the left side of the figure with a choice between scenarios A and B. Conventionally, a choice node is represented by a dark squared box, and to the right of this choice node are the scenarios or treatments being compared.

For each chosen scenario, one of a number of possible pathways will be followed by a child. An example of a pathway is that a child in scenario A may be admitted to an outpatient clinic followed by recovery. These pathways are presented on the right side of a circular node (called chance nodes or probabilistic nodes), which represent the fact that these pathways depend on probabilities. More specifically, if the probabilities of pathways 1, 2 and 3 in scenario A in Figure 2 are 0.25, 0.35 and 0.40 then 25%, 35% and 40% of children will follow pathways 1, 2 and 3 respectively.

Subsequently, each pathway incurs costs during the process and has final outcomes (e.g. DALYs or survival probability), which are added up for all the pathways in both scenarios A and B to give total costs and total outcomes. Finally, the difference in costs and difference in outcomes are compared between scenario A and B to get the ICER (as in Figure 1).

Figure 2: **A schematic presentation of the decision tree modelling approach for CEA**
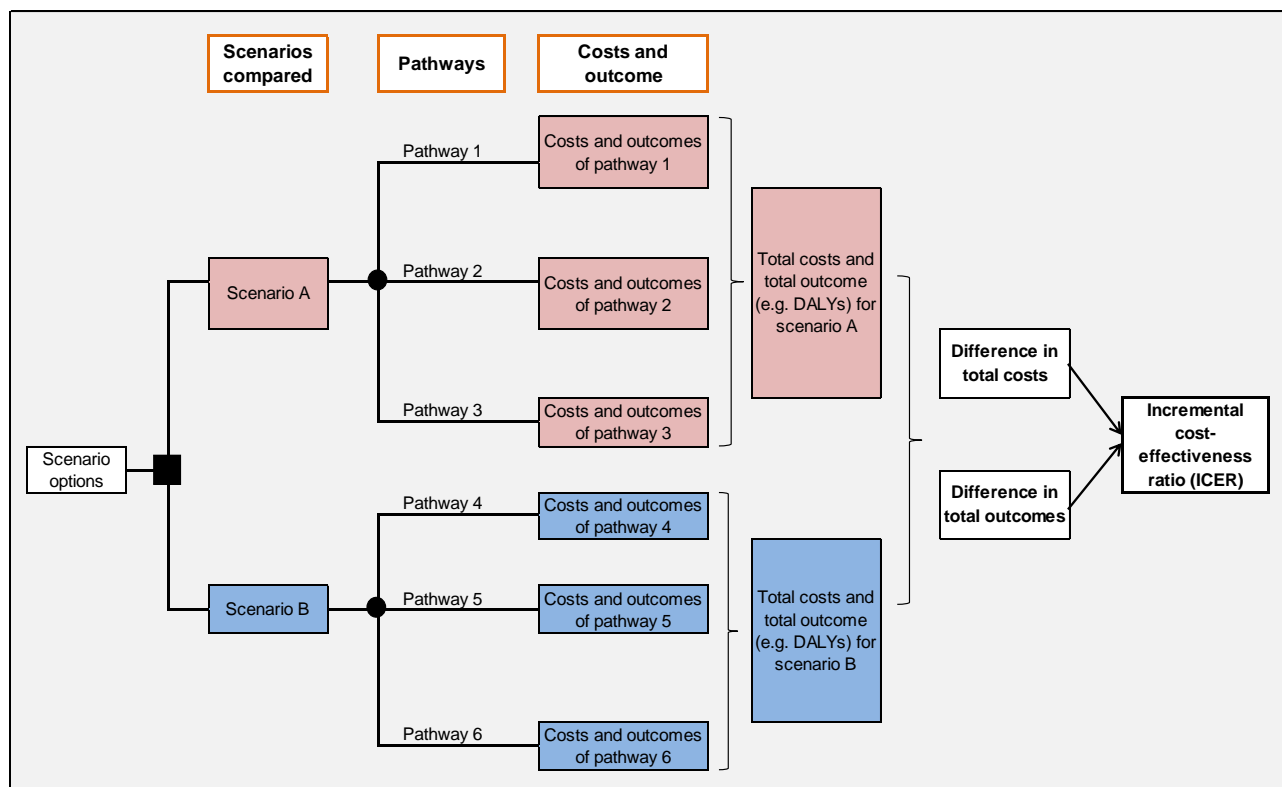
Source: Authors.

For instance, in the case of the CMAM programme economic evaluation, the two scenarios are: (a) CMAM programme implemented; or (b) CMAM programme not implemented. Subsequently, for each scenario, the decision model will evaluate the logical and temporal sequence of events, which are called 'pathways'. For example, in the CMAM programme implemented scenario, a child with SAM may receive treatment at CMAM facilities and subsequently recover from SAM – this illustrates one pathway that a child in treatment at CMAM facilities may follow. The likelihood of these pathways is based on available data (or sensible assumptions), and the consequences are expressed in terms of costs and outcomes (see Figure 2). Next, the costs and outcomes of all pathways in each scenario are added (Figure 2). Finally, difference in costs and difference in outcomes between scenario A and B are calculated and presented as the ICER.

Decision tree models have been used in the published literature on CMAM (Wilford *et al.*, 2011; Bachman *et al.*, 2009) and are a common approach used for economic evaluations. Specific details of the decision model used in the current evaluation are described later in the report.

2.3   Perspective of the CEA

It is important to establish the perspective of the economic evaluation at the outset as this perspective determines which costs are included in the CEA. Two perspectives are commonly used in economic evaluations: a health services perspective and a societal perspective.

The health services perspective evaluates the costs incurred by health service providers (such as LGA and state governments) as well as other organisations that are directly or indirectly involved in providing care (such as WINNN IPs). On the other hand, the societal perspective takes a wider costing approach; in addition to health service costs it also includes costs incurred by service users (i.e. children/carers) and other individuals who may incur further costs (such as CVs). In the case

of developing countries, the perspective taken in an economic evaluation can be crucial. This is because the (direct and indirect) costs incurred by patients and their family members can in some contexts make up a significant part of the total cost.

The argument for taking the societal perspective is that the burden of malnutrition and mortality has direct cost implications for the health system as well as the households, and therefore the aim of an intervention should be to reduce the cost burden on both while maximising health outcomes. The argument for taking a health services perspective is that the WINNN programme will be primarily funded through the health budget, meaning that the aim of the economic evaluation should be to identify interventions that maximise return on health sector investment.

Previously published studies of CMAM have used either a health services perspective or a societal perspective. For instance, Wilford *et al.* (2012) conducted a cost per DALY analysis of the CMAM programme using a health services perspective, meaning no patient-related costs were included in the analysis. Similarly, Bachmann (2009) used the same approach and focused only on the health services perspective. However, Ashworth and Khanum (1997) used a societal perspective to include parent-related costs such as transport costs and wages lost by working parents.

In our study, we will present results based on both the societal perspective and the health services perspective so that decision-makers have more information they can use in order to determine the cost-effectiveness of both the CMAM programme and the IYCF interventions.

2.4   Costs in the CEA

The perspective of the CEA determines the costs that are included in the analysis. The health services perspective includes programme costs incurred by WINNN as well as by state-level and LGA-level governments. In addition, health facility costs are included in the health services perspective, which include capital costs, staff costs and operational costs (see sections 3 and 4 for details). The societal perspective takes a broader approach to costing and includes, in addition to the costs included in the health services perspective, the costs incurred by CVs and caregivers, both in terms of their out-of-pocket expenses as well as the opportunity cost of their time. Sections 3 and 4 (and the separate costing reports on the CMAM programme and the IYCF interventions) provide further details of these cost centres.

Table 1:   **Broad cost centres included in the CEAs**

Perspective	Costs included
Health services perspective	WINNN programme costs State-level programme costs LGA-level programme costs Health facility costs
Societal perspective	All of the above, plus: CV costs (including out-of-pocket and opportunity costs) Caregiver costs (including out-of-pocket and opportunity costs)

The time horizon used in the costing calculations covers most of the programme duration (September 2011 to August 2016). The sixth and final year of the programme is not included due to the timing of this report.

The data used in the costing analysis come from various primary and secondary sources with different currencies and years. Thus, we convert every cost at every year to USD before bringing

all costs together in a single calculation. Cost calculations are done in USD as it is the best practice in the international literature of costing and CEA. However, final calculations in this report have been converted to GBP using an exchange rate USD/GBP of 1.56 (the average USD/GBP exchange rate for the period between Year 1 and Year 5, i.e. September 2011 to August 2016[1]) to facilitate reporting using DFID's official currency. In the main calculations we still present both GBP and USD figures in order to facilitate comparison with cost-effectiveness measures from other studies, which are usually presented in USD.

2.5   Outcomes in the CEA

DALY as outcome measure

DALYs are primarily a measure of disease burden and have been used frequently in economic evaluations. The advantage of using a generic measure like a DALY is that a decision-maker with a broad health sector mandate can compare VfM across several health programmes. DALYs combine years of life lost due to premature death and years of life lost due to disability. DALYs for an intervention group can be represented as:

DALY = Years of life lost due to premature death + Years lost due to disability

The disability weight for SAM is 0.053 (Murray *et al.*, 1996), which has been used in other economic evaluations of the CMAM programme (Wilford *et al.*, 2012; Puett *et al.*, 2013). Based on Frankel *et al.* (2015), the study used the estimate of 37 DALYs per death averted. Hence, the total DALYs gained by the CMAM programme (compared to the non-CMAM programme scenario) is calculated by multiplying the DALYs gained per death averted times the number of deaths averted.

Lives saved as outcome of measure

The number of lives saved is another commonly used outcome measure in economic evaluations of the CMAM programme. As above, this is calculated as the difference is the number of deaths in the no intervention scenario minus the number of deaths in the intervention scenario. This outcome is used in the evaluations of the CMAM programme and IYCF interventions.

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[1] This average of the representative rates for the period September 2011 to August 2016 is taken from the International Monetary Fund (IMF).

3 Cost-effectiveness of the CMAM programme

The aim of this chapter is to present the methods and results of the cost-effectiveness evaluation of the CMAM programme. We start by listing the existing international evidence on the cost-effectiveness of CMAM. These studies will then be used later in the report to compare our methods and findings. Section 3.2 presents the structure of the CMAM programme cost-effectiveness model. Following this, section 3.3 outlines the data sources and assumptions used to estimate the cost-effectiveness model, including the probabilities, costs and outcomes used in the analysis. Section 3.4.1 then presents the results of the CEA. Finally, section 3.4.2 discusses the results and limitations of the study in light of the existing evidence on the cost-effectiveness of CMAM.

3.1 Existing evidence on the cost-effectiveness of CMAM

We identified five peer-reviewed studies reporting full cost-effectiveness analyses and two studies reporting only cost analyses (with or without partial reporting of outcomes) of interventions for severe malnutrition in children. Lessons drawn from these studies have been used to directly inform the methodology proposed in this document. These studies are listed here and summarised in Annex B.

CEAs:

1. Puett, C., Sadler, K., Alderman, H., Coates, J., Fiedler, J.L. and Myatt, M. (2013) 'Cost-effectiveness of the community-based management of severe acute malnutrition by community health workers in southern Bangladesh'. *Health Policy and Planning*, pp. 386-399

2. Tekeste, A., Wondafrash, M., Atene, G. and Deride, K. (2012) 'Cost effectiveness of community-based and in-patient therapeutic feeding programs to treat severe acute malnutrition in Ethiopia'. *Cost Effectiveness and Resource Allocation*, 10(4), pp.1–10.

3. Wilford, R., Golden, K. and Walker, D.G. (2012) 'Cost-effectiveness of community-based management of acute malnutrition in Malawi'. *Health Policy and Planning*, 27(2), pp.127–137.

4. Bachmann, M.O. (2009) 'Cost effectiveness of community-based therapeutic care for children with severe acute malnutrition in Zambia: decision tree model'. *Cost Effectiveness and Resource Allocation*, 7(2).

5. Ashworth, A. and Khanum, S. (1997) 'Cost-effective treatment for severely malnourished children: what is the best approach?' *Health Policy and Planning*, 12(2), pp.115–121.

In addition, we drew on the following CEA of CMAM in northern Nigeria:

Frankel, S., Roland, M. and Makinen, M. (2015) 'Cost-Effectiveness, and Financial Sustainability of Community-based Management of Acute Malnutrition (CMAM) in Northern Nigeria'. *Field Exchange*, 50, pp. 51–53.

Cost analyses:

1. Abdul-Latif, A.M.C. and Nonvignon, J. (2014), 'Economic Cost of Community-Based Management of Severe Acute Malnutrition in a Rural District in Ghana', *Health*, 6, pp. 886-

8992. Purwestri, R.C., Scherbaum, V., Inayati, D.A., Wirawan, N.N., Suryantan, J., Bloem, M.A., Pangaribuan, R.V., Hoffmann, V., Biesalski, H.K., Qaim, M. and Bellows, A.C. (2012) 'Cost analysis of community-based daily and weekly programs for treatment of moderate and mild wasting among children on Nias Island, Indonesia'. *Food and Nutrition Bulletin*, 33(3), pp. 207–216.

A detailed description of these studies is included in Annex B. We will draw on the findings of these studies and compare our results with them in the discussion section of this chapter.

Next we will present the methods and results of the economic evaluation of the CMAM programme in WINNN focal LGAs.

3.2   Structure of the CMAM programme decision model

The decision model compares the cost-effectiveness of the following two scenarios: CMAM programme implemented (scenario 1) and CMAM programme not implemented (scenario 2). Under each scenario, children follow different treatment pathways and there are different outcomes and costs. These are presented in the decision model (Figure 3) and described below.

Figure 3:   Schematic representation of the CMAM programme decision tree model for the CEA
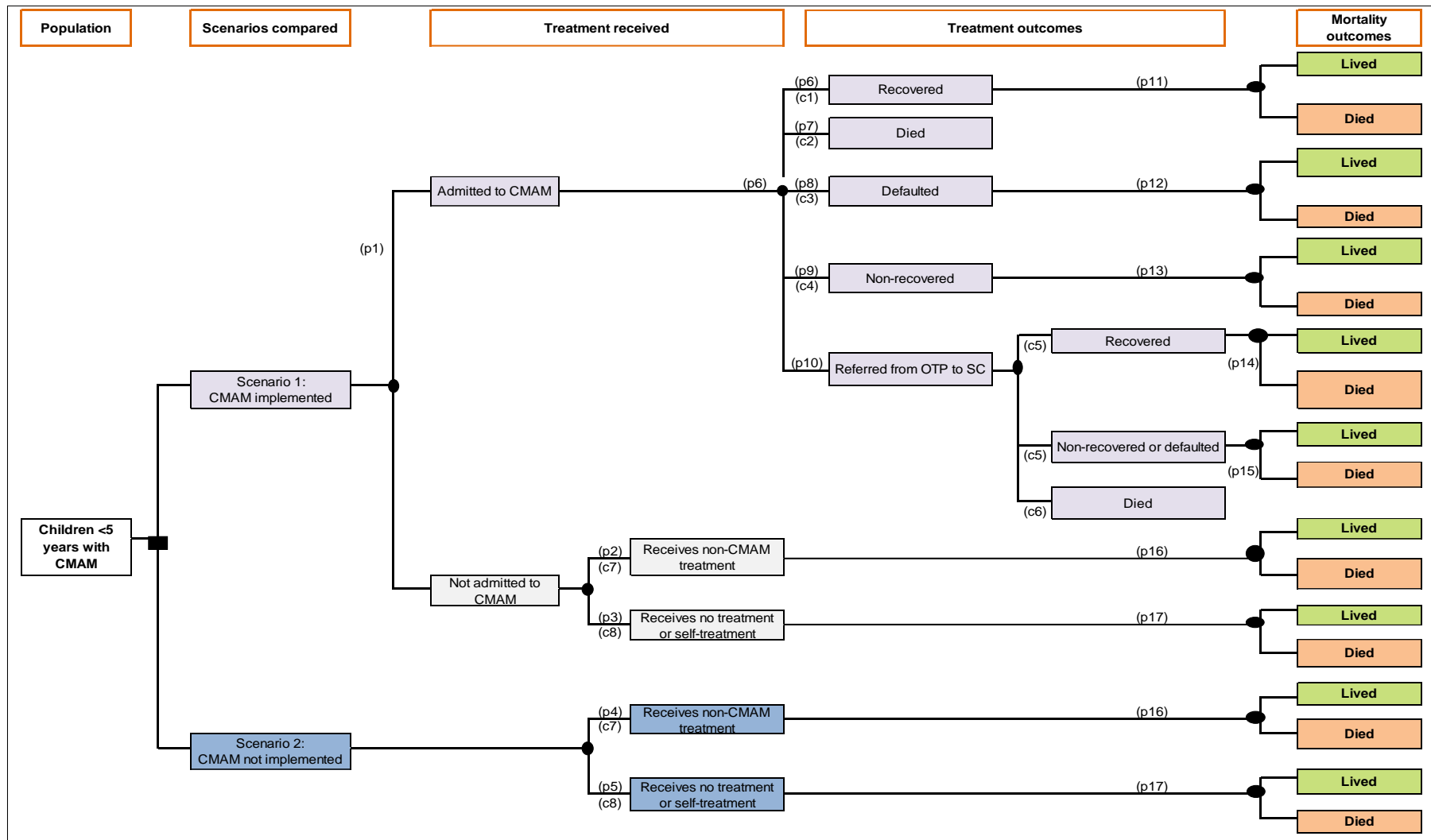
Source: Authors.

Scenario 1: CMAM programme implemented

In this scenario, children follow one of the following pathways:

      a. Admitted to CMAM facility for treatment

      b. Not admitted to CMAM

            i. Receive non-facility for treatment

            ii. Receive no treatment or self-treatment

The above reflects the reality that only a proportion of the children under five with SAM who live in WINNN focal LGAs where the CMAM programme is implemented will actually access the CMAM programme; other children who were not admitted to a CMAM programme facility will either receive non-CMAM programme treatment or no treatment/self-treatment at all. This part of the pathway is determined by the **[probability of treatment access]** (described below in section 3.3.1). Non-CMAM programme treatment includes any treatment for underlying illnesses received at a health centre (excluding therapeutic feeding) or traditional inpatient services (excluding therapeutic feeding).

Children who were admitted to the CMAM programme facility can have one of the following outcomes: (a) recovered; (b) not recovered; (c) defaulted; (d) died in the Outpatient Therapeutic Programme (OTP) facility; (e) referred from OTP facility to stabilisation care (SC) facility. Children who were referred to an SC facility may then recover or die in a SC facility or may not recover (or default from care). This part of the pathway is determined by the **[probability of treatment outcomes]** (described below in section 3.3.1). Finally, children who did not die in the OTP or SC facility (including those who recovered, did not recover or defaulted) still face a risk of death after exiting the CMAM programme (see Figure 3). However, children who recovered in the OTP or SC facility have a much lower risk of death compared to other children. This part of the pathway is determined by the **[probability of mortality outcome]** (described below in section 3.3.1).

Scenario 2: CMAM programme not implemented

In this scenario, children follow one of the following pathways:

      a. Receive non-CMAM programme treatment

      b. Receive no treatment or self-treatment

The above represents that children in the 'CMAM programme not implemented' scenario, i.e. those in LGAs not supported by WINNN or other CMAM programmes, may access non-CMAM programme treatment or receive no treatment/self-treatment. This part of the pathway is determined by the **[probability of treatment access]** (described below in section 3.3.1). As above, children receiving non-CMAM programme treatment or no treatment face a mortality risk in the follow-up period (Figure 3). This part of the pathway is determined by the **[probability of mortality outcome]** (described below in section 3.3.1).

The model is then analysed by assigning probabilities to each pathway in the decision tree.[2] The sources of these probabilities are described in the next section.

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[2] An example of a pathway followed by a child in this model is: child admitted to CMAM programme followed by recovery followed by no mortality.

Next, DALYs (Devleesschauwer *et al.*, 2014) and costs are assigned to each pathway (Bulti *et al.*, 2015; Bachmann, 2009). This is done by assigning costs as they are incurred during patient pathways. For instance, a patient who receives treatment at a CMAM facility and then recovers from SAM will incur costs in the model during treatment. DALYs are assigned at the end of the model depending on the mortality outcome, i.e. a child who received treatment at a CMAM facility and recovered from SAM and stayed alive is assigned to experience 37 DALYs (note that the DALYs methodology is explained in section 3.3.1.4). These costs and DALYs are then aggregated for all pathways within each scenario to calculate total costs and total DALYs for each scenario. Finally, the difference in costs and DALYs between CMAM programme implemented and non-CMAM programme scenarios is calculated to estimate the incremental cost per DALY averted. The same approach is followed for lives saved – in this case, the total probability of being alive is calculated for each scenario, and the difference in probabilities represents the difference in lives saved.

3.3   Data sources for the decision model

This section will present the data sources and assumptions used in the decision model. These data, also called model parameters in this context, include the probabilities of each pathway in the decision model and the associated costs and outcomes. This section will identify the sources and assumptions used to obtain these model parameters. Table 2 summarises the data sources for all model parameters; these are subsequently described in detail.

Table 2:   Data sources for model parameters used in the economic analysis

Model parameters	Data sources
Probabilities used in the decision model	
Probability of use of treatment at CMAM facilities and non-CMAM programme treatment and no treatment/self-treatment	ORIE endline survey [primary analysis] SLEAC survey [sensitivity analysis]
Probability of treatment outcomes among CMAM facility users (including dying during CMAM facility treatment)	WINNN programme service data for the CMAM programme intervention
Probability of mortality in CMAM programme users after exiting from the CMAM programme (presented as mortality outcome in Figure 3)	Follow-up survey of CMAM service users, conducted by Jos University (recovered in the OTP or SC facility) Model assumptions for other treatment outcomes, i.e. not recovered and defaulted
Probability of mortality in children receiving no treatment	Mortality estimated based on the mid-upper arm circumference (MUAC) score of SAM children before they received treatment (explained in section 3.3.1.3)
Probability of mortality in children receiving non-CMAM programme treatment	Assumed to be an average of mortality in the CMAM programme and mortality in children receiving no treatment
Costs used in the decision model	
WINNN programme costs	WINNN programme expenditure data for Year 1 to Year 5, broken down by states, outputs and cost categories
State and LGA-level programme costs	ORIE-conducted interviews with State Nutrition Officers (SNOs), Local Nutrition Officers (LNOs) and WINNN Local Technical Assistants (LTAs) in Jigawa, Katsina, Kebbi and Zamfara
Health facility-level costs	Various data sources were used for the calculations of these costs: Patient registration cards, UNICEF procurement data from WINNN

	and One Health Tool, ORIE-conducted interviews with SNOs, LNOs and LTAs, and the ORIE Health Facility Survey (HFS)
CV costs	HFS, patient registration cards
Caregiver costs	HFS, patient registration cards
Costs of non-CMAM programme treatment	Model assumptions based on Wilford *et al.* (2011) and WHO-CHOICE estimates (explained in section 3.3.2.2)

3.3.1 Probabilities in the decision model

3.3.1.1 Probability of use of CMAM programme and non-CMAM programme treatment

The ORIE endline survey, which was conducted in June 2016, provides the primary source of information by which we estimate some of the main parameters used in this economic evaluation, such as the probabilities of use of CMAM programme and non-CMAM programme treatment. This survey represents a panel of households, using the same households that were surveyed three years previously for the baseline (June 2013). Data were collected in WINNN focal LGAs (treatments) and in LGAs where WINNN has not operated (controls). It covered four states: Jigawa, Katsina, Kebbi and Zamfara. The sampling ensured that estimates are representative of treatment and control LGAs overall – i.e. across the geographical area that these LGAs cover – irrespective of the exact location of WINNN-supported activities within treatment LGAs. Further detail on the sampling methodology and sample size can be found in the ORIE quantitative impact evaluation report ([Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017](#)). The main population of interest for child-level indicators in the quantitative impact evaluation is children aged 0–35 months. Given that the impact evaluation was interested in parameters estimated for children under five, the ORIE endline survey also administered a sub-set of questions on CMAM programme exposure for children who were 0–35 months at baseline (hence, 35–59 months at endline), in addition to the targeted population of children aged 0–35 months at endline. Hence, we include all children 0–59 months in our estimations of CMAM programme parameters coming from the ORIE endline survey.

Under the CMAM programme implemented scenario, the probability of use of the CMAM programme was based on the ORIE endline survey. This probability was calculated in treatment areas as the proportion of children aged 0–59 months whose main caregiver reported that the child was ever taken to a CMAM facility for treatment with Ready-to-Use Therapeutic Food (RUTF) or any therapeutic milk (F75/F100). Caregivers were shown showcards with pictures of those commodities so they could recognise them more easily. We assumed that a report of use of RUTF or therapeutic milks implied the child had accessed treatment at a CMAM facility in WINNN-supported LGAs. The survey also established the undernutrition status of children at the time of the endline survey using different anthropometric measures. Since the decision model focuses on the population of children with SAM (and not the general population of children), we estimated the probability of use of the CMAM programme in children with SAM in treatment LGAs. In order to not restrict our sample size, we use a broad definition of SAM: children aged 6–59 months who have SAM at the time of the survey based on either weight-for-height Z-score <-3SD, and/or MUAC less than 115mm, and/or have visible oedema. The overall estimate of the use of the CMAM programme in SAM children aged 6–59 months in treatment LGAs was 16.7% (95% confidence interval = 11.8% to 23.1%).

The other probabilities under the CMAM programme implemented scenario were also calculated with the ORIE endline data, using the sample of SAM children aged 6–59 months in treatment LGAs. The probability of receiving non-CMAM programme treatment was calculated as the proportion of children aged 0–59 months whose main caregiver reported that the child was ever

taken to a CMAM facility for treatment with other treatment but RUTF or F75/F100 (e.g. Kwash Pap). The probability of receiving self-treatment or no treatment was calculated as the proportion of children aged 0–59 months whose main caregiver reported that the child never received treatment for malnutrition at the health facility. Probabilities under the CMAM programme not implemented scenario were calculated following a similar method as in the CMAM programme implemented scenario but in control LGAs.[3]

Since the estimates coming from the ORIE sample are not estimates of CMAM programme coverage (coverage surveys usually include an active case finding method or a house-to-house screening of SAM cases in their sampling, which is very different to the ORIE sample), we also explore an alternative source of data for the probability of use of the CMAM programme (under the CMAM programme implemented scenario) – the SLEAC surveys available in northern Nigeria. SLEAC is a low-resource method of estimating coverage at the level of small (service delivery) units as well as larger (regional and national) levels. These surveys were conducted by Valid International in all four programme states in 2014 and again in Katsina and Kebbi in 2016. The average coverage estimate for the four states in 2014 was 36.6% (95% confidence interval = 32.3% to 40.9%). The SLEAC estimates were used to conduct a sensitivity analysis of the 'probability of CMAM programme use' parameter in the CEA. We note that SLEAC estimates were much higher than the ORIE endline survey estimates, but this is primarily because of the difference in study design mentioned earlier in this report.[4] Thus, the ORIE survey estimates provide conservative estimates of the cost-effectiveness of the CMAM programme compared to using SLEAC estimates. However, SLEAC estimates were comparable to other published economic evaluations (see Wilford *et al.*, 2012).

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[3] As identified in the Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017, there were spillover effects in terms of children in control LGAs accessing WINNN-supported interventions in treatment areas. We find that 10.3% of SAM children aged 6–59 months in control LGAs accessed the CMAM programme, and 1.3% accessed other non-CMAM programme treatments such as Wash Pap. We assume that those caregivers of children who accessed CMAM facilities were motivated enough to have looked for any other alternative treatment had there not been any spillovers from the WINNN programme. Thus, we estimate an 11.5% probability of receiving non-CMAM programme treatment under the CMAM programme not implemented scenario.

[4] Specifically, SLEAC is a coverage survey that uses a two-stage sampling approach whereby villages (within wards of LGAs) are selected as primary sampling units in stage 1, followed by selection of the target population of SAM children (6–59 months old) within selected villages.

Table 3:   Probability of treatment use in the CMAM programme decision model

Model parameters	Estimate in WINNN states, 2016 [source: ORIE endline survey]	Average coverage estimates in WINNN states, 2014 [source: SLEAC surveys]
CMAM programme implemented scenario	**(WINNN treatment LGAs)**	
Admitted to CMAM programme (p1)	16.7%	36.6%
Received non-CMAM programme treatment (p2)	2.2%	1.7%*
Received self-treatment or no treatment (p3)	81.1%	61.7%*
CMAM programme not implemented	**(WINNN control LGAs)**	
Received non-CMAM programme treatment (p4)	11.5%	11.5%
Received self-treatment or no treatment (p5)	88.5%	88.5%

* When using the SLEAC coverage estimates in the model, the probability of receiving non-CMAM programme or no/self-treatment was based on the ORIE endline survey (and was adjusted so the sum of all probabilities is 1).

3.3.1.2 Probability of treatment outcomes in the CMAM programme

Once enrolled in the CMAM programme, children in an OTP facility can have one of the following treatment (discharge) outcomes, which are mutually exclusive and collectively exhaustive: recovered, died, defaulted, not recovered and referred from OTP facility to SC facility.

The probabilities of these treatment outcomes (except referral from OTP facility to SC facility) were based on WINNN programme service data, which present monthly proportions by state of exit categories for SAM children accessing treatment at CMAM facilities overall. This means these data do not distinguish between OTP or SC facility treatment. We used Year 4 discharge data (i.e. the most recent) for the primary analysis.

For the probability of referral to an SC facility, we assumed that 15% of SAM admissions at an OTP facility were referred to an SC facility. This assumption is based on the CMAM costing tool (FANTA, 2012) and is consistent with the assumptions made in the ORIE costing analysis report. Given that the WINNN programme service data provided were not broken down by type of service (i.e. OTP or SC facility) we needed to re-weight the exit category proportions found in the data to reach a sum of 100% with the inclusion of the 15% estimate for referral cases to SC facilities. The final parameters used in the model are presented in Table 4.

In addition, children who were referred to an SC facility can have one of the following three outcomes: (a) recovered; (b) died; or (c) not recovered or defaulted. Proportions of each of these outcomes were also calculated using the WINNN programme service data, and a similar adjustment was made on proportions to reach a sum of 100%.

Table 4: **Treatment outcomes in CMAM programme**

Region	Estimate [source: programme data, Year 4]*	Estimate [source: programme data, Year 3]*
Northern Nigeria	(p6) Recovered = 73.4%	Recovered = 65.2%
	(p7) Died = 2%	Died = 1.6%
	(p8) Defaulted = 7.6%	Defaulted = 15.3%
	(p9) Non-recovered = 2%	Non-recovered = 2.7%
	(p10) Referred to SC facility from OTP facility = 15%	Referred to SC facility from OTP facility = 15%

* The referral rate from OTP facility to SC facility was assumed to be 15%, and other rates were adjusted to reach a sum of 100%

3.3.1.3 Probability of mortality outcomes

Mortality following discharge among children who recovered in an OTP or SC facility was based on a preliminary analysis from the ORIE cohort study conducted by the University of Jos in two randomly selected LGAs in Jigawa. The study followed 410 children at six and 12 months after discharge from treatment at WINNN-supported OTP sites. The survey included a question on whether the child was ever treated at SC facility between discharge and the follow-up interview. We use this indicator to estimate mortality rates among children discharged from an OTP facility who had only been at an OTP facility and those who were also at SC facility. The mortality rates for the latter subgroup of children is used as a proxy for the post-discharge mortality rates of children recovered in an SC facility, even though the sample size is very low.

It is found that among the children who had only visited OTP facilities, the mortality rate was 6.7% at six-month follow-up, while the post-discharge mortality rate was 11.5% in children who also visited an SC facility. Next, to obtain mortality in children who defaulted from the CMAM programme or did not recover (from OTP or SC facilities), we followed Wilford *et al.* (2012) and conservatively assumed this to be the same as mortality in SAM children receiving no treatment (see below).

Mortality in children receiving no treatment was estimated using the approach recommended by Bulti *et al.* (2015). This approach uses the MUAC score of untreated SAM children and predicts mortality using the slope relationship between MUAC score and mortality – this slope is estimated using four published studies that followed children who received no treatment for SAM. The following slopes for reduction in mortality (per 1,000 children per year) were reported in these studies for a one-unit increase in MUAC score: -12.6 deaths (Briend and Zimicki, 1986); -39.4 deaths (Briend *et al.*, 1987); -31.1 deaths (Vella *et al.*, 1994); and -23.5 deaths (Pelletier *et al.*, 1993). To implement this approach, we used the average MUAC score of untreated SAM children at the time of enrolment in the CMAM programme (i.e. before they started treatment). Using this MUAC score and the slope relationship described above, mortality in the untreated children was estimated. Our estimate was 20.25%, which is close to the estimate of 20.7% in Puett *et al.* (2013) and 20.8% in Bachmann (2009).

Mortality in children receiving non-CMAM programme treatment in WINNN or non-WINNN areas was assumed to be the average of the overall mortality in the CMAM programme (i.e. 11.0%) and the mortality of no treatment (i.e. 20.25%, discussed below) – this was equal to 15.64%. This assumption was made due to lack of evidence on the mortality effect of a variety of prescribed or non-prescribed treatments (including home remedies) that children may receive for SAM. This assumption is slightly conservative compared to the literature; for instance, Wilford *et al.* (2011) assumed that mortality in children receiving non-CMAM programme care was 4% lower than those

receiving no treatment, which is marginally less conservative compared to our estimate. The probability of mortality and related data sources are presented in Table 5.

Table 5:   Mortality outcomes used in the decision model

Mortality parameters	Mortality estimate	Sources
Mortality in the CMAM programme users after exiting from the programme		
Recovered in OTP facility (p11)	6.7%	Jos University follow-up of children discharged from treatment at CMAM facilities
Recovered in SC facility (p14)	11.5%	Jos University follow-up of children discharged from treatment at CMAM facilities
Not recovered or defaulted (p12, p13, p15)	20.2%	Following Wilford *et al.* (2012), mortality was conservatively assumed to be the same as for children receiving no treatment (assumed to be the same for OTP and SC children)
Not admitted to the CMAM programme		
Received no treatment (p17)	20.2%	Predicted mortality based on Bulti *et al.* (2015) using average MUAC score of 108.04 mm before treatment initiation
Received non-CMAM programme treatment (p16)	15.6%	Average of CMAM programme mortality and no treatment mortality

3.3.1.4 Calculating total probability and DALYs for each branch of the decision tree

Next we bring together all the probabilities discussed in the above sub-sections. These probabilities are then multiplied to calculate the total probability of each branch in the decision tree and the probability of survival and the expected DALYs. Finally, the DALYs and survival probabilities are summed for CMAM programme implemented and not implemented scenarios. Note that all calculations are expressed in per child terms.

Table 6 shows the calculations for the CMAM programme implemented and not implemented scenarios. Column A represents the overall path probability for each branch of the decision tree – this is the same as was presented in Table 3 (however, it is now expressed on a probability scale, i.e. 16.7% in Table 3 is expressed as 16.7/100 = 0.167).

Column B represents the probability of survival (i.e. not dying). For children who received non-CMAM programme treatment or no treatment, this is based on Table 5 (e.g. probability of survival in children receiving no treatment is 0.798 in Table 7, which is equal to 1 – 0.202 [or 20.2%] in Table 5). For children who enrolled in the CMAM programme, it is slightly more complicated to obtain the probability of survival (this relates to 0.890 in Table 6). This is because the survival probability for children receiving CMAM programme treatment is based on the probability of treatment outcome (e.g. recovered or defaulted) and the conditional probability of mortality given the treatment outcome. Calculations are presented in Table 7. The table shows that 73.4% of children who received care at an OTP facility had recovered (see Table 4 for the source), and 93.3% of these children (who had recovered in OTP facilities) survived (see Table 5 for the source, i.e. 6.7% died and the remaining survived, so 100% – 6.7% = 93.3%). These probabilities were summed to arrive at 0.890 survival probability for children who enrolled in the CMAM programme.

Next, we calculate the total survival probability for each branch of the decision tree by multiplying columns A and B in Table 6 to arrive at the total survival probability for each pathway (column C).

These survival probabilities in column C were then summed to arrive at the total survival probability for the CMAM programme implemented scenario (= 0.814) and the CMAM programme not implemented scenario (=0.803). These survival probabilities represent the proportion of children who are expected to be alive in each scenario. The difference between these proportions (=0.011) represents the difference in lives saved by the CMAM programme implemented scenario. This is used as the denominator in the calculation of incremental cost per life saved.

Since children who survived were expected to experience 37 DALYs (based on Frankel *et al.*, 2015), column C was multiplied by 37 to arrive at column D (i.e. expected DALYs experienced per child). Finally, DALYs were summed for the CMAM programme implemented scenario to arrive at 30.12 DALYs per child. For the CMAM programme not implemented scenario, this was equal to 29.71 DALYs.

Table 6:   Calculations of probabilities of outcomes and expected DALYs per child for the CMAM programme implemented and the CMAM programme not implemented scenarios

Treatment scenarios	Probability of treatment use (A)*	Probability of survival of each pathway (B)‡	Total survival probability (C)	Expected DALYs experienced per child (D)‡
CMAM programme implemented scenario				
Received CMAM programme treatment	0.167	0.890	0.149	5.50
Received non-CMAM programme treatment	0.022	0.844	0.019	0.69
Received no treatment	0.811	0.798	0.647	23.93
TOTAL	1	-	**0.814**	**30.12**
CMAM programme not implemented scenario				
Received non-CMAM programme treatment	0.115	0.844	0.097	3.59
Received no treatment	0.885	0.798	0.706	26.12
TOTAL	1	-	**0.803**	**29.71**

* This is the same as the probability of treatment use (see section 3.3.1.1 and Table 3).

‡ This is the product of column C x 37 DALYs.

Table 7:   Treatment outcomes and survival probabilities for children who enrolled in the CMAM programme

Treatment outcomes in children who enrolled in the CMAM programme	Probability of CMAM programme treatment outcomes (E)*	Probability of survival for each CMAM programme treatment outcome (F)	Total survival probability (G = E x F)
Recovered in OTP facility	0.734	0.933	0.685
Defaulted in OTP facility	0.076	0.798	0.061
Non-recovered in OTP facility	0.020	0.798	0.016
Died in OTP facility	0.020	0.000	0.000

Referred to SC facility			
Recovered	0.130	0.885	0.115
Defaulted/not recovered in SC facility	0.017	0.798	0.014
Died in SC facility	0.003	0.000	0.000
Total for children enrolled in CMAM programme	**1**	**-**	**0.890**

* Column E is based on Table 4, which presents treatment outcomes in the CMAM programme. Column F is the complement of Table 5, i.e. 1 minus mortality estimate.

3.3.2   Costs in the CMAM model

The cost per child treated were estimated at the various CMAM programme centres before bringing them together for an overall cost per child treated estimate. We estimate costs using both health services and societal perspectives to provide a better understanding of the budgetary costs of the programme. There are three levels at which costs are incurred in the provision of the CMAM intervention:

1. **Health facility costs:** These are all costs that are directly incurred in delivering an intervention to an individual in the health facility—in this case, treating children aged under five with SAM through OTP and SC centres. These are sometimes referred to as treatment costs. Such costs comprise: i) medicines including RUTF, F75/F100 and other routine medicines for treatment at OTP and SC facilities; ii) health worker inputs—the time spent by different cadres of health workers on delivering the intervention; and iii) a proportion of overhead costs attributable to treatment delivered within the CMAM facility.

2. **Community:** These are costs incurred by CVs, who are recruited, trained and supervised by WINNN to support at OTP facilities. CVs receive stipends to cover training and meeting-related costs but are not generally remunerated for their time. The second group at the community level is the caregivers of children with SAM, who incur costs in accessing CMAM-related services in terms of their time and expenses spent travelling to and from and waiting at health facilities.

3. **Higher-level programme**: These are costs incurred at a 'higher level' than the health facility or patient; that is, money that funds activities at the national, state and LGA levels that enables the effective implementation of the CMAM programme. Two broad groups incur these costs: i) the WINNN programme; and ii) State and LGA government. Broad categories of activities include training, social mobilisation, monitoring and evaluation, and planning and coordination.

Each cost level and the methodology for its calculation is explained in detailed in the ORIE costing report (ORIE Costing Report, 2017). Table 8 shows the estimates of the cost per child treated of the various cost centres of the CMAM intervention.

Table 8:   Cost per child treated by type of service and cost centre

	CMAM programme overall		
Cost centre	**GBP**	**USD**	**%**
Higher-level costs	**30.4**	**47.5**	**36%**
WINNN programme	27.2	42.5	33%
State and LGA	3.2	5.0	4%
Health facility-level costs	**44.3**	**69.2**	**53%**

RUTF and F75/F100	29.2	45.6	35%
Other medicines	0.6	0.9	1%
Health worker time	7.7	12.1	9%
Facility overheads	6.8	10.5	8%
CV costs	**1.9**	**3.0**	**0.0**
Expenses	0.6	0.9	**0.0**
Opportunity cost	1.3	2.1	**0.0**
Caregiver costs	**7.1**	**11.0**	**8%**
Expenses	4.5	7.1	5%
Opportunity cost	2.5	4.0	3%
Total: Health services perspective	*74.8*	*116.7*	*89%*
Total: Societal perspective	*83.7*	*130.7*	*100%*
1/ Using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF)			

3.3.2.1   Costs of CMAM programme treatment in the decision model

For the CEA, the overall costs explained above were also estimated for each pathway in the decision model.

Table 9 brings together the CMAM programme costs per child estimated above and shows costs per child for those children who received treatment at a CMAM facility, along with associated path probabilities. Total costs per child treated using the CMAM programme pathway is £84.94. Note that due to rounding in the costs calculations of the CMAM programme pathway (where costs are weighted based on the probability of the treatment outcome), the total of £84.94 does not correspond exactly to the overall figure of costs per child presented in Table 8 (£83.7), although the difference is marginal and does not affect our overall estimates.

During treatment at OTP facilities, costs were higher for children who received treatment at a CMAM facility but did not recover, followed by children who recovered after receiving treatment. Costs were lower for children who defaulted or died during treatment at OTP facilities because they received only part of their CMAM programme treatment. Costs per child for those referred to SC facilities were the most expensive since these children incurred costs during treatment at OTP facilities and then in treatment of associated complications in inpatient facilities. Also, the human resource model at SC facilities is very different to that at OTP facilities; SC centres usually operate seven days a week, with relatively more qualified staff, given the level of care required, which also has implications in terms of costs.

Table 9:   Calculations of costs per child treated in the CMAM programme

Treatment outcome in children enrolled in the CMAM programme	Cost per child treated in CMAM facility (A)	Probability of treatment outcomes in CMAM programme (B)*	Cost of the outcome pathway C=(A x B)
Recovered (c1)	£73.38	0.734	£53.89
Died in OTP facility (c2)	£50.24	0.020	£0.99
Defaulted (c3)	£54.34	0.076	£4.12
Non-recovered (c4)	£88.31	0.020	£1.77
Referred to SC facility			
Survived (c5)	£161.77	0.147	£23.70
Died (c6)	£137.24	0.003	£0.47

*This is the same as column E in Table 7.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

3.3.2.2 Costs of non-CMAM programme treatment in WINNN and non-WINNN LGAs

As described in section 3.3.1.1 and Table 3, 11.5% and 2.2% of SAM children accessed non-CMAM programme treatment in non-WINNN and WINNN LGAs respectively. Using the ORIE endline data, we assume that 7.8% of the above children receive inpatient care while all children were assumed to receive outpatient care at (non-CMAM programme) primary health centres. Following Wilford *et al.* (2011), we also assumed that outpatient consultations at primary health centres included three visits. The unit cost of a health centre visit was based on the WHO-CHOICE estimate of a visit to an outpatient health facility in Nigeria, inflated to the year 2016. In addition, these children incurred caregiver costs for three visits. Finally, consistent with the literature, children receiving no treatment were assumed to incur no cost. We bring all these assumptions together in Table 10 and estimate costs per child for the full CMAM programme pathway.

Table 10: CMAM programme cost per child, outcome probabilities and cost in children under the CMAM programme implemented and not implemented scenarios

Care pathway	Cost per child (A)	Probability of CMAM programme pathway (B)	Total cost of care pathway (A x B)
CMAM programme implemented scenario			
CMAM programme treatment received	£84.94*	0.167	£14.19
Non-CMAM programme treatment received (c7)	£16.53	0.022	£0.37
No treatment (c8)	£0	0.811	£0
Total	-	1	£14.55
CMAM programme not implemented scenario			
Non-CMAM programme treatment received (c7)	£16.53	0.115	£1.90
No treatment (c8)	£0	0.885	£0
Total	**-**	**1**	**£1.90**

*This is the sum of costs in column C in

Table 9. We note that this is slightly higher than the total cost reported in the costing report (£83.7) because here costs are weighted based on the probability of treatment outcome.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

3.4 Results of the CMAM programme CEA

This section presents the results of our CEA of the CMAM programme. First, primary results are presented that are based on data sources and assumptions presented in the methods section. This will be followed by the results of sensitivity analyses that are based on alternative data sources and assumptions outlined in the method section and again summarised in the results section.

3.4.1 Results of the primary CEA of the CMAM programme

Table 11 presents the results of our CEA of the CMAM programme in WINNN focal LGAs from the societal perspective. The table shows that the cost per child in the CMAM programme implemented scenario was £14.6 while the cost was £1.9 per child in the CMAM programme not implemented scenario (see Table 10 for the calculations). Hence, the cost difference between the two scenarios was £12.6. Next, the DALYs per child in the CMAM programme implemented and the CMAM programme not implemented scenarios were 30.1 and 29.7 respectively (see Table 7 for the calculations). The proportion of children alive was 81.4% in the CMAM programme implemented scenario compared to 80.3% in the CMAM programme not implemented scenario. Finally, the ICER for cost per DALY averted was £30.8 ($48.0) and for cost per life saved was £1,138 ($1,778).

Table 11: **Cost-effectiveness results of the CMAM programme in WINNN focal LGAs (societal perspective)**

Scenarios	Cost (GBP) per child*	DALYs per child‡	Proportion alive‡
CMAM programme implemented scenario ‡	£14.55	30.12	81.40%
CMAM programme not implemented scenario	£1.90	29.71	80.28%
Difference	£12.65	0.411	1.11%
		Cost per DALY averted	**Cost per life saved**
ICER	-	**£30.77 ($48.04)**	**£1138.44 ($1,777.55)**

‡ Note that in the CMAM programme implemented scenario, not all SAM children use CMAM programme treatment (see Table 3).

* See Table 10 for detailed calculations.

‡ See Table 6 for detailed calculations.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

Table 12 shows the results from a similar analysis using a health services perspective. Costs per child in the CMAM programme implemented and not implemented scenarios were £12.9 and £1.5 respectively. The difference in costs is £11.4, which is similar to but slightly smaller than the cost difference in the societal perspective. This is because, under a health services perspective, the costs incurred by CVs providing CMAM services and caregivers are excluded from the analysis, which reduces the CMAM programme costs. Finally, the ICER for cost per DALY averted was £27.8 ($43.4) and for cost per life saved was £1,028 ($1,606).

Table 12: **Cost-effectiveness results of CMAM programme in WINNN focal LGAs (health services perspective)**

Scenarios	Cost (GBP) per child	DALYs per child	Proportion alive
CMAM programme implemented scenario	£12.92	30.12	81.40%
CMAM programme not implemented scenario	£1.49	29.71	80.28%

		Cost per DALY averted	Cost per life saved
Difference	£11.43	0.411	1.11%
ICER	-	£27.80 ($43.40)	£1028.45 $1,605.81

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

3.4.2 Results of the sensitivity analyses of the cost-effectiveness of the CMAM programme

The following cost-effectiveness estimates in Table 13 and Table 14 show the results of a sensitivity analysis of the 'probability of CMAM programme use' parameter, i.e. the probability of children in WINNN focal LGAs accessing the CMAM programme. Results presented previously were based on the ORIE endline survey. However, as was described in section 3.3.1.1, these parameters are not coverage estimates *per se* and thus we explored the use of alternative parameters based on the SLEAC coverage surveys to evaluate how robust our results are to those changes.

As expected, cost-effectiveness results from both a societal and a health services perspective are improved when using the higher estimates for access to CMAM programme coming from the SLEAC surveys. This is basically explained by the fact that the proportion of children who will be affected by a lower mortality through accessing CMAM programme treatment is increased, while the costs of CMAM programme treatment remain the same. However, the differences between estimates are not substantial: with SLEAC estimates, the cost per DALY averted is around £3 ($4) cheaper than with the ORIE endline estimates while cost per life saved is around £95 ($150) cheaper, for both the societal and health services perspectives. Thus, the ORIE survey estimates provide more conservative estimates of the cost-effectiveness of the CMAM programme compared to using SLEAC estimates.

Table 13: **Sensitivity analysis of 'probability of CMAM programme use' parameter using SLEAC surveys' coverage estimates in WINNN states (societal perspective)***

Scenarios	Cost (GBP) per child*	DALYs per child[ǂ]	Proportion alive
CMAM programme implemented scenario	£32.26	30.79	83.21%
CMAM programme not implemented scenario	£1.92	29.71	80.28%
Difference	£30.34	1.08	2.92%
		Cost per DALY averted	Cost per life saved
ICER	-	£28.07 ($43.83)	£1038.53 ($1,621.55)

* In this sensitivity analysis, the source of data on access to the CMAM programme was based on the SLEAC survey instead of the ORIE endline survey. Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

Table 14:   Sensitivity analysis of 'CMAM programme use' parameter using SLEAC surveys' coverage estimates in WINNN states (health services perspective)*

Scenarios	Cost (GBP) per child*	DALYs per childᶥ	Proportion alive
CMAM programme implemented scenario	£28.79	30.79	83.21%
CMAM programme not implemented scenario	£1.51	29.71	80.28%
Difference	£27.29	1.08	2.92%
		Cost per DALY averted	**Cost per life saved**
ICER	-	**£25.24 ($39.41)**	**£933.99 ($1,458.32)**

* In this sensitivity analysis, the source of data on access to the CMAM programme was based on the SLEAC survey instead of the ORIE endline survey.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

4 Cost-effectiveness of the IYCF interventions

The aim of this chapter is to present the methods and results of the cost-effectiveness evaluation of the WINNN-supported IYCF interventions. We start by listing the existing international evidence on economic evaluations of IYCF interventions. Section 4.2then presents the structure of the IYCF interventions cost-effectiveness model. Following this, section 4.3 sets out the data sources and assumptions used to estimate the cost-effectiveness model, including the probabilities, costs and outcomes used in the analysis. Section 4.4 presents the results of our CEA.

4.1 Existing evidence on the cost-effectiveness of the IYCF interventions

We identified two peer-reviewed studies reporting only cost analyses of IYCF interventions. These two studies are:

1. Nkonki, L.L., Daviaud, E., Jackson, D., Chola, L., Doherty, T., Chopra, M. *et al.* (2014) 'Costs of Promoting Exclusive Breastfeeding at Community Level in Three Sites in South Africa'. *PLoS ONE* 9(1).
2. Chola, L., Nkonki, L., Kankasa, C., Nankunda, J., Tumwine, J. *et al.* (2011) 'Cost of individual peer counselling for the promotion of exclusive breastfeeding in Uganda'. *Cost Effectiveness and Resource Allocation* 9(11).

Further details of these studies are included in Annex C. We will compare our results with them in the discussion section of the present chapter.

Next we will present the methods and results of the economic evaluation of the IYCF interventions in WINNN LGAs.

4.2 Structure of the IYCF interventions decision model

In general, the methodology of economic analysis of the IYCF interventions is similar to that of the CMAM programme. Both analyses use decision models that represent alternative pathways for the interventions being compared. The IYCF interventions aim to influence breastfeeding practices and in turn have an impact on mortality outcomes. Since the IYCF interventions were also available in non-WINNN areas through other programmes, this analysis used a DID approach. More specifically, we assessed the breastfeeding rates at baseline and endline in WINNN implemented and not implemented areas. These rates are assessed for the following four age groups: <1 month, 1 to 5 months, 6 to <12 months and 12 to <23 months. Based on these breastfeeding rates, we projected the mortality outcome (using the LiST, which will be described in more detail later) at baseline and endline for WINNN and non-WINNN areas. Finally, the change in mortality outcome (between baseline and endline) is calculated for WINNN areas ($diff_W$) and non-WINNN areas ($diff_N$) – the difference between these changes (i.e. $diff_W$ minus $diff_N$) is the impact of the IYCF interventions on mortality (i.e. the estimate of deaths averted). Similarly, the DID estimate of cost was calculated by applying the cost of the IYCF interventions at baseline and endline in WINNN and non-WINNN areas. Finally, the ratio of the DID estimate of cost and of mortality outcome is used to obtain the ICER (i.e. incremental cost per death averted). Below we describe the economic analysis in more detail.

Figure 4:   Schematic representation of the IYCF interventions decision tree model for cost-effectiveness analysis

| Population of interest | comparator | Exposure to IYCF counselling | Age of child | IYCF practices | Mortality outcomes |
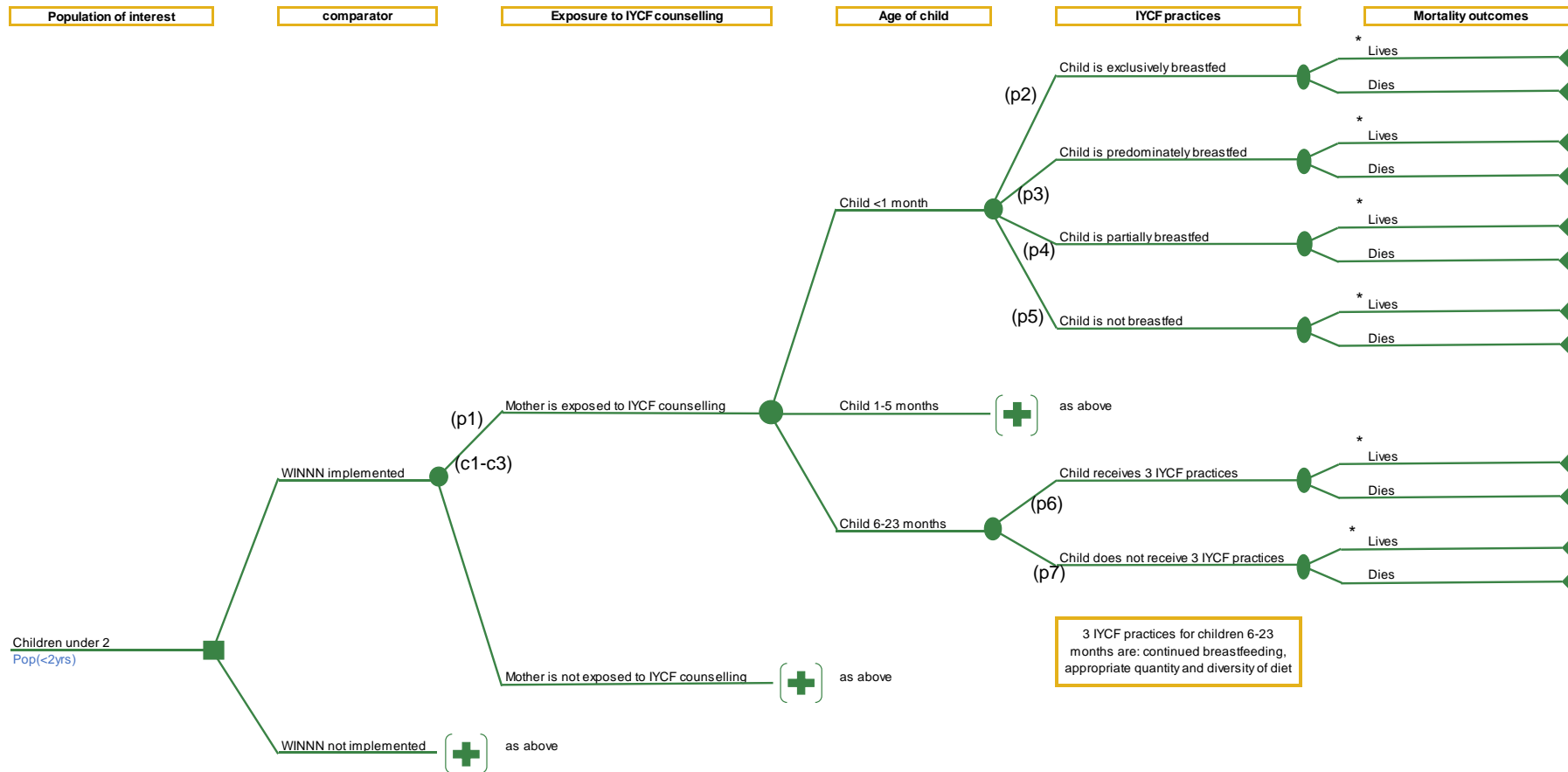
* Mortality outcomes were based on the LiST.

Source: Authors.

The population of interest for the IYCF interventions is children under the age of two years. A decision tree model (see Figure 4) is developed around the IYCF interventions exposure pathways. The decision model compares the cost-effectiveness of the following two scenarios: the IYCF interventions are implemented (scenario 1) and the IYCF interventions are not implemented (scenario 2). Conventionally, a choice node is represented by a dark squared box, and to the right of this choice node are the scenarios or treatments being compared.

For each chosen scenario, one of a number of possible pathways will be followed by a child. An example of a pathway is that a child in scenario A may be admitted to a programme followed by a positive outcome. These pathways are presented on the right side of a circular node (called chance nodes or probabilistic nodes), which represent the fact that these pathways depend on probabilities.

In the case of the IYCF interventions model, the proportion of children assigned to each pathway or branch is based on data from the ORIE quantitative endline survey (Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017). The final mortality outcome is then calculated using the LiST (described later) and then aggregated for WINNN and non-WINNN scenarios before and after the implementation of the IYCF interventions. The difference in costs and mortality outcomes between the WINNN IYCF interventions implemented and WINNN IYCF interventions not implemented scenarios will be used to estimate the incremental cost per death averted.

Costs are assigned as they are incurred during the pathway. For instance, a mother may receive IYCF counselling and then practice EBF. This will incur cost in the model when she is exposed to IYCF-related services. The mortality outcome for children is evaluated at the end of each pathway. These costs and mortality are then aggregated for all pathways within each scenario to calculate total costs and total mortality for each scenario. Finally, difference in costs and mortality between the IYCF interventions and the no IYCF interventions scenarios is calculated to estimate the incremental cost per life saved (or death averted).

The decision model is described below.

Scenario 1: WINNN IYCF interventions implemented

In this scenario, children have one of the following exposure outcomes:

a. Mother exposed to IYCF counselling

b. Mother not exposed to IYCF counselling

The above reflects that only a proportion of children who live in areas where WINNN's IYCF interventions were implemented will actually be exposed to IYCF counselling. The definition and probability of exposure is presented later in the report (see **[probability of exposure to the IYCF interventions]** in section 4.3.1).

Next, we evaluated the outcome of interest for the IYCF interventions, i.e. breastfeeding rates. These were evaluated for mothers exposed to the IYCF interventions as well as those not exposed to the IYCF interventions. The breastfeeding outcome was evaluated based on the age of the child because the recommended breastfeeding practices depend on the age. Hence, the following breastfeeding outcomes were evaluated based on the age:

i.   Child <1 month

- EBF: Proportion of infants receiving only breastmilk during the previous day

- Predominantly breastfed: Proportion of infants receiving only breastmilk plus water and/or other non-milk liquids during the previous day

- Partially breastfed: Proportion of infants receiving breastmilk plus complementary foods and/or milk-based liquids during the previous day

- No breastfeeding: Proportion of infants not receiving any breastmilk during the previous day

ii. Child 1–5 months old

- As above (for children <1 month)

iii. Children 6 to <12 months

- Continued breastfeeding (exclusive, predominant or partial): Proportion of infants receiving breastmilk during the previous day

- No breastfeeding

iv. Children 12 months to <24 months

- As above (for children 6 to <12 months)

This part of the pathway is described in the **[probability of breastfeeding outcomes]** section (see section 4.3.1). Finally, based on breastfeeding practices, children may have different mortality rates by the age of five years. This part of the pathway is described in the **[probability of mortality outcome]** section (see section 4.3.1).

Scenario 2: WINNN IYCF interventions not implemented

As before, in this scenario, mothers may or may not be exposed to IYCF counselling, and subsequently have different levels of breastfeeding practices. This is because IYCF counselling is also offered at routine primary care in non-WINNN-supported LGAs. The 'WINNN IYCF interventions not implemented' scenario has similar pathways as the 'WINNN IYCF interventions implemented' scenario but with different rates of exposure to the intervention and different breastfeeding rates.

4.3   Data sources for the decision model

This section will present the data sources and assumptions used in the decision model. These data (also called model parameters in this context) include the probabilities of each pathway in the decision model and the associated costs and outcomes. Table 15 summarises the data sources for all model parameters; these are then described in detail in the text.

Table 15:   Data sources for model parameters used in the economic analysis

Model parameters	Data sources
Probabilities used in the decision model	
Probability of exposure to the IYCF interventions	ORIE baseline and endline survey

Child breastfeeding practices	ORIE baseline and endline survey
Probability of under-five mortality	The LiST (based on breastfeeding rates)
Costs used in the decision model	
WINNN programme costs	WINNN programme expenditure data for Year 1 to Year 5, broken down by states, outputs and cost categories
State and LGA-level programme costs	ORIE-conducted interviews with SNOs, LNOs and WINNN LTAs in Jigawa, Katsina, Kebbi and Zamfara
Health facility-level costs	Various data sources were used for the calculations of these costs: ORIE-conducted interviews with SNOs, LNOs, and LTAs, WHO estimates, and ORIE HFS
CV costs	Various data sources were used for the calculations of these costs: WINNN CV motivation study, ORIE HFS, and WINNN monitoring service data

4.3.1   Probabilities in the decision model

4.3.1.1 Probability of exposure to the IYCF interventions

WINNN supports the delivery of IYCF interventions through facility-based IYCF (f-IYCF) and community-based IYCF (c-IYCF) counselling.

- f-IYCF counselling is provided at routine primary health care (PHC) services such as antenatal care (ANC) and CMAM facilities – as well as at health events such as Maternal, Newborn and Child Health Week (MNCHW) events. f-IYCF counselling is designed to be provided by trained health workers, although in practice CVs also support f-IYCF counselling in many facilities due to inadequate human resources for health (Qualitative Evaluation of the WINNN Programme – summary report, 2017). f-IYCF counselling includes counselling to groups of mothers and also one-to-one counselling.
- c-IYCF counselling is provided by trained female and male CVs. Female CVs facilitate 'mother's support groups', and provide one-to-one counselling. Male CVs reach out to fathers, local and religious leaders, while both male and female CVs provide broader IYCF sensitisation in communities. WINNN supported the significant expansion of c-IYCF counselling to additional wards, from August 2015 to February 2016.

Estimates on exposure to f-IYCF or c-IYCF counselling were derived from the ORIE quantitative endline survey (Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017). The baseline and endline surveys asked mothers of children aged 0–35 months whether they received IYCF counselling in the community generally and whether they had received IYCF counselling at health facilities at specific ANC and post-natal care (PNC) sessions for their children. These exposure indicators were estimated in WINNN and non-WINNN areas at baseline and endline.

The overall estimate of the IYCF interventions exposure at either community or facility at endline was 58.3% (95% confidence interval = 54.2% to 62.4%) in WINNN LGAs and 36.1% (95% confidence interval = 32.7% to 39.6%) in non-WINNN LGAs. Baseline and endline estimates of exposure to the IYCF interventions are presented in Table 16.

Table 16: **Probability of exposure to the IYCF interventions at baseline and endline in WINNN and non-WINNN areas (p1)**

Exposure	Baseline		Endline	
	WINNN areas	Non-WINNN areas	WINNN areas	Non-WINNN areas
f-IYCF counselling only	14.6%	14.3%	27.0%	28.7%
c-IYCF counselling only	2.3%	1.7%	11.8%	3.2%
f-IYCF counselling as well as c-IYCF counselling	5.2%	2.6%	19.7%	4.2%
f-IYCF or c-IYCF counselling (sum of the above)	22.1%	18.6%	58.3%	36.1%

4.3.1.2 Probability of breastfeeding outcomes

Child breastfeeding practices are estimated in WINNN and non-WINNN LGAs at baseline and endline for children in the following three age groups: <1 month, 1 month to <6 months, and 6 months to <24 months. The sources for this are the ORIE quantitative baseline and endline surveys, which asked about breastfeeding practices and dietary recall in the last day. With that information, we estimated whether the child is currently breastfed and the level of breastfeeding, i.e. exclusive, predominant or partial breastfeeding for children up to 6 months of age, and continued or no breastfeeding between 6 months and <24 months. Table 17 presents the breastfeeding rates at baseline and endline in WINNN and non-WINNN LGAs.

Table 17: **Breastfeeding practices (by age) at baseline and endline in WINNN and non-WINNN LGAs**

Age groups	Baseline		Endline	
	WINNN LGAs	Non-WINNN LGAs	WINNN LGAs	Non-WINNN LGAs
Children 0–<1 months				
Exclusively breastfed (p2)	13.4%	5.3%	29.2%	7.0%
Predominantly breastfed (p3)	67.8%	80.5%	64.1%	76.7%
Partially breastfed (p4)	9.9%	10.0%	6.1%	8.8%
Not breastfed (p5)	8.9%	4.3%	0.7%	7.5%
Children 1–5 months				
Exclusively breastfed	8.5%	2.7%	17.6%	7.2%
Predominantly breastfed	70.2%	76.6%	64.5%	75.5%
Partially breastfed	20.0%	20.1%	17.8%	17.3%
Not breastfed	1.4%	0.5%	0.1%	0.0%
Children 6–11 months				
Breastfed (p6)	98.8%	97.2%	99.5%	100%
Not breastfed (p7)	1.2%	2.8%	0.5%	0.0%
Children 12–23 months				
Breastfed	68.1%	71.7%	73.7%	76.9%
Not breastfed	31.9%	28.3%	26.3%	23.1%

4.3.1.3 Probability of mortality outcome

The evidence suggests that breastfeeding behaviour is strongly related to the risk of diarrhoea and pneumonia in children and the subsequent mortality (Lamberti *et al.*, 2011; Horta *et al.*, 2013; Walker *et al.*, 2013; Lamberti *et al.*, 2013). Since our data did not include longer-term follow-up, it

was not possible to estimate under-five mortality directly from the primary data on breastfeeding rates. However, we used the well-established LiST, which was initially developed as part of Child Survival Series published in *The Lancet* in 2003 (Walker *et al.*, 2013; Jones *et al.*, 2003). The model has since been extended by the Child Health and Epidemiology Reference Group to handle further interventions and to handle populations and cohorts.

The LiST

The LiST software is freely accessible as part of the publicly available software package Spectrum. Its model is a linear, deterministic mathematical model. It includes breastfeeding as a critical tool for the prevention of diarrhoea morbidity and mortality, quantifying the increased risk of suboptimal feeding from 0 to 5 months, 6 to 11 months and 12 to 23 months of age.

It inputs into the model breastfeeding rates as presented in Table 17, and then produces mortality per 1,000 live births as the output. Further details of the methodology can be found in Walker *et al.* (2013), Winfrey *et al.* (2011) and Steinglass *et al.* (2010).

In the case of the IYCF interventions, the following process was followed:

a. **Inputs:** breastfeeding rates (i.e. age-appropriate rates of exclusive, predominant and partial breastfeeding) in WINNN and non-WINNN areas were used as inputs (see Table 17). These rates were provided for baseline and endline time points.

b. **Calculations:** the model then used evidence on the relationship between IYCF practices and under-five mortality outcomes to calculate the under-five mortality rate in WINNN and non-WINNN areas based on the level of breastfeeding practices.

c. **Outputs:** the model finally produces estimates of under-five mortality per 1,000 live births in WINNN and non-WINNN areas at the baseline and endline time points. Subsequently, we calculated the following DID estimate:

$$\text{DID (mortality)}$$
$$= (\text{difference in mortality between WINNN and non} - \text{WINNN areas at endline})$$
$$- (\text{difference in mortality between WINNN and non} - \text{WINNN areas at baseline})$$

This DID estimate for mortality was used as the outcome in the CEA.

4.3.2 Costs in the IYCF interventions model

Costs per mother reached were estimated for the various IYCF interventions cost centres before bringing them together into an overall cost per mother reached estimate. We estimate costs using the health services and societal perspectives to provide a better understanding of the budgetary costs of the programme. There are three levels at which costs are incurred in the provision of the IYCF interventions:

1. **Health facility costs:** These are all costs that are directly incurred in delivering an intervention to an individual in the health facility (e.g. counselling mothers at ANC, PNC services, CMAM days and health events such as MNCHW events). These are sometimes referred to as treatment costs. Such costs comprise: i) health worker inputs—the time spent by different cadres of health workers on delivering the intervention; and ii) a proportion of overhead costs attributable to the IYCF interventions delivered within the health facility.

2. **Community[5]:** These are costs incurred by CVs, who are recruited, trained and supervised by WINNN to establish and facilitate 'mother's support groups' as well as broader IYCF promotion in the communities. CVs receive stipends to cover training and meetings but are not generally remunerated for their time. The support group approach is intended to allow for peer support among pregnant women and mothers of children under two.

3. **Higher-level programme**: These are costs incurred at a 'higher level' than the health facility or patient; that is, money that funds activities at the national, state and LGA levels that enable the effective implementation of the IYCF interventions. Two broad groups incur these costs: i) the WINNN programme; and ii) state and LGA governments. Broad categories of activities include training, social mobilisation, monitoring and evaluation, and planning and coordination.

Table 18: **The IYCF interventions costs per mother reached by type of service and cost centre**

Cost centre	f-IYCF component			c-IYCF component		
	GBP1/	USD	%	GBP1/	USD	%
Higher-level costs (c1)	**8.7**	**13.6**	**87%**	**9.9**	**15.4**	**80%**
WINNN programme	8.7	13.6	87%	8.7	13.6	70%
State and LGA	-	-	-	1.2	1.9	10%
Health facility-level costs (c2)	**1.3**	**2.0**	**13%**	**-**	**-**	**-**
Health worker time	0.8	1.3	8%	-	-	-
Facility overheads	0.5	0.8	5%	-	-	-
CV costs (c3)	**-**	**-**	**-**	**2.5**	**3.8**	**20%**
Total: Health services perspective	*10.0*	*15.6*	*100%*	*9.9*	*15.4*	*80%*
Total: Societal perspective	*10.0*	*15.6*	*100%*	*12.3*	*19.2*	*100%*
1/ Using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF)						

In the CEA, cost per mother reached was multiplied by the level of exposure to the IYCF interventions in WINNN and non-WINNN areas (i.e. the data presented in Table 16). For instance, at the endline time point, 27% of mothers in WINNN areas were exposed to only f-IYCF counselling, 11.8% were exposed to only c-IYCF counselling and 19.7% were exposed to both facility-based and community-based IYCF counselling. Hence, the total cost of the IYCF interventions at the endline in WINNN areas was calculated as follows:

WINNN IYCF interventions cost = (f-IYCF counselling cost x 27%) + (c-IYCF counselling cost x 11.8%) + ([f-IYCF counselling cost + c-IYCF counselling cost] x 19.7%)

Here, f-IYCF and c-IYCF counselling costs represent facility-based and community-based IYCF counselling costs per mother reached, respectively. Since cost data for the IYCF interventions were only available for WINNN areas through the ORIE evaluation, we assumed that the cost per

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[5] Mothers or caregivers receiving IYCF-related services also incur costs in accessing IYCF-related services in terms of time and expenses. However, these costs are very difficult to collect and estimate, given that IYCF-related services are integrated into other services such as treatment at CMAM facilities, MNCHW events and other routine PHC services such as ANC or PNC. The time mothers spend on a CMAM day, including IYCF counselling, is already costed as part of the CMAM programme costing. Thus, the only costs for caregivers that are excluded from our analysis are those related to the time and expenses spent on c-IYCF and f-IYCF counselling at ANC or other facility services such as PNC or MNCHW events. However, it should be noted that we expect this cost to be marginal given the time IYCF-related services take in reality.

mother reached is the same in both WINNN and non-WINNN areas (although the probability of reaching mothers was different in WINNN and non-WINNN areas).

Following the DID approach (as above), we calculated the DID in cost using the following formula:

$$\text{DID (cost)} = (\text{difference in cost between WINNN and non} - \text{WINNN areas at endline})$$
$$- (\text{difference in cost between WINNN and non} - \text{WINNN areas at baseline})$$

In the sub-section below, we will present the methods used to calculate cost per mother reached in health facility or community.

4.4　Results of the IYCF interventions CEA

The primary results of the CEA are presented below. Table 19 presents estimates of the IYCF interventions costs and mortality outcomes for WINNN and non-WINNN LGAs from the societal and health services perspectives. When using the societal perspective, the cost per mother (i.e. cost per mother reached x probability of exposure to the IYCF interventions) at baseline was £2.90 and £2.22 for WINNN and non-WINNN areas respectively. Hence, the difference in costs at baseline was £0.69 per mother. At endline, this difference was £4.35. As a result, from a societal perspective, the DID estimate was £3.66 per mother (see

Table 20). When using a health services perspective, the DID estimate for cost was £3.15 per mother. Next, we predicted mortality at baseline and endline for WINNN and non-WINNN LGAs using the child breastfeeding rates in the LiST. The tool anchored the baseline under-five mortality per 1,000 live births at 116.61 (based on the mortality estimates for Nigeria). It then predicted mortality using breastfeeding rates at endline, which were 108.64 in WINNN areas and 113.83 in non-WINNN areas. The DID estimate of mortality per 1,000 live births was 5.19 (or 0.00519 per live birth) between WINNN and non-WINNN LGAs (see

Table 20).

Table 19:   Costs and mortality at baseline and endline in WINNN and non-WINNN areas

Costs	Baseline		Endline	
	WINNN areas	Non-WINNN areas	WINNN areas	Non-WINNN areas
Societal perspective				
IYCF interventions cost per mother*	£2.90	£2.22	£8.54	£4.19
Difference between WINNN and non-WINNN areas in costs per mother	£0.69		£4.35	
Health services perspective				
IYCF interventions cost per mother*	£2.72	£2.11	£7.77	£4.02
Difference between WINNN and non-WINNN areas in costs per mother	£0.61		£3.75	
Mortality	Baseline		Endline	
	WINNN areas	Non-WINNN areas	WINNN areas	Non-WINNN areas
Predicted mortality per 1,000 live births‡	116.61	116.61	108.64	113.83

* IYCF interventions cost per mother = IYCF interventions cost per mother reached x probability of exposure.

‡ In the LiST, the baseline mortality in WINNN and non-WINNN areas is anchored at the observed mortality per 1,000 live births in Nigeria in 2013. Then, mortality at endline is predicted based on the change in breastfeeding rates from baseline.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

Finally, we calculated the ICER using DID estimates of costs and mortality outcomes. Our estimate shows that the incremental cost per death averted is £706 ($1,102) from a societal perspective and £607 ($947.9) from a health services perspective (

Table 20).

The LiST allowed for the estimation of long-term mortality for the IYCF interventions but did not allow any estimation of DALYs averted. This could be related to the preventative nature of the IYCF interventions, which can affect various long-term conditions – each of them with a different disability weight. In the case of CMAM, which is a curative intervention, the estimation of DALYs was more straightforward given that a single condition (SAM) is linked to a known disability weight. In this report, for comparison purposes, we assume 37 DALYs lost per premature death (as in the case of CMAM) to convert per life saved to per DALY averted. We estimate that the incremental cost per DALY averted for the WINNN IYCF interventions is £19.1 ($29.8) from a societal perspective and £16.4 ($25.6) from a health services perspective. The DALY estimate assumes that long-term mortality and disability in children who were alive at the age of five in the IYCF interventions model is similar to the children who were alive in the CMAM model after recovering from an episode of malnutrition. This is a conservative estimate (i.e. DALYs experienced by children who were alive in the IYCF interventions model may be under-estimated) given that we expect children with a history of SAM to have a higher long-term probability of disability/mortality compared to other conditions affected by suboptimal breastfeeding.

Table 20: DID estimates and ICERs of the IYCF interventions (societal and health services perspectives)

Incremental analysis	Societal perspective	Health services perspective
DID estimate of costs between WINNN and non-WINNN areas*	£3.66	£3.15
DID estimate of deaths averted per live birth between WINNN and non-WINNN areas‡	0.00519	0.00519
ICER for cost per life saved‡	**£705.78 ($1,102.0)**	**£607.09 ($947.9)**
ICER for cost per DALY averted¶	**£19.09 ($29.8)**	**£16.40 ($25.6)**

* DID estimate of costs is £3.66 = £4.35 minus £0.69 (from the previous table).

‡ DID estimate of deaths averted by live birth is based on the previous table and is calculated as follows: (difference)$_{endline}$ – (difference)$_{baseline}$ = 5.19 – 0 = 5.19 per 1,000 live births = 0.00519 per live birth.

‡ The ICER is calculated as a ratio of the DID estimate of cost and DID estimate of deaths averted per live birth.

¶ Following the CMAM analysis, we assumed 37 DALYs lost for every premature death.

Calculations were made in USD and then converted to GBP using an exchange rate of 1.56, calculated as the average of representative rates for the period September 2011 to August 2016 (Source: IMF).

5 Discussion

- This study aimed to evaluate the cost-effectiveness of the CMAM and IYCF interventions in northern Nigeria. The analysis was conducted from the societal and health services perspectives using a lifetime horizon. A decision modelling approach was used to estimate the difference in costs and health outcomes due to the WINNN programme. Based on our analysis, both the CMAM and IYCF interventions were found to be cost-effective and compare well with estimates in recent studies of CMAM programmes in northern Nigeria and in other countries.

- For the CMAM programme, the ICER from a societal perspective was £30.8 ($48.0) for cost per DALY averted and £1,138 ($1,778) for cost per life saved. From a health services perspective, the ICER for the CMAM programme for cost per DALY averted was £27.8 ($43.4) and for cost per life saved was £1,028 ($1,606).

- For the IYCF interventions, the ICER from a societal perspective was £19.1 ($29.8) for cost per DALY averted and £706 ($1,102) for cost per life saved. From a health services perspective, the ICER for the CMAM programme for cost per DALY averted was £16.4 ($25.6) and for cost per life saved was £607 ($947.9).

- For the purpose of decision-making, the ICER values can be compared against the recommended cost-effectiveness threshold. A commonly used threshold is based on the WHO-CHOICE model, which suggests that if the ICER per DALY averted is below the value of GDP *per capita* then the intervention is 'very cost-effective' while if it is between one and three times the GDP *per capita* then the intervention is 'cost-effective' (Hutubessy *et al.*, 2003; Shillcutt *et al.*, 2009). As a result, any intervention with ICER per DALY averted of over three times the GDP *per capita* is considered not cost-effective. The GDP *per capita* of Nigeria in 2015 was $2,617 according to the World Bank (World Bank, 2017); hence, the ICER per DALY averted is 'very cost-effective' in all analyses. An alternative recommendation is to use the WHO regional GDP *per capita* value, which is $1,695 for the WHO region of 'Afro D'[6] (WHO, 2017). Regardless, the CMAM programme is still 'very cost-effective' based on this regional cost-effectiveness threshold.

- A recent development in the literature is the cost-effectiveness threshold based on opportunity cost. This country-level threshold was proposed by Woods *et al.* (2016) – the authors combined the GDP *per capita* and the value of a statistical life to propose a threshold to reflect the health opportunity cost. Based on this study, the threshold range for Nigeria is $239 to $1,545. Hence, an intervention that costs more than the higher estimate of $1,545 per DALY averted is considered not cost-effective. Based on this alternative threshold, the CMAM intervention is still considered to be cost-effective. Based on both thresholds, we can conclude that investing in the CMAM intervention provides a good return on health sector investment.

- For decision-makers, it is also important to compare cost per DALY averted estimates with other health care interventions that are competing for the health care budget. We found that the WINNN CMAM and IYCF interventions have a much lower cost per DALY averted compared to many other preventative and curative interventions. For example, the cost per DALY averted is $117 for family planning programmes, $922 for antiviral therapy (DIFD, 2011)and $94 for an integrated prevention campaign focused on diarrhoea, malaria and HIV (Marseille *et al.*, 2014).

- When comparing the results of economic evaluations, it is of course important to acknowledge that estimates of cost-effectiveness inevitably differ between studies. This is for several reasons, which include differences in: the data sources used to collect cost data; sampling strategies; population groups; cost of goods and services in the evaluation area (including differences in staff salaries, overheads and transportation costs, both between and within

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[6] Nigeria is in the 'Afro D' region based on WHO classification

countries); assumptions about costs, probabilities and outcomes in the analysis; and the perspective of the economic evaluation.

Cost-effectiveness of the WINNN-supported CMAM programme

- The results of our CEA of the CMAM programme in northern Nigeria are comparable to the estimates in recent studies of CMAM. For instance, Wilford *et al.* (2012) used a health services perspective and estimated that the ICER for CMAM in Malawi was $42 per DALY and $1,365 per life saved. Similarly, Bachmann (2009) conducted a CEA of CMAM in Zambia using a health services perspective and found that the ICER for CMAM was $53 per DALY averted and $1,760 per life saved. In another study, Puett *et al.* (2013) evaluated CMAM in southern Bangladesh from a societal perspective and found that the ICER for CMAM was $29 per DALY averted and $1,344 per life saved. The reason for the lower estimates from Puett *et al.* (2013) is that the CMAM model was assumed to be implemented only by community workers (hence, outpatient staff and overhead costs were not included).

- Another important study was conducted by Frankel *et al.* (2015) in Nigeria and estimated that the CMAM programme costs $30 per DALY averted and $1,117 per death averted. The difference in estimates between our study and Frankel *et al*'s (2015) is small and can be explained by a number of reasons. For instance, the cost estimate of CMAM per child in Frankel *et al.* (2015) was $123 compared to $131 (£84) in our study. The lower cost might be explained by the different methodology used. Also, Frankel *et al.* (2015) used different assumptions about treatment outcomes compared to our study. For instance, based on primary data collected in our study, the difference in mortality between untreated SAM and those children who recovered in OTP was estimated to be 13.5%; however, Frankel *et al.* (2015) assumed that this mortality difference is 15.7%, which makes CMAM more cost-effective. Similarly, mortality reduction in children admitted to SC was 8.7% (based on primary data) compared to 9.6% in Frankel *et al.* (2015). Also, Frankel *et al.* (2015) assumed higher mortality of untreated SAM (21.4%) compared to our estimated mortality of 20.2%, which is comparable to the 20.7% seen in Puett *et al.* (2013) and 20.8% in Bachmann (2009).

- Another important point to note is that it appears that Frankel *et al.* (2015) did not take account of the coverage of the CMAM programme – instead, they appear to directly compare children who enrolled in the CMAM programme with those who did not. As a result, the treatment benefit (in terms of mortality and DALYs averted) will clearly be large as all children in the CMAM programme implemented scenario were assumed to enrol in the programme – this approach overestimates the treatment effect as it does not account for the fact that only a proportion of SAM children will enrol in the CMAM programme. Hence, it is not surprising that the ICER estimate of Frankel *et al.* (2015) is lower than the one in our study.

- Finally, Tekeste *et al.* (2012) evaluated community-based therapeutic care in Ethiopia from a societal perspective and found that the cost of the intervention was $135 per child treated – a similar finding to the estimate of $131 (£84) per child treated in the current study. However, Tekeste *et al.* (2012) did not report any ICERs.

Cost-effectiveness of the WINNN-supported IYCF intervention

- The results of our CEA of the IYCF interventions were compared with the wider literature (see Annex C for a summary of the relevant studies). Only two relevant studies were found: Chola *et al*'s (2011) was conducted in Uganda and Nkonki *et al*'s (2014) in South Africa. Both studies were conducted by the Promoting Infant Health and Nutrition in Sub-Saharan Africa: Exclusive Breastfeeding Group (PROMISE-EBF). The intervention involved offering support provided by peer-supporters who recruited pregnant women attending routine ANC, establishing their feeding practices and then supporting them in breastfeeding practices.

- Both studies conducted economic evaluations from the provider's perspective and excluded any costs incurred by mothers. The costing of the project was done using budget and expenditure data from the PROMISE-EBF programme. However, while these studies report intermediate outcomes, such as number of visits or number of weeks of EBF, neither evaluate the long-term outcomes, either in terms of reduced mortality or morbidity. Thus, it was not possible to compare our findings with these studies because long-term health benefits were not calculated/reported.

Limitations

- The economic evaluation has several limitations. While our study collected a significantly large amount of primary data on costs and outcomes compared to most other published studies, it still relied on some modelling assumptions. For instance, the estimates of access to the CMAM programme based on the endline survey were quite different – and are not comparable due to methodological differences – to coverage estimates coming from SLEAC surveys. Thus, the cost-effectiveness estimated with the probabilities of access coming from the endline are slightly more conservative. Second, because it is unethical to leave SAM children untreated after they are identified, it was not possible to directly estimate mortality in untreated SAM cases. Hence, following the conventional literature, we estimated this mortality using MUAC score in children before they received treatment. Our estimates were very similar or more conservative compared to other published studies. Another limitation is in relation to the cost estimation. WINNN personnel costs and other shared costs in WINNN higher-level expenditure were allocated using an activity-based costing apportioning. Although a standard approach, this method will be less precise than directly coded costs (i.e. if WINNN staff kept timesheets by output). It is also difficult methodologically to draw the line between which WINNN support costs are necessary for the successful implementation of the current IYCF and CMAM interventions and which are more related to future implementation. In our costing, we include all these costs that can have implications in the overall costs.
- Finally, the CEA was based on mean estimates of costs and outcomes and did not consider the uncertainty in these estimates, which can be done using a probabilistic sensitivity analysis. This would be a useful exercise for future research.
- We note that the findings of the CEA are somewhat different from the overall impact evaluation. There can be several possible explanations for this. First, the CEA specifically evaluates the effect of an intervention on treatment pathways (in terms of mortality and disability) rather than estimating the population-level effect of the intervention. Moreover, the CEA evaluates the longer-term effect of the intervention in terms of long-term mortality or DALYs averted, something which is not considered in the 'within-study' impact evaluation. However, it is important to note that the findings of our CEA are completely consistent with all the studies in the literature, which find that CMAM and IYCF interventions are cost-effective.

6   Key lessons and recommendations

The principle objective of this CEA was to assess the return on investment of the WINNN interventions, not to develop detailed operational recommendations. ORIE has produced a separate document – the ORIE Nigeria Integrated Report (2017) – which draws on evidence from across ORIE workstreams to fully draw out lessons learned and recommendations targeted toward specific stakeholder groups such as the Nigerian government, donors and IPs. The Integrated Report also draws on evidence from across ORIE workstreams to report on WINNN's logframe indicators.

However, several important lessons and recommendations emerge from our CEA and are outlined below. In addition to DFID, the WINNN programme and the Government of Nigeria, these will hopefully prove useful to any professionals involved in the design of nutrition-specific and nutrition-sensitive programmes in Nigeria.

Lessons

1) The economic analysis of the WINNN programme has demonstrated that nutrition-specific interventions in Northern Nigeria can be cost-effective.

2) While both interventions were found to be cost-effective, we learnt that high-level programme delivery costs, including those incurred by the WINNN programme, make up a significant proportion of the total programme cost (see ORIE Costing report (2017) for detailed analysis of the programme costs). Funding bodies should work with local governments to assess ways of reducing these costs while building local capacity and transferring programme ownership to state governments to scale up these interventions to the population level.

3) This study has important lessons for future CEAs. ORIE engaged the implementers early in the programme, which allowed for the development of survey tools that were tailored to the evaluation to provide robust data (see Quantitative Impact Evaluation of the WINNN Programme – Volume 1, 2017 for details on the effectiveness data). This also allowed investigators to pilot test and improve the data collection methods for within-programme and follow-up data. As a result, compared to other economic studies of nutrition-specific interventions, this evaluation had to make fewer assumptions for the CEA.

4) However, the cost-effectiveness estimates were constrained by the lack of data on health outcomes and particularly long-term ones such as children mortality. This should be planned for in future studies. This study also identified gaps in data in non-intervention areas, such as the type and quantity of care received by children and their outcomes of care – this was overcome by making informed conservative assumptions based on the literature.

5) Cost-effectiveness estimates were also constrained by the lack of long-term data on costs, which should equally be planned for in future studies. Data issues were also encountered in relation to programme-specific costs at state government level, with data both challenging to obtain and having significant variations in estimates and quality. These issues can be overcome through structured and coordinated efforts between funding bodies and state governments to develop and/or improve programme-specific budgetary reporting mechanisms.

6) Our study found that the cost-effectiveness estimates of nutrition-specific interventions varied based on the perspective of decision-making, and therefore it is important for future studies to plan data collection and present results from both the societal as well as health services perspective.

Recommendations

1) The cost-effectiveness evidence in this study found that both the CMAM programme and the IYCF interventions are cost-effective interventions for improving child health in northern Nigeria. This evidence is consistent with other studies conducted in Nigeria and other countries globally. This provides a basis to recommend that both programmes be considered by policy-makers and funding institutions as interventions that offer VfM in terms of improving child health outcomes.

2) The coverage or exposure rate of the CMAM programme and the IYCF interventions is one of the determinants of cost-effectiveness. While both programmes were found to be cost-effective in this study, the coverage rates of both interventions remain low. The wider literature suggests that higher coverage level is likely to make the interventions even more cost-effective – this is because the fixed costs (such as high-level administrative expenditure) per child tends to reduce with increase in coverage due to economies of scale. Strategies to increase coverage should therefore be pursued by state governments in order to improve the cost-effectiveness of those interventions. Such strategies can include strengthening active case finding through a strong network of CVs, improving the access to IYCF-related services or improving the quality of service delivery.

3) To further improve the cost-effectiveness of the CMAM programme, the programme should also aim to reduce default rates among enrolees, which will improve survival rates in children. While this may require additional resources, the expected health gains in treatment completers will likely outweigh the additional costs.

4) For the scale up of the CMAM programme and the IYCF interventions, resource implications must be considered carefully. This applies to both the resources required at higher-level as well as costs incurred at the level of health facilities and in the community. For instance, WINNN programme costs make up a large proportion of the cost of CMAM and IYCF interventions (i.e. 1/3rd of the total costs in case of the CMAM programme and at least 4/5th in case of the IYCF interventions). Therefore, the state governments should evaluate the budgetary capacity for scaling-up of these programmes.

5) Given the challenges surrounding high-quality data in northern Nigeria, it is important to develop, at least at LGA level, a population-level monitoring and surveillance system on the nutritional status of children, their access to services, short-term treatment outcomes (such as rate of recovery after care and rate of recurrent episodes of malnutrition) and long-term outcomes (including mortality and disability rates), so future evaluations can benefit from robust data.

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Annex A Inception report

A.1 Volume I (excerpts)

A.1.1 Economic evaluation

A.1.1.1 Rationale and objectives of the economic evaluation workstream

The World Bank estimates that malnutrition is costing poor countries up to 3% of their yearly GDP. Moreover, malnourished children are at risk of losing more than 10% of their lifetime earnings potential. In resource-constrained health systems, the prioritisation of resource allocation across competing interventions requires evidence not only on effectiveness but also on cost-effectiveness. Such analysis is vital to the efficient allocation of resources to maximise health gains.

The objectives of the economic study include:

a) To estimate the direct and indirect costs and health-related outcomes associated with implementation of CMAM and IYCF interventions in northern Nigeria (WINNN Outputs 1 and 2);

b) To evaluate the cost-effectiveness of CMAM and IYCF interventions compared to routine care; and

c) To evaluate the direct provider-related costs associated with WINNN outputs 3 and 4.

A.1.1.2 Approach and methods

We propose to conduct separate economic evaluations of each WINNN programme output, primarily because the outputs have different objectives, target health conditions, health outcomes and population groups. A full economic evaluation of the CMAM programme will be based on the cost-utility approach. The cost-utility approach uses a generic outcome, in this case the DALY that allows comparison of cost-effectiveness across programmes. Primary studies will be conducted to evaluate programme effectiveness, service delivery costs, health service utilisation costs and household costs. Based on this, a decision tree model (or an alternative Markov model) will be developed to evaluate patient treatment pathways (from identification of malnutrition to treatment to health outcomes) using costs and outcomes in CMAM programme and non-CMAM programme care to estimate the incremental cost per DALY averted.

The economic evaluation of the IYCF interventions will compare programme delivery costs and health services costs against health outcomes that are directly influenced by the IYCF interventions. Based on primary data from the impact evaluation survey in intervention and control areas, the CEA will estimate the cost per unit of effectiveness outcomes such as the proportion of infants aged 0–6 months who are EBF and the proportion of children aged 6–23 months receiving foods from four or more groups (and if feasible, cost per DALY averted). Programme-related costs will be obtained in a primary costing exercise.

The economic evaluation of outputs 3 and 4 will be take the form of a programme-based cost analysis, as no direct outcome data will be collected/available for these outputs. These costing studies are important for understanding the budgetary and economic implications of the programmes for health services and the funder.

A.1.1.3 Key deliverables

CMAM programme and IYCF interventions:

- results of the primary data analysis for costs and outcomes of the CMAM programme;
- a fully functional economic model and cost per DALY analysis; and
- a detailed report outlining and explaining findings.

Outputs 3 and 4:

- analysis of programme-related costs; and
- a detailed report outlining and explaining findings.

A.1.1.4 Key activities by year

- 2012: Key decision-making on primary data collection and the approach to analyses.
- 2013: Planning and organisation of primary data collection activities for all four outputs (first half of 2013); data collection initiated during second half of the year.
- 2014: Primary data collection of economic data completed by the end of 2014; report on findings. Structure of the economic models completed in 2014.
- 2016: Data from the impact evaluation exercise will be available. Analysis of primary economic data for all outputs will be conducted. Economic models and cost analysis will be completed. Report writing and dissemination.

A.2 Volume II (excerpts)

A.2.1 ORIE economic evaluation

A.2.1.1 Introduction

Childhood malnutrition remains an important public health and development problem in low- and middle-income countries, especially in sub-Saharan Africa. The World Bank estimates that malnutrition is costing poor countries up to 3% of their yearly GDP. Moreover, malnourished children are at risk of losing more than 10% of their lifetime earnings potential (Bachmann, 2009). This can have a devastating economic impact on households. Caulfield *et al.* (2004) conducted a pooled analysis using 10 studies to estimate that 53% of child mortality is attributable to being underweight. Causes of death in malnourished children ranged from 44.8% for deaths due to measles to 60.7% for deaths attributable to dehydration as a result of diarrhoea.

Prevalence of malnutrition in Nigeria has been found to be consistently high in most national and international studies. The **Nigeria demographic and health survey 2008** suggests that **26.7%** of children under five are moderately or severely underweight; of these, **12.7%** were found to be severely underweight. More important, compared to previous surveys, the prevalence of malnutrition has not improved (27.3% in 1999 and 27.2% in 2003). Therefore, tackling malnutrition is one of the public health priorities for Nigeria.

DFID Nigeria is rolling out an ambitious £50 million, six-year programme to improve maternal, newborn and child nutrition which will reach 6.2 million under-fives in five states of northern Nigeria. The programme has five outputs that are listed below:

- Output 1: treatment of SAM via the **CMAM programme** through integrated services in primary health facilities;
- Output 2: community-based interventions to improve **IYCF practices** through EBF, weaning and complementary feeding;

- Output 3: the integration of **micronutrient interventions and deworming** into routine primary health services (Vitamin A supplementation for children, iron and folic acid for pregnant women);

- Output 4: more effective government planning and coordination in nutrition and related sectors at the national and state levels, and a stronger health system, through the **integration of direct nutrition interventions into routine health services** funded by the government;

- Output 5: improved knowledge of what works to tackle child undernutrition in northern Nigeria via **ORIE**, which will be conducted by independent researchers and evaluation experts (output 5).

The economic evaluation workstream will concentrate primarily on outputs 1 and 2 for full economic evaluation, i.e. the CMAM programme and IYCF interventions of the programme. However, we will also discuss the scope of conducting costing studies (not full economic evaluations) for workstreams 3 and 4, i.e. the institutional implementation cost of the integration of micronutrient interventions and deworming (workstream 3) and integration of direct nutrition interventions into routine health services (workstream 4).

A.2.1.2 Economic evaluation of CMAM programme/IYCF interventions: rationale and approaches

In resource-constrained health systems across the world, and in particular in developing countries, the prioritisation of healthcare resource allocation across competing interventions requires evidence not only on effectiveness but also on cost-effectiveness. The CEA involves evaluating the impact of interventions on both costs and health outcomes. Such analysis is vital to the efficient allocation of resources to maximise health gains.

There are primarily three potential approaches to full economic evaluation that can be used for the evaluation of the CMAM programme and the IYCF interventions (we have ignored cost–benefit analysis and cost-minimisation analysis as they are not relevant to the context of evaluation of CMAM programme/IYCF interventions). These are CEA, cost-utility analysis and cost-consequence analysis. The three approaches differ in terms of how the outcome is measured against the costs. All three approaches are described below and their usefulness in the context of the current study is discussed.

A.2.1.3 Approaches to economic evaluation

Cost-effectiveness approach

In a CEA, the outcome is programme-specific, such as the reduction in blood pressure (Logan, 1981), number of positive cases detected (Hull *et al.*, 1981), change in asthma episode days (Sculpher *et al.*, 1994) and gain in life years (Mark *et al.*, 1995). In the particular case of the CMAM programme, such outcomes may be related to indicators of nutritional status such as anthropometric indicators based on body size and composition. In the case of IYCF interventions, the relevant indicators may be the proportion of infants aged 0–6 months who are EBF and/or proportion of children aged 6–23 months receiving foods from four or more food groups. The CEA will produce estimates of VfM in terms of cost per unit of outcome measure.

CEA is an incremental analysis, i.e. it evaluates the difference in costs and difference in outcomes between the interventions being evaluated. The resulting ICER of the CMAM programme/IYCF interventions will reveal the optimal alternative (compared to the control intervention), which may be: i) same cost but more effective than the alternative; ii) less expensive and at least as effective as the alternative; or iii) more expensive while providing additional benefit that is worth the cost.

This last scenario is the most common likely outcome of CEA. The incremental cost per unit of outcome is then evaluated against the willingness to pay for gain in one unit of the outcome.

CEA can be useful when the decision-maker is interested in comparing alternatives within a particular field, for instance the CMAM programme against other interventions targeting malnutrition. However, the government or international funding organisations (i.e. a decision-maker with a broad health sector mandate) with priorities across all health conditions need to use outcome measures that are directly comparable across several health conditions to evaluate the maximum VfM in terms of health gain. As a result, generic measures of health, such as DALYs or quality-adjusted life years (QALYs) are frequently employed.

On the other hand, CEA's outcome (such as reduced incidence of malnutrition) can be easier to understand and communicate, especially when the focus of health gain is restricted to malnutrition. Moreover, the CEA approach is also useful in situations when converting specific outcomes to generic outcomes is not straightforward. This is likely to be the case when evaluating interventions that aim to promote breastfeeding and weaning (such as the case in IYCF interventions). However, as we will discuss in the literature review section, only a limited number of economic studies have achieved this using modelling approaches.

Cost-utility approach

The cost-utility analysis is the most common method of economic evaluation in the literature. It uses a generic measure of health outcome that can be compared across programmes. The most commonly used outcome measure in the economic literature related to developing countries is the DALY. An alternative to DALYs is the QALY outcome, which values health outcomes based on public preferences. QALYs have been more commonly used in the literature related to developed countries, where country-specific value weights (or utility weights) are available for specific population groups. Both outcomes combine survival and health-related quality of life. We will discuss the DALY in detail below as it relates directly to the evaluation of CMAM programmes in the literature.

The DALY is primarily a measure of disease burden and has been used frequently in economic evaluations. DALY incorporates an age-weighting function assigning different weights to life years lived at difference ages. The calculation of DALYs is relatively simple as constant disability is often assumed. The formula to calculate DALYs averted is (Cairncross *et al.*, 2003):

DALYs averted= no. of deaths averted * YLL + no. of cases of illness averted * YLD

YLL = years of life lost due to premature mortality

YLD = year of life spent with disability

As discussed above, the advantage of using a generic measure like DALYs is that a decision-maker with a broad health sector mandate can compare VfM across several health programmes. For instance, Wilford *et al.* (2012) compared the cost per DALY averted of the CMAM programme in Malawi against other interventions such as the iron fortification programme in Malawi, with a cost per DALY of $66–70/DALY compared to the treatment of SAM with A cost per DALY of $41/DALY. Such an analysis puts the value of the intervention into perspective and allows decision-makers to prioritise healthcare financing.

It should be noted that the two terms 'cost-effectiveness' and 'cost-utility' are often used interchangeably in the literature. **This is because cost-utility analysis can be understood as a**

specific type of CEA where the outcome of interest is a generic measure. Cost-consequence analysis

While it is common practice in the health economics literature to take the cost-effectiveness or cost-utility approach based on short- or long-term outcomes (Briggs *et al.*, 2006; Drummond *et al.*, 2005), these approaches rely on translating the process or intermediate outcomes into a common outcome denominator, such as DALYs or QALYs. However, for interventions that have a diverse range of short-term outcome measures, a cost-consequence analysis is also appropriate. This approach is defined as an analysis 'in which costs and effects are calculated but not aggregated into quality-adjusted life-years or cost-effectiveness ratios' (Russell *et al.*, 1996). This method is used to display all the key costs and consequences associated with the intervention for the purpose of comparison; the consequences are expressed in the most appropriate natural units for each outcome measure. This approach is particularly relevant when a wide range of multidimensional process outcomes are of interest for a particular intervention (Godber, Robinson and Steiner, 1997). The information presented in this format is understandable and usable for non-health economists (Mauskopf *et al.*, 1998), and it also overcomes the need for complex economic modelling to estimate the long-term effects expressed in terms of a single common outcome. This approach has been used in many studies in recent years (e.g. Burger, 2010; Ritchie *et al.*, 2005; Bergmo, 2009; Barnett *et al.*, 2009).

However, the primary limitation of this approach is that it does not produce cost-effectiveness estimates in terms of cost per unit of outcome. Moreover, there is no generic measure of outcome to allow comparison across several conditions. Hence, cost-consequence analysis has limited application to situations where a single index cannot be used or is not meaningful.

Costing study

A costing study evaluates the costs associated with the delivery of an intervention; hence, a costing study should consider all relevant costs, depending on the perspective of the cost analysis (perspective is discussed in detail later). A costing study is a form of partial economic evaluation because only the costs are examined without reference to outcomes. However, this does not imply that a costing study is unimportant, as such studies are crucial for examining the budgetary implications of health services (Drummond, 2005) and represent an important stage in our understanding of the economic consequences of the workstreams for the health services and the funding bodies. Moreover, a costing study represents an important intermediate stage for future CEAs.

Costing studies may use either a top-down or bottom-up data registration approach, and may be prospective or retrospective in relation to time. Cost-related data for costing studies may be obtained from accounting systems, budgets (allocated or spent), billing histories, accounting and statistical reports and other information systems.

A.2.1.4　　Perspective of the economic evaluation

The perspective of an evaluation is important to the decision-maker, in order to determine to whom the costs incur. This matters because an intervention might be cost-effective from one point of view (e.g. a societal one) but not from another (e.g. a health care provider view). Hence, stating the perspective adopted is therefore an essential task for researchers and is consistently recommended in guidelines for economic evaluations. The two commonly used perspectives in economic evaluations are the health services perspective and the societal perspective. The former evaluates only the costs incurred by health service providers and associated organisations directly or indirectly engaged in providing care, such as the IPs in the case of the CMAM programme and the YCF interventions. However, the societal perspective also includes costs incurred by health

service users (i.e. patients and carers) and other members of society who may be directly or indirectly affected by the intervention (or no intervention).

In the case of developing countries, the perspective of an economic evaluation can be crucial. This is because the costs (direct and indirect) incurred by patients and their family members can be significant compared to the actual health-related costs incurred by the health care systems. For example, out-of-pocket payments for medication, food, transportation and informal payments can amount to significant sums. Moreover, the opportunity cost of visiting health facilities can be huge due to wage loss. If such matters are taken into account, these costs can potentially make up a significant amount of the total societal cost of interventions.

There is no consensus on which perspective should be used in an economic evaluation. In developing countries, there are no guidelines for such evaluations. Some reimbursement agencies in more developed countries, such as England and Wales' National Institute of Clinical Excellence, recommend that cost should be adapted from the National Health Service and Personal Social Services perspective. The National Health Service perspective determines the mix of interventions that would maximise health outcomes within the limited health care budget.

The advantage of using the societal perspective in economic evaluation is that it provides an estimate of the value of the societal return of health services investments. However, estimating societal costs may be time-consuming and resource-intensive and is therefore not always included in economic analyses. Moreover, in some cases the decision-maker is not interested in the opportunity cost and out-of-pocket expenditures of the beneficiaries of health services.

Below we present a summary of cost elements that are included or excluded based on the perspectives of economic evaluation.

Table 21:   Inclusion and exclusion of costs by perspectives

Cost elements	Perspectives			
	Societal	**Public purchaser**	**Private purchaser**	**Provider**
Health service costs	All	Covered expenses	Covered expenses	Expenses of provided services
Productivity costs	Included	Excluded	Excluded	None
Informal carers	Included	Excluded	Excluded	Excluded
Transportation	All	If any paid	If any paid	Excluded
Other non-health service costs	All	If any paid	If any paid	Excluded

Source: Luce (1996)

A.2.1.5   Focused review of economic evaluations of nutrition interventions

We undertook a focused literature review to identify previous economic evaluations in CMAM and IYCF programmes to review the evaluation approaches used in the economic analyses, outcomes evaluated, data sources used and types of costs considered. The literature search was targeted to assist with the current study and was not intended to be a systematic review.

We identified three relevant studies that reported full economic evaluations of interventions aimed at reducing severe malnutrition in children. One of these studies was an evaluation of the CMAM programme in Malawi (Wilford *et al.*, 2011). We did not find any economic studies that evaluated the cost-effectiveness/cost-utility of any IYCF programmes. However, we found a health

technology assessment report that evaluated the economic impact of interventions promoting breastfeeding. We will summarise all four studies below. Lessons drawn from these studies have been used directly to inform the design methodology proposed in this document.

Wilford *et al.* (2011)

Wilford *et al.* (2011) evaluated the cost effectiveness of a CMAM programme among children under five in Dowa district, Malawi.

A decision tree model was used to evaluate the cost-effectiveness of CMAM integrated into existing health services compared with the *status quo* (existing health services without CMAM) in Dowa district. Hence, the first two branches of the decision tree represented areas where CMAM was implemented against non-programme areas. Each malnourished child may be treated by the CMAM programme or the alternative programme or may go untreated. Each scenario was further divided into additional decision nodes, i.e. children in the CMAM programme exit the OTP facility in one of four possible ways: cured, died, non-recovered, or referred to the inpatient therapeutic programme due to complications. A child is assumed to be non-recovered after missing two consecutive fortnightly visits. These nodes are further divided until a terminal node of alive or death is reached. The proportion of malnutrition cases assigned to each node and its respective mortality was based on the data collected from the Dowa CMAM programme.

The study was based on a health services perspective. The outcome (effect) was based on the DALY, which was estimated using the decision tree model for each treatment pathway (scenario). The incremental cost and effect of the two scenarios was used to estimate the incremental cost per DALY averted. This decision tree is an extension to the original Bachmann (2009) study; however, this present study includes an option of non-CMAM care alongside CMAM and no treatment.

The cost of the CMAM programme was broadly separated between capital cost (cars, motorbikes and computers, which amounted to 3% of the total cost of the programme) and recurrent cost (97% of the total cost). Recurrent cost included: RUTF (32%), administration (24%), direct staff (19%), transport (8%), others (surveys/reviews, HIV and AIDS mainstreaming, upgrading storage – 5%), clinic staff (5%), training (2%), medical supplies (1%), and inpatient costs for OTP facility referrals (1%). All costs were converted into 2007 USD for the purpose of analysis.

The cost-effectiveness results showed that the ICER of implementing CMAM integrated into existing health services was $42 per DALY averted (or $1,365 per life saved), which is well within the Gross National Income *per capita* threshold of $250 (World Bank, 2008).

We identified a few limitations of the Wilford *et al.* (2011) study. First, the perspective was limited to health services. Hence, patient-related resource use (e.g. time taken off work, health-related expenses, etc.) was not considered in this study. Second, the capital costs did not include the cost of new building work, renovation of office premises and the depreciation cost of existing facilities. Moreover, the cost of inpatient stays appears to be very small in comparison to other cost elements (i.e. 1% of the total cost), which would need to be further investigated. Further limitations are identified in the paper itself.

Bachmann (2009)

Bachmann (2009) assessed the cost-effectiveness of community-based therapeutic care (CTC) against no treatment for children with SAM in Lusaka, Zambia. This study later served as a precursor for the Wilford *et al.* (2011) study.

The CEA was based on a decision tree model and the health services perspective was used for cost and effectiveness. Two scenarios were considered: CTC or no treatment. Children receiving CTC could have one of four possible outcomes: referred to hospital, defaulted, died, or recovered. For the no treatment group, mortality was based on children's HIV status. This option was not considered for the CTC group because the HIV status was not known for most children and also some of the symptoms would already be incorporated into CTC outcomes.

The probability for each option was used in the model to estimate the expected rate of outcome (i.e. recovery or death). Relevant costs were also added into the model with the exception of the no treatment option. Effectiveness was measured in terms of DALYs. Mortality rates were based on a community-based cohort study conducted in Malawi and Uganda.

The relevant cost components used in the model included: health centre visits, RUTF, hospital admissions, community mobilisation, and technical support. All costs were converted to 2008 USD.

The cost-effectiveness results showed that the cost of CTC was $1,760 per life saved and $53 per DALY gained. The cost-effectiveness acceptability curve showed that, at a willingness to pay of at least $88 per DALY gained, CTC was more than 80% likely to be cost-effective.

Ashworth and Khanum (1997)

Ashworth and Khanum (1997) assessed three alternative cost-effective approaches for treating severely malnourished children in Bangladesh. The study was based on a longitudinal, prospective controlled trial conducted to evaluate the most cost-effective treatment for severe malnutrition. In total, 573 children were sequentially allocated to three treatment groups. The three main treatment options evaluated were: inpatient management, day care, and domiciliary care.

The cost component was categorised into institutional cost and parental cost. Institutional cost comprised capital cost, salary cost, utilities, laboratory tests, medical supplies and food costs. Parental cost comprised transport costs, wage loss of working mother and child food cost (day care). The cost-effectiveness was evaluated as the total cost (institutional and parental cost) to achieve 80% weight-for-height. All costs were reported in USD.

The study showed that the institutional cost of inpatient treatment was 2.6 times more than for day care, and 5.3 times higher than domiciliary care. When combined institutional and parental costs were considered, domiciliary care was 1.6 times more cost-effective than day care and 4.1 times more cost-effective than inpatient care.

This study is more comprehensive in terms of collection of cost data than the earlier studies. However, the study did not use a generic measure of effectiveness that can be compared across health programmes.

Renfrew *et al.* (2009)

The objective of this study was to estimate the long-term costs and benefits of enhanced staff contact in promoting breastfeeding to mothers whose infants were admitted to neonatal units.

The rationale of the model structure was that enhanced staff contact increases milk expression; in turn, it was assumed that this would lead to increased milk consumption by the infant. Milk consumption was then assumed to reduce the incidence of illness episodes, thereby improving long-term health outcomes. The health benefits evaluated were in the form of QALYs.

Population: All mothers with infants (<2500g) in neonatal units. Weight-based subgroups were developed with the rationale that the incidence of diseases increases greatly as the birth weight decreases: 500–999g, 1,000–1,749g, 1,750–2,500g. A health care perspective was used, and costs and benefits were discounted at the annual rate of 3.5%.

Intervention: In the base case model two interventions were evaluated: enhanced staff contact – the addition of specially trained staff, which would be available to advise and support mothers on milk expression and breastfeeding – compared with normal staff contact, i.e. no addition of specially trained staff.

Model: The model divides the population into those women who intend to breastfeed and those who do not intend to breastfeed prior to their infant's birth. The model was designed to capture the health effects for three different levels of milk consumption: all own mother's milk, some mother's milk (supplemented by formula in the base case) and formula alone. The literature suggests that there are potential cost and benefit differences in the different levels of mother's milk consumption.

Clinical outcomes: In hospital clinical outcomes were sepsis and mortality. Sepsis was further divided into Gram-negative, Gram-positive and fungal infection. Resource use and utility outcomes were captured by these subdivisions of clinical outcomes.

Long-term outcomes: QALYs were used as a long-term outcome. The outcome was linked to disability by mean of neurodevelopment impairment, which is a composite measure that captures many elements of disability including visual, hearing and mobility impairments. The neurodevelopment impairment scores were divided into four categories: no, mild, moderate, and severe disability. The utility values for each of the health states were then used to quality weight life expectancy. Life expectancy for infants in each of the four disability states were taken from Colbourn *et al.* (2007). A combination of life expectancy and utilities were used to derive QALYs for each of the disability states.

A.2.1.6   Aim of the economic evaluation

The aim of this ORIE study is to evaluate the incremental cost-effectiveness (or cost-utility) of the CMAM programme (workstream 1) and the IYCF interventions (workstream 2) compared to routine care, and to evaluate the costs associated with delivery of the micronutrients and deworming programme (workstream 3) and integration of direct nutrition interventions into routine health services (workstream 4) in northern Nigeria.

Specific objectives of the study include:

a. To estimate the direct and indirect costs associated with implementation of the CMAM and IYCF interventions;

b. To evaluate the health-related outcomes associated with the CMAM and IYCF interventions for the purpose of economic evaluation;

c. To evaluate the cost-effectiveness of the CMAM and IYCF interventions compared to routine care in northern Nigeria; and

d. To evaluate the direct provider-related costs associated with the implementation of workstreams 3 and 4.

A.2.1.7 Study methodology

Overall approach of the economic evaluation of the CMAM programme and the IYCF interventions

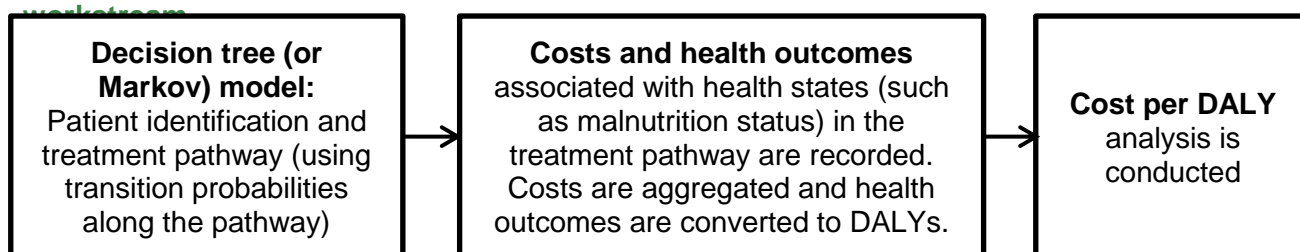**Separate workstream-specific evaluation or joint evaluation?**

For the purposes of an economic evaluation, it is important that the interventions being compared are targeted toward the same condition, such as severe malnutrition. Since the two programmes being evaluated in this study (i.e. CMAM programme and the IYCF interventions) have different objectives and different target health conditions, health outcomes and even population groups, we propose that, for the purposes of the economic evaluation, the CMAM and IYCF interventions are evaluated and reported on separately. Moreover, the two programmes work or can work independently of each other. For instance, the CMAM programme is operational in several countries as an independent programme in itself. The programme has been evaluated and published as such in the following four countries: Zambia, Ethiopia, Malawi and Bangladesh. We strongly believe that, besides the technical reasons outlined above, a separate economic evaluation to determine the VfM of each workstream can be crucial for decision-makers.

However, we acknowledge that DFID as the funding institution may require that the two workstreams are evaluated together as one programme. Hence, although we do not recommend that the workstreams are evaluated jointly, one such potential joint approach is discussed later on.

CMAM programme (Workstream 1)

We propose to conduct a full economic evaluation of the CMAM programme based on a cost-utility approach (i.e. cost per DALY method) outlined above. Following Wilford *et al.* (2011) and Bachman *et al.* (2009), we propose that a decision tree model (or an alternative Markov model based on the same principles) is developed for the evaluation of the CMAM programme to evaluate the cost per DALY of the intervention compared to non-CMAM programme care. The decision model (discussed below) evaluates patient treatment pathways (from identification of malnutrition to treatment to health outcomes) based on the probability of different outcomes along the pathway for the alternative interventions being compared. Costs and health outcomes along the pathway are evaluated and aggregated. Health outcomes (i.e. malnutrition-related health state) are converted into DALYs (as discussed in the cost-utility section above). Costs and outcomes are subsequently evaluated together to estimate the incremental cost per DALY for the intervention (i.e. CMAM programme) compared to routine care. This approach is summarised in the figure below. The detailed decision tree approach will be discussed in the following sections.

Figure 5:   Proposed approach for the economic evaluation of the CMAM programme workstream

Decision tree (or Markov) model: Patient identification and treatment pathway (using transition probabilities along the pathway) → **Costs and health outcomes** associated with health states (such as malnutrition status) in the treatment pathway are recorded. Costs are aggregated and health outcomes are converted to DALYs. → **Cost per DALY** analysis is conducted
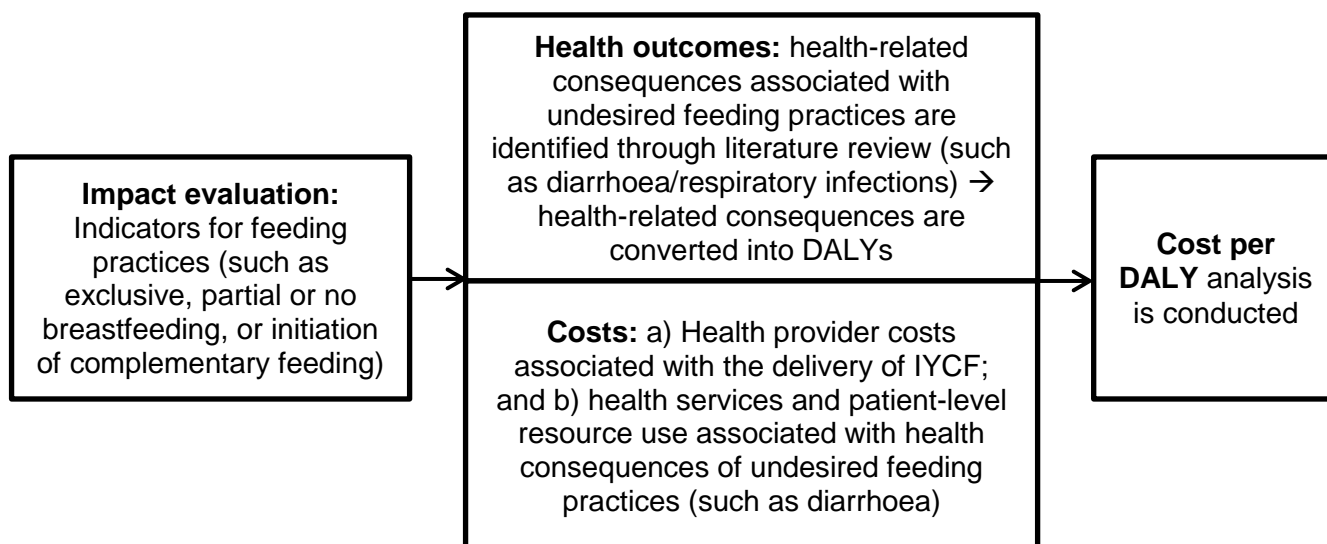
IYCF interventions (Workstream 2)

For our evaluation of the IYCF intervention, we propose two alternative options:

- A model-based cost-utility analysis where the intermediate outcomes of breastfeeding (and possibly weaning and complementary feeding) can be converted into a generic utility-based measure of DALY or QALY as presented in the literature review above (see Health Technology Assessment report);

- Cost-consequence analysis (discussed above);

The cost-consequence analysis is relatively straightforward as it does not require the aggregation of multiple outcomes to generate a single outcome. However, for decision-makers intending to compare across programmes, such an approach may have limited application. The other alternative, i.e. the cost per DALY approach, is similar to the approach proposed for the CMAM programme; however, unlike malnutrition, it is not straightforward to derive disability-weighted outcome measures for breastfeeding, weaning and complementary feeding outcomes. Nevertheless, an indirect approach has been used in the literature. In this approach, indicators of feeding practices (such as whether or not a child is breastfed) are obtained from an impact evaluation; following this, estimates of the probability of the health-related consequences of undesired feeding practices (such as no EBF) are obtained from the literature for the specific population or the closest population group. Subsequently, the disability weights are attached to health-related consequences based on the estimates available in the literature – this allows us to calculate DALYs associated with the intervention. The same is done for the control areas to obtain DALY estimates. To estimate cost data, intervention-related costs for the providers are obtained using the institutional cost approach (discussed later). Furthermore, the health services costs and patient-related costs associated with treating health-related consequences (such as diarrhoea) are obtained. All the cost data are aggregated and compared against DALYs to obtain the cost per DALY. This approach has been used in several studies (including Renfrew *et al.* (2009) presented above) and is recommended for full economic evaluation. The approach is summarised in the figure below.

Figure 2: Proposed approach for the economic evaluation of the CMAM programme workstream

Combined analysis of CMAM and IYCF interventions

While we recommend that the economic evaluation of the CMAM programme and the IYCF interventions workstreams are conducted and reported on separately (i.e. that the costs per DALY

are estimated separately for the two programmes), the evaluation of the two workstreams can potentially be combined. This may only make sense if the resources used for the two workstreams have a significant degree of overlap, such as the use of community health workers. For a combined evaluation, the health benefits of the two programmes, expressed in terms of a common currency (i.e. DALYs averted), can be combined to estimate the combined effect in terms of DALYs averted; this outcome measure is then evaluated against the costs associated with implementing the two workstreams.

However, in this case, it is **crucial to avoid double counting costs and outcome benefits**. Some of the health service resources may be common across the two workstreams, such as support/advice provided by community health workers or high-level supervision provided by senior management. It is important that such costs and any health benefits that may be common to the two workstreams are identified early on through discussions with programme delivery teams and that the evaluation process reflects these common costs and outcomes to avoid double counting.

Micronutrient interventions and deworming (workstream 3) and integration of direct nutrition interventions into routine health services (workstream 4)

While an outcome evaluation of workstreams 3 and 4 is not part of the impact evaluation exercise (as no outcome data will be available for them), these workstreams can/will be evaluated as part of the economic evaluation. We propose that the economic evaluation of workstreams 3 and 4 takes the form of a costing study or cost analysis.

The costing study will take a health provider or institutional perspective. Further details are discussed in the following section.

Table 22:   Proposed approaches for the economic evaluation

Programme	Approaches for the economic evaluation	
CMAM intervention (Workstream 1)	Cost-utility analysis (cost per DALY)	
	Options	
IYCF intervention (Workstream 2)	Cost-utility analysis	Cost-consequence analysis
Micronutrients/deworming (Workstream 3)	Costing study	
Integration of direct nutrition interventions into routine health services (Workstream 4)	Costing study	

A.2.1.8   Framework for the economic evaluation

It is common practice in economic evaluations to use decision tree models or Markov models, especially in situations when the aim is to evaluate the long-term cost-effectiveness of interventions. The decision tree represents a sequence of events with different probabilities along the pathway with associated costs and health outcomes. The decision tree is then rolled back to estimate the expected costs and expected health benefits of interventions and comparators. These values can be averaged on the basis of the likelihood, or probability, of each path in the tree.

CMAM programme model: the decision tree approach

The decision tree approach was also used in the Wilford *et al.* (2011) study, which also evaluated the cost-effectiveness of a CMAM programme. Similarly, Bachmann (2009) also used the same approach. An alternative approach would be to develop a Markov model, which is a cohort model that is commonly used when the decision tree becomes too unwieldy with recurrent events or when time is an important consideration in the transition pathway. For relatively simpler cases, the decision tree approach is usually appropriate and sufficient; however, we suggest that the option to

use a Markov model should be considered if it becomes obvious that more states and/or decision nodes are required than can be comfortably handled by the decision tree.

We propose that the economic analysis is based on a decision modelling approach that uses a decision tree or Markov model. The decision tree approach is close to the method used by Wilford *et al.* (2011). However, our interpretation of the Wilford model suggests that it has several limitations that can be improved upon in this study:

- The Wilford *et al.* (2011) model is primarily a treatment-based model, i.e. it does not explicitly model community-based case findings; this is an important and integral part of the CMAM programme. We propose that the model in this study starts by introducing probability at the start of the decision tree to take into account the case finding of a malnourished child who is then referred to outpatient or inpatient therapeutic care.
- The Wilford *et al.* (2011) model was based on a health services perspective but we propose that a societal perspective is taken to capture the full impact of the WINNN interventions on society.
- The Wilford *et al.* (2011) study did not collect any data from control or non-CMAM programme sites, and made assumptions around programme effectiveness. This is a serious limitation that we propose addressing in the current study.
- Wilford *et al.* (2011) assumed that the no treatment arm did not incur any costs. We think this assumption needs to be evaluated.
- Wilford *et al.* (2011) used several other assumptions when data were not available. The validity of some of these assumptions may be contestable. We propose that robust data are collected so that fewer assumptions are made.
- We do not see that the Wilford *et al.* (2011) model considered the cost of death, i.e. the high expenditure associated with healthcare before death.

Thus, the Wilford *et al.* (2011) model should be revisited and further areas of improvement should be explored. However, we agree with the general approach of using a decision tree for this purpose, although as noted above the need for a Markov model should be revisited later on. We understand that there may be opportunities to contact the authors directly to better understand the model parameters and how our study can improve on them.

For illustration purposes, we present a modified version of the decision tree presented by Wilford *et al.* (2011). It should be noted that the decision tree is likely to be modified at a later stage. The required model parameters will be discussed in the cost and outcomes sections.

Figure 6:   Decision tree for the CEA of the CMAM programme
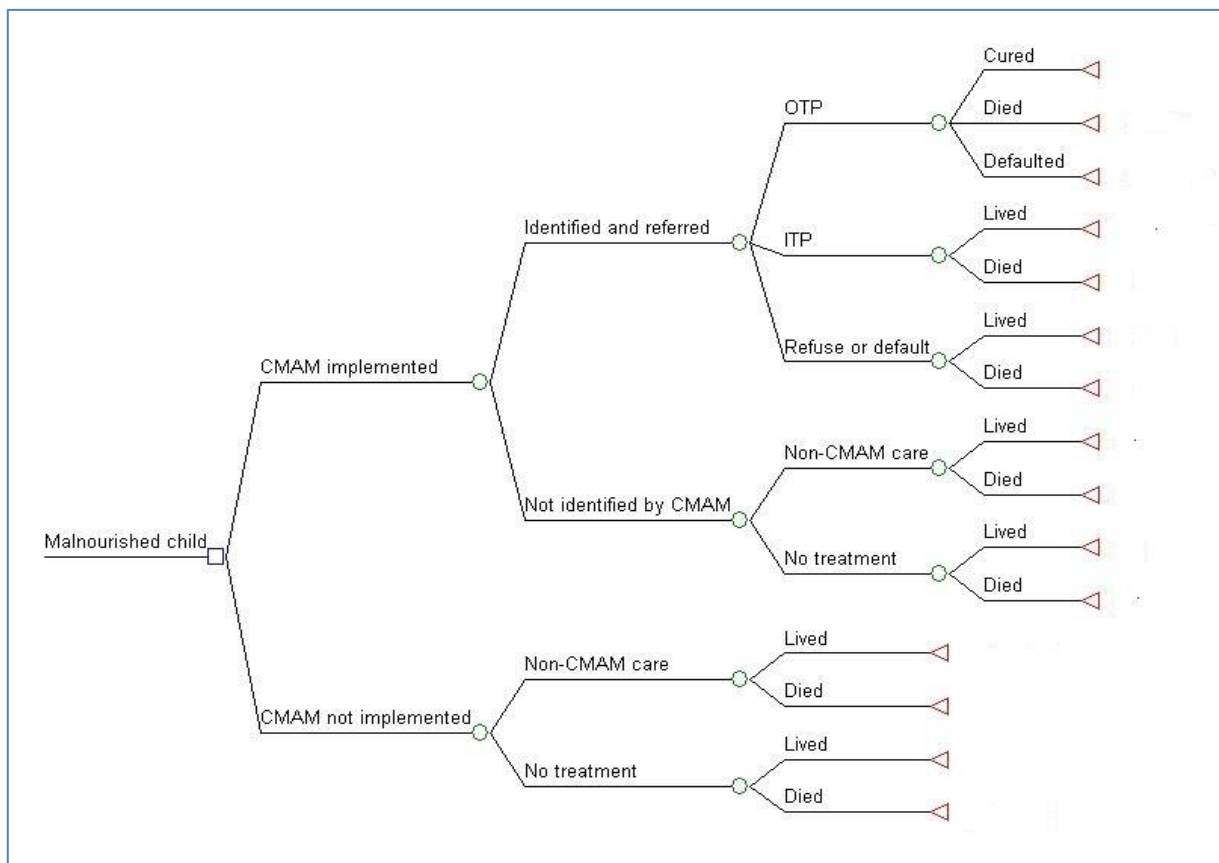
Analysis of the IYCF interventions workstream

As discussed earlier, the analysis of the IYCF intervention will take one of the two forms: a cost-utility analysis or a cost-consequence analysis. We propose that the cost-utility analysis option should be explored first because it would allow decision-makers to compare the VfM of the IYCF intervention against other competing interventions. While the outcomes of IYCF interventions cannot be directly associated with disability or utility weights, we propose that the immediate outcomes from the impact evaluation (e.g. breastfeeding rate) are mapped onto the probability of longer-term benefits in terms of health-related consequences averted (such as diarrhoea, respiratory infections or possibly other infections), which are then used to estimate DALYs averted. We have presented one study in the literature review section (Renfrew *et al.*, 2009) that conducted such an analysis for an intervention aimed at promoting breastfeeding.

Analysis of workstreams 3 and 4: costing study

Cost studies are usually conducted to provide budgetary estimates or to estimate the costs of a programme initiative. The costing study of workstreams 3 and 4 will be conducted from a provider's perspective to capture all programme-related costs. These are discussed in detail later and will include programme investment costs and operational costs, including staff salaries, procurement and distribution of supplies (such as Vitamin A capsules for children and iron and folic acid for pregnant women), supervision costs, training costs and travel costs.

A.2.1.9   Perspective of the economic evaluation

As discussed above, it is important to establish the perspective of an economic evaluation. Both health services and societal perspectives have been used in economic evaluations of interventions targeting severe malnutrition (presented in the literature review section above). Wilford *et al.*

(2011) conducted a cost-per-DALY analysis of the CMAM programme using a health services perspective. No patient-related costs were included in the analysis. Similarly, Bachmann (2009) used the same approach and focused only on the health services perspective. However, Ashworth and Khanum (1997) used a societal perspective to include parent-related costs such as transport costs, wage loss for working parents, payments to neighbours for looking after the family in the mother's absence and child's food cost when at home. However, the costs of out-of-pocket expenditure on health services were not considered.

We propose that, for the full economic evaluations of the CMAM programme and the IYCF interventions workstreams, the preferred option is to take a societal perspective. The potential cost elements to be included in Table 21 presented earlier are discussed in detail in the following section. There are several reasons for proposing a societal perspective for this analysis: 1) a societal perspective in an economic evaluation provides an estimate of the return of investment on health services for society; 2) the burden of malnutrition and the burden of care seeking have direct cost implications for households; and 3) a restricted budget perspective is inconsistent with decisions based on willingness to pay for DALYs. However, for pragmatic reasons we propose that due consideration should be given to both perspectives. In the following discussion on cost components, we will discuss all relevant costs, including societal costs. A decision can be reached later in terms of which perspective should be adopted.

Costing studies generally tend to take a provider's perspective. This is mainly because the aim of the costing study is to provide budgetary estimates or to estimate the costs of a programme initiative to the provider. A broad health services or societal perspective is more appropriate when a full economic evaluation is planned. For the current scenario, we propose that all costs associated with delivering workstreams 3 and 4 are captured during the evaluation using the provider's perspective.

In the following sections, we discuss the costs and outcomes to be included in the economic evaluation. We present specific cost components, line items, potential sources, method of data collection and process of cost estimation. We will also discuss a CMAM-specific costing tool that has been developed by Food and Nutrition Technical Assistance (FANTA). Following this, the next section will discuss the outcome measures required for the economic analysis and their potential sources, and will also identify the sources used by previous studies.

A.2.1.10 Cost components of CMAM programme and the IYCF interventions

Two broad categories of cost for economic evaluation

The following cost elements will be collected for the evaluation of all four workstreams:

1. **Programme delivery costs (A):** these include capital costs, fixed operating costs and variable operating costs, which are outlined in the table below. These cost elements relate to programme inputs for service delivery, monitoring, training, supervision, community visits to households and provision of curative care. These costs are discussed in detail in the following section.

2. **Household costs (B):** these costs relate to household expenditures in relation to the health condition. As discussed above, the household costs will only be considered in the evaluation of workstreams 1 and 2 and will not be part of the costing study of workstreams 3 and 4.

For programme delivery costs of all workstreams, the CMAM cost template from USAID's FANTA-2 project (summarised later in the document) will be used. This document can be adapted to suit

workstreams 2–4 and will ensure that cost elements are captured in a standardised format across all workstreams.

Programme delivery costs (A)

Programme costs may be incurred by the IPs, i.e. UNICEF, Save the Children, and ACF, and the government health provider that provides care. Hence, during the process of evaluation, all programme-related costs should be evaluated for all organisations involved in the delivery, management, supervision or other directly related activities of the programme.

The programme components of the CMAM intervention can be represented by the diagram below, which shows community outreach services, outpatient services, inpatient care and services and programmes addressing management of malnutrition. Based on this, the cost components can be identified and are listed below.

Figure 7:   Programme-related components of the CMAM intervention
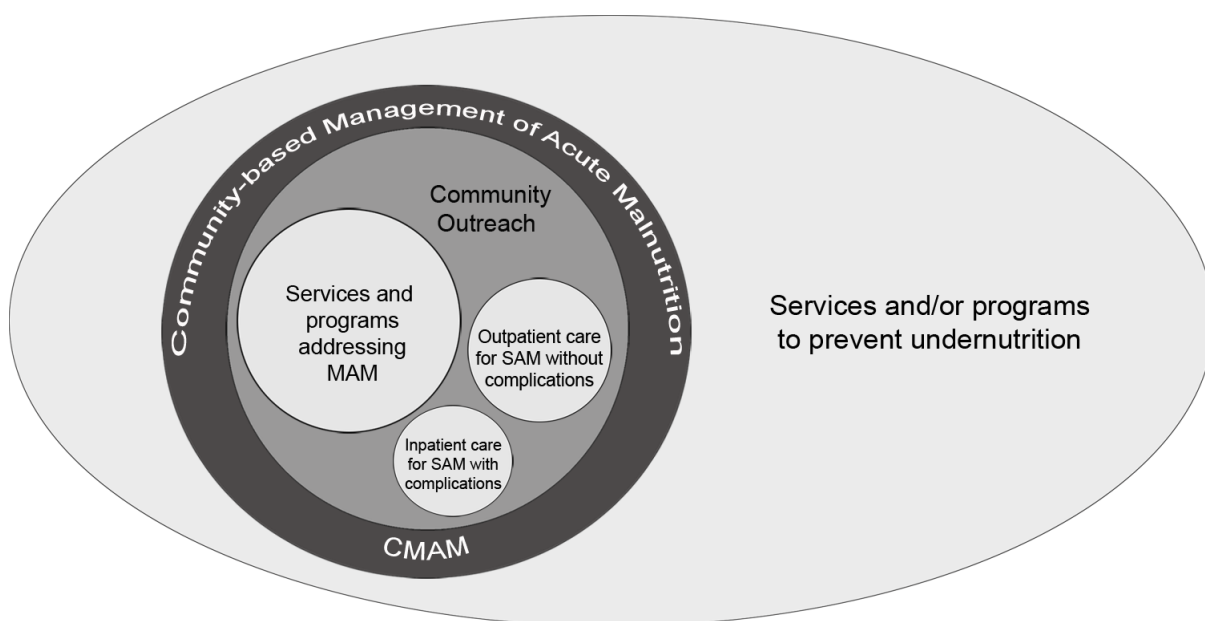
Source: UNICEF (2013)

Activities that will incur costs in the CMAM programme:

- **Treatment** (or case management) of children with SAM (on either an inpatient or an outpatient basis);
- **Community outreach** in support of the management of SAM;
- **Supply logistics** (transportation and storage of supplies, especially of RUTF and other therapeutic food);
- **Training** of health care providers and health managers;
- **Supervision** of health care providers and health managers; and
- **Management** of the service/programme (e.g. planning, budgeting, monitoring).

Activities that will incur costs in the IYCF interventions:

Similarly, the cost components of the IYCF interventions are listed below:

- **Mothers' support group training** and other training;

- **Information, education and communication** materials;
- **Sensitisation** and community outreach;
- **Training** of health workers;
- **Supervision** of health care providers and health managers;
- **Management** of the service/programme (e.g. planning, budgeting, monitoring);
- **Festivals** (e.g. breastfeeding weeks); and
- **Mass media**.

For the economic evaluation of the IYCF intervention, the last two cost elements may not be included in the analysis.

Activities that will incur costs in workstreams 3 and 4:

- **Supply logistics** (procurement, transportation and storage of supplies, especially Vitamin A capsules for children and iron and folic acid for pregnant women);
- **Distribution costs**;
- **Training costs**;
- **Supervision** of health care providers and health managers; and
- **Management** of the service/programme (e.g. planning, budgeting, monitoring).

Household costs related to health conditions

These costs are related to household out-of-pocket expenditure or opportunity costs associated with the health condition. For instance, for the evaluation of the CMAM programme, the household costs may include the following:

- Out-of-pocket payments for medication;
- Informal payments;
- Expenses on transportation;
- Expenses on food;
- Employment status;
- Daily wage; and
- Payments to neighbours for looking after the family in the mother's absence.

Types of programme-related costs for all workstreams

For practical purposes of cost analysis, we propose that the above cost components are evaluated in three categories: capital costs, fixed operating costs and variable operating costs. These are defined with specific examples from the CMAM/IYCF interventions in the table below. In the following section, we have identified specific cost line items for each one of these categories, and further details are provided.

Table 23:   Types of programme-related cost included in the economic evaluation of the CMAM/IYCF interventions

Type of cost	Description	Programme-specific costs for CMAM programme and IYCF interventions
Programme capital costs	* These are direct costs that can be incurred at the start of a programme or at later stages. * These will include infrastructure-related costs, equipment and vehicle purchase costs and training costs. * To avoid losing cost-related information, it is best practice to collect this cost data early on, and also at later time points.	* Construction or start-up renovation/repair of facilities. * Depreciation of existing facilities. * Cars and other vehicles. * Computers and other office equipment.
Fixed operating costs	* These are fixed direct costs that are incurred regularly regardless of programme-related variable indicators. * These may include the salaries of staff members (full or part time), facility rents and utilities.	* Salaries of full-time and part-time staff. * Rent of facilities/items. * Utilities and other bills.
Variable operating costs	* These are variable direct costs that increase with the volume of service, and may not have much impact on cost *per capita* * These may include medical supplies, training materials, maintenance costs, supplies and variable staff costs.	* Ready-to-use food supplements. * Medication supplies. * Laboratory tests. * Vehicles (repairs and fuel). * Training costs (including training materials).

Capital costs to be evaluated for the economic analysis of all workstreams

Summaries of the cost data required, estimation methods, sources of data and assumptions are presented in the tables below. These include capital costs (i.e. costs related to starting up a nutritional programme at a health facility) and operating costs (i.e. the expenditure required to keep the facility fully functional). Operating costs are further divided into fixed operating costs, which include staff salaries, and variable operating costs, which include RUTF, medical supplies, laboratory test, utility bills, training costs and vehicle maintenance and fuel costs.

These cost elements should be thought of as programme inputs to service delivery, monitoring, training, supervision, community visits to households and provision of curative care. All cost elements below should be collected with such activities in mind.

Table 24:   Capital cost elements for CEA of CMAM/IYCF interventions

Capital costs	Who will incur the cost?	Cost estimation
Building facilities		
a. Cost of any <u>new</u> building facilities developed specifically for the programme (such as community-based treatment facilities). b. Start-up cost of renovating/restructuring <u>existing</u> building facilities used for CMAM/IYCF intervention (i.e. outpatient and inpatient treatment facilities). Also, depreciation cost of existing buildings used for CMAM/IYCF intervention will also be considered.	These costs are likely to be related to renovation/redecoration/construction of government health facilities. However, they may be incurred by the health service provider (i.e. the government) or IPs (i.e. Save the Children and ACF). Costs incurred at the central offices and local and community offices will be investigated. It is important to ensure that costs are not double counted when gathering data from multiple sources.	*Estimation of depreciation cost:* Attributable depreciation cost of building facilities will be estimated based on proportionate service activity (i.e. number of patients seen or admissions) attributable to the CMAM/IYCF intervention. A lifespan of 30–50 years will be assumed, discounted at 3% and 5%, and uniform depreciation will be used in calculations.
Equipment and furniture		
a. Purchase of <u>new</u> equipment, such as laboratory machines, and furniture for the programme (including community-based care, outpatient and inpatient facilities). b. Estimated depreciation cost of <u>existing</u> equipment shared with other services (such as machines in outpatient and inpatient facilities). Also, initial cost of repairs will also be included.	These costs can be related to purchases or use of existing equipment and furniture based at the offices of the IPs or health provider.	*Estimation of depreciation cost:* Attributable depreciation cost of equipment will be estimated based on proportionate use attributable to the programme annualised to 10 years, discounted at 3% and 5%.
Vehicles		
a. Purchase of <u>new</u> cars, motorbikes and other means of transportation for the programme and start-up repair costs. b. Depreciation cost of <u>existing</u> vehicles used for the programme.	These costs are likely to be related to IPs.	*Estimation of depreciation cost:* For vehicles used only for the programme, depreciation costs will be calculated over the lifespan of the vehicle and attributed completely to the programme. For vehicles shared with other programmes, depreciation cost will be estimated by keeping a

		log of total kilometres driven for CMAM/IYCF intervention purposes. For practical purposes, this can be done at representative sites and assumed to be constant across sites.
Computer and office equipment		
a. Purchase of <u>new</u> computer equipment and other office supplies specific to the programme. b. Use of <u>existing</u> computer equipment for the programme.	As above.	<u>Estimation of depreciation cost:</u> These costs will be annualised over three years to calculate the depreciation cost, discounted at 3% and 5%.

Operating costs to be evaluated for the economic analysis of all workstreams

Fixed and variable operating costs will be considered for all four workstreams. Details of these costs and how they should be estimated are presented in the table below.

Activity-based costing approach

For staff time operating costs (part of the operating costs), we propose to use an activity-based costing approach. This approach allocates activity-based staff time to specific programmes based on the proportion of the staff time spent on certain activities. Waters (2006) defines activity-based costing in the following way: 'Activity-based costing essentially defines the principal activities of the individuals who work within an organization, then traces costs, first, to these activities, and then from the activities to products and services. Human and financial resources within a department (production centre) are traced to activities, which are in turn traced to products and services. Allocation of personnel time among the activities becomes the principal means for assigning overhead and other indirect costs'.

This approach will be used to allocate costs to specific workstreams for staff who share work across several programmes or activities.

Table 25: **Operating cost elements for CEA of CMAM/IYCF interventions**

Type of cost	Cost details	Who/what will incur the cost?	Cost estimation
Fixed operating costs	**Staff salaries** Salaries of staff specific to the CMAM/IYCF interventions as well as non-programme-specific staff (shared with other programmes). Staff members employed by the IPs and the government will be included in the analysis based on their share of time. The staff members may be in: * Management and administrative roles * Community-based roles (although many may be volunteers) * Health facility-based (including nurses, doctors, medical assistants, district staff, district nutritionists, maternal and child health coordinators and health management information system officers). * Salaries of international staff and consultants * Salaries of staff members shared with other programmes.	A previously published CEA of the CMAM programme (Wilford, 2012) suggests that programme-specific management and administrative costs and international staff costs are incurred mainly by the IPs. However, the staff salaries of health centre staff and district staff are incurred by the government.	Staff cost attributable to the programme will be calculated based on whether staff are employed solely (full or part time) by the programme or shared with other projects. Solely employed staff costs will be equal to the salary for staff working only for the CMAM/IYCF interventions. For staff members with shared work activities, proportionate time to CMAM/IYCF interventions will be estimated by interviewing staff at each level about their role share with other programmes, and subsequently costing based on time share using salary data.
	Any rented facilities/items – to be investigated with field staff.	These can be incurred by government or IPs.	Data on rent paid divided by the time period will be used to estimate cost over the period of the programme.

Variable operating costs	RUTF * Cost of all RUTF procured and used during the study period should be documented.	A previous evaluation suggests that these costs are incurred mainly by IPs. Any government facilities used for this purpose (such as warehouses) should also be evaluated.	It should include the cost of purchase, transport from the producer's factory and warehousing. Distribution mechanisms will be explored before they are costed to avoid double counting.
	Medication supplies * Including cost of medication and other supplies used to treat patients at OTP or SC facilities.	Incurred by government facilities or IPs.	Programme-specific drug costs will be estimated based on supplies dispensed/used (or, if these data are not available, then supplies purchased).
	Laboratory tests.	As above.	All laboratory tests will be documented for each patient and their costs will be obtained from the Department of Health. If not available, their market price may be considered. Alternatively, a micro-costing approach may be used at selected facilities.
	Vehicles * Cost of repairs and cost of fuel (staff costs will be covered in the salaries category).	Incurred primarily by the IPs.	Running costs of dedicated programme vehicles will be based on financial accounts and/or receipts. Cost of shared cars will be allocated based on logs recording total kilometres driven for CMAM programme purposes.
	Utility bills (gas, electric, water, others).	As above.	Taken directly from the financial accounts of bill history.
	Training costs, including venue and per diems.	As above.	These will be calculated directly from the financial accounting records of IPs.

Available/recommended template for collection of cost data

As mentioned earlier, we are aware of the FANTA costing tool developed by USAID specifically for costing CMAM programmes in developing countries. This tool can be very useful in ensuring that all line items are captured and a standardised costing practice can be used across all CMAM programmes. Below we present a summary of the extensive list of staff salaries that are required to be captured by this tool. We propose that this tool is used as much as possible for costing purposes.

Table 26:   List of line items required to be collected by the CMAM costing tool developed by USAID

Health care providers and other staff	Provided type and functions
Central HQ	
Senior Central HQ staff (head/deputy head of department)	Manage and advocate for CMAM at national level
Mid-level Central HQ staff (programme manager)	Establish, coordinate CMAM activities
Group area HQ	
Senior group area HQ staff (graduated nutrition officers – more experienced)	Regional Nutrition Officer – management of CMAM
Mid-level group area HQ staff (technical officers)	Assistant Nutrition Officer – supervision and training of area HQ staff
Junior group area HQ staff (community health nurse or officer at regional level)	Technical Officer – monitoring/data collection and analysis and assisting with other management tasks
Area HQ	
Senior area HQ staff (District Nutrition Officer, who graduated within 1–3 years)	Nutrition Officer (graduate/technical officer) – Management of CMAM
Mid-level area HQ staff (technical officers)	Technical officers/National service officers – Supervision and training at outpatient care sites/inpatient care sites
Junior area HQ staff (community health nurses or officers at district level)	Technical officers/community health nurses – Monitoring/data collection and analysis and support to mid-level and senior staff
Outpatient care site – Health care providers	
Senior outpatient care staff (senior nurse, medical assistant – health facility in-charges)	Medical assistant/midwifes/clinical nurses – management of SAM cases, establishing community outreach, training of COWs, data management
Junior outpatient care staff (community health nurses, community health officers, and public health nurses)	Community health nurses – assisting with management of SAM cases, supervision of COWs, helping establish community outreach, data collection
Community Outreach Worker	CMAM outreach in the community (volunteers)
Inpatient care site – Health care providers	

Senior inpatient care staff (clinician, paediatrician, or other medical specialist)	Physician/paediatricians – in-house supervision of health care providers, managing SAM children with complications, data analysis
Mid-level Inpatient Care staff (clinical nurses, dieticians, graduate nutritionist)	Clinical nurses/graduate dietician/graduate nutritionist – day-to-day management of SAM in inpatient care, nursing care supervision of feeds and preparation, monitoring and reporting
Junior inpatient care staff (health aids, health extension workers)	Health aid/heath extension worker – assisting in care of SAM cases with complications, preparation of therapeutic foods, data collection
Other workers (all levels)	
Driver	Driving vehicles carrying supplies or people
Store guard	Guarding stores of RUTF

We propose that patient (carer)-related costs are also captured in this study to reflect the societal perspective of the value of the intervention compared to the control. Patient-related costs may make up a significant proportion of the total cost of the programme. Below we present a list of patient (carer)-related costs that will be captured in the current study.

Sources of cost data

Summaries of the sources of the cost data required, as well as some consideration of requirements and assumptions, are provided in the tables below.

Table 27:   Sources of cost data, requirements and assumptions

	Source of data	Requirements and assumptions	Notes
Building facilities	Capital cost: Financial accounting books and financial reports (systems). Alternatively, they can be estimated according to the local market price, using current replacement costs. Service-level activity: Hospital and outpatient records required to estimate proportion of service activity attributable to the programme.	Assumption: - Financial accounting data exists and is accessible. - Data on service-level activity is available and accessible. - Technical resources are available to carry out estimation based on the approach described. - Qualification: We recommend basic knowledge of financial accounting.	This type of cost, albeit important, is sometimes ignored in economic evaluations, partly due to the difficulty of estimation of depreciation costs (especially, cost of existing facilities). Although this is ideal, if it is a challenge to collect this cost, the approach can be revisited.

Equipment and furniture	Same as capital cost sources above.	As above.	Cost of existing equipment and furniture may not be available. Hence, replacement cost can be used and depreciation cost applied.
Vehicles	As above. In addition, vehicle logs will be required.	Vehicle logs will be required. We assume that this may be part of routine practice or can be implemented for evaluation purposes, at least in selected sites.	If vehicles logs are not available or cannot be used, an estimate of the proportionate share of use of vehicles can be obtained by interviewing selected programme staff and/or drivers at each level.
Computer and office equipment	Same as capital cost sources above.	Accounting data will be available. If not, then data on the market price of the used models will be available or can be estimated.	Cost of any relevant purchases, such as software, should be included.

Further sources of cost data were identified through our communication with Dr Kenneth Ojo in Nigeria. These are listed below. These sources will be explored with a view to identifying cost-related data and other inputs for the economic analysis.

Table 28:   Costing studies in Nigeria

UNFPA/DFID/PATHS2: Report on Costing the Integrated Maternal, Newborn and Child Health Package of Interventions

Harmonized Nigeria Living Standard Survey 2011: Data collection for poverty analysis using a welfare and expenditure approach.

The Costs and Benefits of a Maternal and Child Health Project in Nigeria, Health Policy Initiative, USAID: The Initiative completed interviews with officials from the government, health maintenance organisations and development partners, as well as academics and several primary healthcare providers, and collected information on the costs of delivering services on NHIS/MDG Maternal and Child Health Project and analysed the financial sustainability and incentive structure of the programme design.

NPHCDA Costing Ward Minimum Health Care Package. It provides an estimate of the cost of providing a minimum level of health care package at each PHC and by inference at each ward of Nigeria.

SMART Nutrition Survey in eight Sahel states of northern Nigeria, 2010/2011; Kano, Jigawa, Katsina, Kebbi, Sokoto, Yobe, Zamfara, and Borno.

Multiple Indicator Cluster Survey 4 (MICS 4) funded by UNICEF Nigeria 2010. The survey collected data on maternal and child health care and MDG health indicators.

Household Baseline Survey by Partnership for Transforming Health Systems 2 (PATHS2) 2010/11, 2011/12, Collected baseline data for health systems strengthening.

Baseline Survey on Drug Revolving Fund Programme by PATHS2.

Core Welfare Indicator Questionnaire Survey. It involves data collection for poverty analysis using a welfare approach.

Outcome measures in the economic evaluation

The other important aspect of the economic evaluation is the outcome data. These are the model parameters that will inform the decision model. These data will be collected through various

sources and using different methods. Where possible, we have proposed that data on outcome parameters for the economic analysis are collected alongside the impact evaluation. Details of the model parameters and their sources are presented below.

A.2.1.11   Outcome measures for evaluation of the CMAM programme

Table 29:   Model parameters, sources of data and method of data collection

Model parameters	Source	Method
Prevalence of malnutrition		
Prevalence of moderate and severe malnutrition in under-fives in programme evaluation areas.	- The ORIE baseline population survey (impact evaluation).	- Random sample of households within each LGA.
	- Other sources: Demographic and Health Survey (DHS) of Nigeria (report available online). - Other data sources and major reports.	- Focused literature search for published reports/papers based on DHS, Nigeria. - Further data or reports may be available from or through Dr Kenneth Ojo's team at the Centre for Health Economics and Development, Nigeria (we have had direct correspondence through Aly Visram).
Identification and referral to OTP/SC facility in CMAM programme areas		
Probability of identification and referral to OTP facility for moderate malnutrition in CMAM programme implemented areas **[Pr(OTP)].**	- The ORIE impact evaluation survey.	- The ORIE impact evaluation survey will evaluate the malnutrition status of children and establish whether or not the malnourished patient was identified and referred to OTP/SC facility through the CMAM programme
Probability of referral to SC facility for severe malnutrition in CMAM programme implemented areas **[Pr(SC)].**	- As above.	- These data will be used to estimate the probability of being referred to OTP/SC facility, given moderate malnutrition.
Probability of refusal or default without seeking referred care in CMAM programme implemented areas **[Pr(RD)].**	- As above.	- As above - Alternatively, patient records available with the CMAM programme community team will be evaluated against OTP and SC facility attendance data to estimate default and refusal rates.
Probability of not identifying malnutrition through CMAM programme **[Pr(notI)]**		$[Pr(notI)] = 1 - [Pr(OTP) + Pr(SC) + Pr(RD)]$
Probability of seeking non-CMAM programme outpatient or inpatient care for	- As above.	- The ORIE impact evaluation survey.

malnutrition among those not identified by CMAM programme (in CMAM programme areas).		
Type of non-CMAM programme care sought for malnutrition.	- As above.	- The impact evaluation survey will ask about the kind of non-CMAM programme care sought.
Referral to OTP/SC facility in non-CMAM programme areas		
Probability of seeking outpatient care for malnutrition in non-CMAM programme areas.	- Same as for CMAM programme areas – based on data collected from control sites.	- Same as for CMAM programme areas.
Type of outpatient care sought.	- As above.	- The impact evaluation survey will ask about the kind of non-CMAM programme care sought.
Probability of referral (including self-referral) to inpatient care for malnutrition in non-CMAM programme areas.	- As above.	- As above.
Outcome of care at OTP facility in CMAM programme areas		
Probability of being cured during treatment at OTP facility/community-based treatment.	- CMAM programme data.	- Routine data collection system will be put in place to collect patient-level data for all children seeking care at OTP facility over a period of 12 months (preferably once the programme is well established).
Probability of death during treatment at OTP/community-based treatment.	- As above.	- The database should collect the following outcome data for each patient seeking care at OTP facility: cured, referred to SC, died or refusal or discontinuation of treatment, revisit during the 12-month period for malnutrition.
Probability of referral to SC facility during treatment at OTP facility.	- As above.	
Probability of refusal or discontinuation of treatment at OTP facility.	- As above.	
Outcome of outpatient care in non-CMAM programme areas		
Probability of being cured during outpatient treatment in non-CMAM programme areas.	- Data from non-CMAM programme facilities.	- A routine data collection system will be established for control OTP facility area/s and the abovementioned data should be collected.
Probability of death during outpatient treatment in non-CMAM programme areas.	- As above.	
Probability of referral to SC facility during treatment at OTP facility.	- As above.	
Probability of refusal or discontinuation of non-CMAM	- As above.	

programme outpatient treatment in non-CMAM programme areas.		
Outcome of SC facility care in children directly referred to SC facility through CMAM programme		
Probability of being cured during treatment at SC facility.	- Hospital routine data.	- A routine data collection system will be put in place to collect patient-level data for all children seeking care at SC over a period of 12 months (during the same period when data from OTP facilities are being collected). The database should collect the following outcome data for each patient seeking SC care: cured, referred to OTP facility, died or refused or discontinued treatment.
Probability of death during treatment at SC facility.	- Hospital routine data.	
Probability of refusal or discontinuation of treatment at SC facility.	- Hospital routine data.	
Outcome of care at SC facility for non-CMAM programme patients/areas		
Probability of being cured during treatment at SC facility.	- Hospital routine data.	- As above.
Probability of death during treatment at SC facility.	- Hospital routine data.	
Probability of refusal or discontinuation of treatment at SC facility.	- Hospital routine data.	

Below we summarise the main categories of data that will be required for the economic evaluation (as presented in detail above), and the sources/studies proposed in this design document.

A.2.1.12   Outcome measures for evaluation of the IYCF interventions

As discussed in the methods section, the outcome measures for the economic evaluation of the IYCF interventions are the same as the outcome measures of the impact evaluation, i.e. young children and infant feeding related outcomes. These outcomes will be converted into probabilities of health consequences (as discussed earlier) and subsequently converted into DALYs. Hence, the outcome data for the evaluation of IYCF interventions will come from the impact evaluation exercise.

Sampling strategy for data collection (cost and outcome data)

In order to get a representative sample of the population to reflect the costs and outcomes associated with the programme, we propose that variation across states and between LGAs within states should be considered. With regards to the economic evaluation, the functional capacity/performance of the healthcare system, level of disease burden, socioeconomic gradient and cultural differences are among the variables of interest.

For the impact evaluation exercise, stratified random samples of households will be collected from four states, i.e. Zamfara, Jigawa, Kebbi and Katsina. Within each state, two or three LGAs will be selected and then households will be randomly selected within each LGA. The expected sample size for each state is 500 households for the intervention group and 500 for the control group within each state.

We have had a detailed discussion with Dr Kenneth Ojo of the Centre of Health Economics in relation to variability across states and between LGAs to achieve a representative sample in terms of variability in the factors outlined above. Based on this, we propose the following:

1. Cost and outcome data are collected from two states only, Jigawa and Zamfara. Jigawa is in the North East while Zamfara is in North West of Nigeria. Jigawa has relatively better health indicators compared to other northern states of Nigeria and much better compared to Zamfara.

2. Within each state, we propose that random samples of households are drawn from all three LGAs following the same strategy as the impact evaluation. Taking this approach would ensure that sufficient variation in health services, socioeconomic gradient and other regional variations will be captured. Hence, the household survey will be conducted using the same sample as the impact evaluation within the chosen LGAs. Both intervention and control households will be included in the sample, in line with the impact evaluation. The sample size used within each state for the impact evaluation will be sufficient for the economic evaluation.

3. For facility-based data collection (for programme-related costs and facility-based patient outcome data for CMAM programme; see below), the same strategy will be used as above. Hence, three LGAs will be selected from Jigawa and Zamfara. Within each LGA, we recommend that two health facilities are selected, one from the intervention area and one from control area. These health facilities should be close to each other in terms of rural/urban characteristics and socioeconomic status (and, possibly, disease burden).

The following data will be collected from the proposed states and LGAs:

1. Programme-related capital and operating costs, including all the costs identified in Table 23 and Table 24. This relates to all four workstreams. Areas of shared resources should also be identified so that double counting can be avoided if a combined evaluation is conducted. These costs will be collected once for the health facilities (as discussed above).

2. Facility-based data collection: Outcome data for patients who used outpatient and inpatient facilities during a period of one year (i.e. during a one-year period when the programme is fully operational – preferably year 2 or year 3 to allow for data analysis and modelling work) – this will be used in the evaluation of the CMAM programme workstream. The outcome data for the IYCF interventions analysis will come from the household survey conducted as part of the impact evaluation.

3. Facility-based data collection: Patient-related cost data will be collected to capture direct and indirect resource use, including opportunity cost (discussed later). These may be collected using a questionnaire-based survey or based on focused group interviews (recently used for the economic evaluation of CMAM in Bangladesh). As above, these data will also be collected in a cross-sectional manner, i.e. patients will be asked once about health-related costs.

4. Household survey data: Outcome data will be collected to be used for the evaluation of workstreams 1 and 2. This will be an add-on to the impact evaluation exercise and will be collected at baseline and follow-up.

Timing of data collection

We propose the following timetable for data collection:

1. **Programme delivery costs** will be collected from intervention and control areas once the programme is fully operational, which is likely to be between years 2 and 4. However, to allow time for data analysis and economic modelling, we would propose that programme delivery costs are collected during year 2 or year 3.

2. **Facility-based outcome and cost data** from patients should cover a period of one year for all patients admitted to health facilities during the one-year period. Using the same argument as above, we propose that this data is collected during year 2 or year 3 of the programme. In order to spread the data collection process, it may be feasible to collect programme delivery cost data during year 2 and facility-based outcome and cost data during year 3. Year 1 will allow preparation time for data collection.

3. **Household survey data:** This will be conducted in line with the impact evaluation exercise.

Annex B   Literature on the cost-effectiveness of CMAM

This section presents a summary of the cost-effectiveness evidence on the CMAM intervention. This literature helped inform the study design, model parameters and assumptions used in the economic evaluation of CMAM in Nigeria.

These studies were conducted mainly in South/ South-East Asia and sub-Saharan Africa. The literature review provides useful insights into the methods for our cost-effectiveness study, not least because both societal and health services perspectives have been used in this literature.

Published studies have used the following comparators: (1) inpatient facility-based care; (2) existing health services without CMAM; or (3) do nothing. Comparator (2) includes inpatient care as well as outpatient care. This approach was taken by Wilford *et al.* (2012) in Malawi.

Most of the published studies have captured a broad range of cost centres, including capital costs (such as purchase of vehicles and equipment, and building costs), recurrent costs (including overhead costs, staff salaries and utilities), and cost of therapeutic food and medication. Only a few studies have considered the cost for the caregiver, including out-of-pocket expenditure and the opportunity cost of seeking care.

Another aspect of the CMAM evaluation is how model parameters were obtained for non-CMAM control areas. Puett *et al.* (2013) estimated the probability of inpatient care in the comparator arm using primary data on the proportion of total SAM cases (identified by community health workers in the community) who were referred and subsequently used inpatient care. However, Tekeste *et al.* (2012) directly compared patients treated in CMAM community-based therapeutic centre versus non-CMAM inpatient care using data collected in these facilities; this approach ignores differences in coverage/referral and probability of use of the two interventions by directly comparing resource use and outcomes of patients actually using the facilities. Finally, Wilford *et al.* (2012) used existing non-CMAM health services as the comparator, and assumed that one in four SAM cases received SC in control areas, while three in four received a set of three clinic visits. They then conducted sensitivity analyses with +/-25% of base case costs.

Finally, both cost per child treated and cost per DALY have been used to report final results of the study. There is huge variability in cost per child treated, which can be explained by the differences in the cost centres included in the analysis. The two relatively robust studies in our review, in terms of data and analysis, found cost per child treated to be $169.3 in CMAM areas and $16.7 in non-CMAM area (Wilford *et al.*, 2011), and $165 per child treated by CMAM and $520 per child treated by inpatient treatment (Puett *et al.*, 2013). In these studies, while cost per child treated is similar in CMAM areas, it is significantly different in non-CMAM areas ($520 vs $17 per child treated). This is primarily due to differences in the treatment received in control areas. Wilford *et al.* use existing health services (without CMAM) as the comparator, while Puett *et al.* use more expensive inpatient care as the comparator. Using inpatient care as the comparator implies that CMAM is likely to be relatively cheaper. However, the direction of difference in effect between the more expensive non-CMAM inpatient care and the OTP/SC facility pathway may be less straightforward to predict – this is because children using inpatient care often tend to be sicker (with worse prospects); on the other hand, inpatient care may be better at treating SAM (assuming the same level of sickness) and have a better treatment effect.

Table 30:   Summary of published economic evaluation studies on SAM in children

Study	Country	Type of analysis	Perspective	Comparator	Costing approach	Cost elements	Cost per child treated	Cost per DALY averted	Cost per death averted
Abdul-Latif and Nonvignon (2014)	Ghana	Cost analysis	Societal	None	Traditional expenditure-based costing	Vehicles purchase Equipment purchase Staff salaries Vehicle operation Training cost Job aids Monitoring cost Building rent RUTF	$805.36 per child detected and treated	-	-
Puett *et al.* (2013)	Bangladesh	Cost-effectiveness	Societal	Inpatient treatment (facility-based)	Activity-based costing	Monitoring cost Training cost Supervision cost Growth Monitoring and Promotion sessions Household visits by CHWs Curative care	Community treatment = $165 per child Inpatient treatment = $520 per child	Community treatment = $26 Inpatient treatment = $214	Community treatment = $869 Inpatient treatment = $7,276
Purwestri *et al.* (2012)	Indonesia	Cost analysis (with some outcomes presented separately)	Societal	None	Traditional expenditure-based costing	Capital costs Staff salaries Transportation Incentives for voluntary workers Food supplements Haemoglobin and health assessment	Daily programme: US$376.2 per child Weekly programme: US$331.8 per child	-	-
Tekeste *et al.* (2012)	Ethiopia	Cost-effectiveness	Societal	Inpatient treatment (facility-based)	Traditional expenditure-based costing	All personnel salaries Capital depreciation Utilities Medicines RUTF/milk-based formula	Therapeutic Feeding Centre: $262.62 (institutional) and $21.01 (opportunity cost) per child treated	-	-

						Caretakers' food Non-food and other supplies	Community-based therapeutic care :$128.58 (institutional) and $5.87 (opportunity cost) per child treated	
Wilford *et al.* (2012)	Malawi	Cost-effectiveness	Health Services	Existing health services without CMAM	Traditional expenditure-based costing	Capital costs: cars, motorbikes, computers Recurrent costs: RUTF, admin cost, direct staff cost, transport, training cost, medical supplies, inpatient cost	CMAM area = $169.3 Non-CMAM area = $16.7	$42 per DALY averted (base case) $493 per DALY averted (worst case)	$1,365 per death averted
Bachmann (2009)	Zambia	Cost-effectiveness	Health Services	Do nothing	Traditional expenditure-based costing	Cost of health centre visit Cost of RUTF Cost of community mobilisation	CTC = $203 per child No treatment = $0	$53 per DALY averted	$1,760 per death averted
Ashworth and Khanum (1997)	Bangladesh	Cost-effectiveness	Societal	i) Inpatient care ii) Day care	Traditional expenditure-based costing	Staff salaries Capital depreciation Utilities Laboratory costs X-ray cost Medicines/supplies Child's food Carer's food	Inpatient = $159 Day care = $63.8 Domiciliary = $38.8	-	-

Annex C   Literature on economic evaluations of IYCF interventions

This section presents a summary of the economic evidence on the IYCF intervention.

The study by Chola *et al.* (2011) was conducted in Uganda, while that of Nkonki *et al.* (2014) was conducted in South Africa. Both studies were conducted by the PROMISE-EBF and used similar methodology by costing the PROMISE-EBF intervention, which was evaluated in a cluster randomised trial. The intervention involved offering support provided by peer-supporters who recruited pregnant women who come for routine ANC, established their feeding practices and then supported them in breastfeeding practices. Peer support workers were supervised by one supervisor per site, who supported 10–14 peer-supporters.

Both studies conducted an economic evaluation from the provider's perspective and excluded any costs incurred by mothers. Costing of the project was done using the budget and expenditure data of PROMISE-EBF programme. For other goods, market prices were used in the absence of available primary data.

The studies found that cost per mother counselled was US$139 and US$228 in Uganda and South Africa respectively, while cost per visit was US$26 and US$52 respectively in the two countries. Chola *et al.* (2011) also report the cost per week of EBF as US$15 per week. Overall, costs in South Africa were higher than costs in Uganda, which is due to higher cost structures in South Africa. For instance, community health workers are remunerated at the rate of US$152 per month compared to only US$20 per month in Uganda.

The main limitation of these studies is that they did not model long-term outcomes, either in terms of reduced mortality, morbidity (for instance, infection rates) or a combined measure of mortality and morbidity, such as DALYs. Both studies report intermediate outcomes, such as number of visits or number of weeks of EBF. However, to allow comparison between interventions and across health conditions, it is important to express health benefits in terms of generic health outcomes.

Table 31: Summary of published economic evaluation studies of feeding practices in children under 2

Study	Country	Type of analysis	Perspective	Intervention	Comparator	Costing approach	Cost elements	Results
Chola *et al.* (2011)	Uganda	Cost analysis	Health provider	Individual peer support counselling intervention	None	Activity-based costing and an ingredient approach	**Start-up** Travel Manual adaptation and initial training **Overheads** Communication Utilities Office rent **Peer support** Personnel cost Bicycles Field materials **Peer supervision** Personnel cost Transport cost Supervisory meetings Office supplies Capital costs	Cost per mother counselled was US$139 Cost per visit was US$26 Cost per week of EBF was estimated to be US$15 at 12 weeks postpartum.
Nkonki *et al.* (2014)	South Africa	Cost analysis	Health provider	Individual peer support counselling intervention	None	As above	As above	Cost per mother counselled was US$228 and cost per visit was US$52. In an operational 'non-research' scenario, these were US$137 and US$32 per mother and per visit, respectively.