Cost Effectiveness Analysis of the Community-based Management of Acute Malnutrition (CMAM) Surge Approach

Niger

Final Report

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This report was prepared by Jean Christophe Fotso and Mark Myatt

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List of Acronyms

CEA	Cost-effectiveness analysis
CMAM	Community-based management of acute malnutrition
Concern	Concern Worldwide
DALY	Disability adjusted life year(s)
EVIHDAF	Evidence for Sustainable Human Development Systems in Africa
GAM	Global acute malnutrition
MAM	Moderate acute malnutrition
MOH	Ministry of Health
NGO	Non-governmental organization
OTP	Outpatient therapeutic program
RUTF	Ready-to-use therapeutic food
SAM	Severe acute malnutrition
SC	Stabilization Center
UNICEF	United Nations Children's Fund
YLD	Years lived with the disability
YLL	Years of life lost

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Executive Summary

The effectiveness of the community-based management of acute malnutrition (CMAM) approach to treating acute malnutrition has been established since 2007 following an endorsement by United Nations agencies, which provided a framework for the expansion of the intervention. The cost-effectiveness of the intervention has been proven and documented by a number of studies. Drawing from his experience implementing CMAM in more than 16 countries over the last 15 years, Concern developed the *CMAM Surge* approach which seeks to support health systems to become more resilient by helping them to better manage seasonal 'surges' in the demand for treatment of acute malnutrition that occur in many vulnerable contexts. While previous assessments have shed light on its ability to respond to increases in caseload, an equally critical question of whether the Surge approach offers similar level of cost-effectiveness as other models for delivering CMAM services remains to be answered. This report presents the results for Niger. The study compares the cost-effectiveness of the CMAM Surge approach in Niger to international standards and to CEA results from a variety of CMAM programs in other countries that did not use the Surge approach.

The study focuses on the 13 outpatient therapeutic program (OTP) sites which began CMAM Surge implementation in 2017, which includes eleven health centers and two health posts. Also included in this study is the stabilization center (SC) in the district's general hospital (*Centre hospitalier regional* [CHR]), which serves as the referral site for inpatient therapeutic feeding for all OTP sites in the two districts. The study period was defined as January-December 2018. We adopted an approach to costing which encompasses both the intuitional and societal costs. Primary data collection with districts, health facilities, community volunteers and caregivers took place between October 2018 and January 2019. Data was collected in two waves covering the periods July-September and October-December. Data extraction (e.g. from OTP/SC registers) was also undertaken during the same period.

The outcomes of interest to the study are number of children cured, number of deaths averted (number of lives saved), and number of disability adjusted life years (DALYs) averted. The principal outcome of interest is the number of DALYs averted. Some costs were in US dollars and others were in the local currency (CFA Francs). Costs in the CFA Francs were converted into US dollars using the mid-year (June 15th, 2018) mid-market exchange rate (1 US Dollar = 567.13 CFA Francs).

The 'No-frills' approach was used (i.e. age-weighting and discounting were not used) for DALY calculations. In this study, uncertainty was accounted for by the use of fuzzy triangular numbers (informed by literature review and analysis of the collected data) and propagated through calculations using fuzzy (interval) arithmetic. Estimates of results with 95% confidence intervals were made using a geometric method to find the central 95% of the triangular distribution represented by a fuzzy triangular number.

Our measures of cost-effectiveness (CE) are defined as:

$$CE = \frac{cost}{outcomes}$$

They are calculated by dividing the total cost by the number children cured, the number of deaths averted (number of lives saved), and the number of DALYs averted.

The total cost is estimated at $**249,154.60**, and the cost per DALY is estimated at $26.25. Cost-effectiveness estimates are usually interpreted by comparison with other programs and/or against commonly used standard or threshold values.

It is common to use standard (threshold) values. Two standards are commonly used:

- **A single fixed standard for cost per DALY averted**: Interventions achieving a cost per DALY averted of less than US$100 at the time of analysis are classified as being very cost-effective. The cost per DALY averted achieved by the current program was US$26.25. This program would, therefore, be classified as being very cost-effective.
- **Variable standard per DALY averted**: The most commonly-used standard in the public health nutrition field is one proposed by the WHO. This compares the cost per DALY averted by an intervention with the per capita GDP of the country in which the intervention is implemented:
  - Highly cost-effective interventions avert a DALY for less than a country's GDP per capita.
  - Cost-effective interventions avert a DALY for between one and three times a country's GDP per capita.
  - Interventions that are <u>not</u> cost-effective avert a DALY for more than three times a country's GDP per capita.

  The proportion of GDP required to avert one DALY by the current program is 0.0694 (i.e. 6.94%) of GDP. The current program can, therefore, be considered to be highly cost-effective.

In conclusion, the Niger CMAM Surge program appears to be a very cost-effective strategy. The cost-effectiveness of the CMAM services, including CMAM Surge within the 13 OTP sites is still acceptable in relation to global benchmarks/standards and in comparison to CMAM programs without CMAM Surge.

1. Introduction

The effectiveness of the community-based management of acute malnutrition (CMAM) approach to treating acute malnutrition has been established since 2007 following an endorsement by United Nations agencies, which provided a framework for the expansion of the intervention [1]. The cost-effectiveness of the CMAM intervention model has been proven and documented by a number of studies [2,3,4].

As one of the first non-governmental organizations (NGO) to pilot the CMAM model, Concern Worldwide has been at the forefront in the fight against child malnutrition in many countries [5,6]. Drawing from this experience implementing CMAM in more than 16 countries over the last 15 years [7], Concern developed the CMAM Surge approach, which seeks to support health systems to become more resilient by helping them to better manage seasonal 'surges' in the demand for treatment of acute malnutrition that occur in many vulnerable contexts [8]. This approach is currently being implemented by Concern in Burundi, Chad, Ethiopia, Kenya, Pakistan, and Niger and has also been introduced by other organizations in other countries. While previous assessments have shed light on its ability to respond to increases in caseload [9,10], an equally critical question of whether the Surge approach offers similar level of cost-effectiveness as other models for delivering CMAM services remains to be answered. EVIHDAF was commissioned by Concern to develop a practical cost-effectiveness analysis (CEA) framework, protocol, and related analytical tools, and to lead on its immediate application in Ethiopia and Niger. This report presents the results for Niger. The study compares the cost-effectiveness of the CMAM Surge approach in Niger to international standards and to CEA results from a variety of CMAM programs in other countries that did not use the Surge approach.

2. Concern's CMAM Surge Intervention in Niger

Concern has been implementing nutrition programs in the Tahoua region of Niger since 2005. Its approach has evolved from using mobile sites directly managed and staffed by Concern teams to working with the ministry of health (MOH) to integrate the management of acute malnutrition into the standard health facility package. In 2014, Concern introduced the CMAM Surge approach in two health districts (urban/commune and rural/department) in Tahoua. CMAM Surge began with 10 health centers and gradually expanded to a total of 40 health centers as shown in Table 1.

Table 1. Geographic coverage of CMAM Surge in the Tahoua region of Niger, 2014-2018

Year	District		
	Urban (commune)	Rural (Department)	Total
2014	3	7	10
2017	3	8	11
2018	3	16	19
Total	9	31	40

3. Methodology

3.1. Study design and setting

Following discussions with the Concern program staff during an inception meeting held in Niger in June 2018, it was decided to focus the study on the 13 outpatient therapeutic program (OTP) sites which began CMAM Surge implementation in 2017, which includes eleven health centers and two health posts. Also included in this study is the stabilization center (SC) in the district's general hospital (*Centre hospitalier regional* [CHR]), which serves as the referral site for inpatient therapeutic feeding for all OTP sites in the two districts. By the time of the inception meeting in late June 2018, the 19 OTP sites for the 2018 wave were still being enrolled, and could not be part of the study. With the focus on the 2017 wave of OTP sites, the study period was defined as January-December 2018.

Table 2. Target health centers/health posts

District	Health facility location	Facility type
Rural Tahoua	1. Affala	Health center
	2. Amaloul Nomade	
	3. Amaoul Guidiss	
	4. Edir	
	5. Inkarkadan	
	6. Safarfari	
	7. Takanamat	
	8. Toro	
	9. Rididi	Health post
	10. Chakot	
Urban Tahoua	11. AMA	Health center
	12. Garkawa	
	13. Wadata	

3.2. Costs data

3.2.1. Cost approach

We adopted an approach to costing which encompasses both the intuitional and societal costs, as detailed in Table 3.

Table 3. Description of institutional and societal costs

Type of cost	Cost items
1. Institutional costs	
MOH – OTP sites	• Time of clinical staff involved in CMAM service delivery. • Supervision and monitoring visits by clinical staff involved in CMAM service delivery • Supply delivery and collection for CMAM service delivery • Health management information systems for CMAM service delivery
MOH – Districts	• Time of managerial staff involved in CMAM service delivery • Supervision and monitoring visits by managerial staff of CMEM service delivery • Supply delivery and collection for CMAM consumables • Health management information systems for CMAM service delivery
Concern	• Time of national staff at Concern working on CMAM, and staff at the SC involved in CMAM service delivery. • Supervision and monitoring visits by Concern • Supplies and equipment delivery and collection by Concern • Training and meetings by Concern
UNICEF	• CMAM supplies (RUTF, antimicrobials, anthelminthics, Vitamin A, therapeutic feeding milks …) for OTP sites and SC • CMAM miscellaneous consumables for OTP sites, SC, and community sensitization
2. Societal costs	
Caregivers at OTP	• Travel time and cost to/from OTP sites • Time and out-of-pocket expenses at OTP sites
Caregivers at SC	• Travel time and cost to/from the SC • Time and out-of-pocket expenses at the SC
Community volunteers	• Time spent on CMAM activities and training • Transportation for CMAM activities

Details on the specific costs covered can be seen in the questionnaires and forms for data collection presented in Annex A.

3.2.2. Data collection

Following the June 2018 inception meeting, primary data collection with districts, health facilities, community volunteers and caregivers took place between October 2018 and January 2019. Data was collected in two waves covering the periods July-September and October-December, as shown in Table 4. Data extraction (e.g. from OTP/SC registers) was also undertaken during the same period. Questionnaires and forms for data collection are presented in **Annex A**.

Table 4. Cost data sources

Type of cost	Data source / methods
1. Institutional costs	
MOH – OTP sites	Structured interviews with nutrition focal points at districts (n=2) and OTP sites (n=13): Two rounds of data collection covering July-Sept. 2018 and Oct-Dec. 2018, respectively (See Tools #1 and #2 in Annex A).
MOH – Districts	
Concern	Concern's accounting records for Jan-Dec 2018 covering all NGO costs associated with the delivering of the CMAM Surge program.
UNICEF	UNICEF's accounting records for Jan-Dec 2018 covering all UNICEF logistics costs associated with the delivering of CMAM in the district of Tahoua
2. Societal costs	
Caregivers at OTP	Structured interviews with caregivers at OTP sites and SC: Two rounds of data collection covering July-Sept. 2018 and Oct-Dec. 2018, respectively (in total: 108 caregivers at OTP; 65 caregivers at SC) (See Tools #4a and 4b in Annex A).
Caregivers at SC	
Community volunteers	Structured interviews with community-based volunteers (CBVs): Two rounds of data collection covering July-Sept. 2018 and Oct-Dec. 2018, respectively (in total: 132 Community volunteers) (See Tool #3 in Annex A).

3.3. Effectiveness

The outcomes of interest to the study are number of children cured, number of deaths averted (number of lives saved), and number of disability adjusted life years (DALYs) averted. The principal outcome of interest is the number of DALYs averted. Data sources are presented in Table 5. The forms used for data extraction are in Annex A.

Table 5. Effectiveness data sources

Type	Data source / methods
Admissions at OTP	Data extracted from OTP and SC registers for Jan-Dec 2018 on admissions, admission MUAC, lengths of stay, and attendance rates. Total: 1,576 records at
Admissions at SC	

Type	Data source / methods
	OTPs[a]; 1,173 records at SC[a] (See Tools #5a and #5b in Annex A)
Outcomes (i.e. cured and not-cured)	Routine program monitoring data

[a] 1,576 OTP records for all admissions from the 13 study OTP sites. The 1,173 records from the SC were for all 40 OTP sites in the program and were used to estimate the cost to beneficiary households of treatment in the SC which was multiplied by 13/40 to estimate the cost for cases referred to SC from the 13 study OTP sites (see text).

3.4. Analytical strategy

3.4.1. Cost

Some costs were in US dollars and others were in the local currency (CFA Francs). Costs in the CFA Francs were converted into US dollars using the mid-year mid-market exchange rate (1 US Dollar = 567.13 CFA Francs based on the 15th June 2018 mid-market exchange rate retrieved from https://www.xe.com/currencycharts/?from=USD&to=XOF&view=2Y). Annex B1 summarizes the cost categories and their aggregation into total costs. All costs were adjusted to give annual costs.

- **District and OTP costs:** Using Niger's official mid-point salary for each grade, staff cost was calculated based on the hours worked and expressed as a fractional fulltime equivalent salary based on a 40-hour working week. Data collection focused on CMAM-related activities. Annex B2 shows the method for aggregating district and OTP costs.
- **SC costs:** Retrieved from Concern's and UNICEF's accounting records for the year 2018. Concern directly funded 13 SC staff (nurses, assistant nutritionists and hygienists). Admissions to SC resulted from referrals from all 40 OTP sites in the program. Costs related to the admissions from the 13 OTP sites were calculated on a *pro rata* basis (i.e. 13/40 of total SC costs).
- **Community volunteer costs:** Data collection focused on CMAM-related activities. A daily shadow wage was valued at 500 CFA Francs (or $0.88) was used. This was based on Government guidelines for monthly incentives of 5000 CFA Francs from NGO sources plus 5000 CFA Francs from the Government and 20 working days per month. As a comparison, the 2017 estimated per-capita GDP for Niger is $378.06 (World Bank data) which is approximately $1.04 per day or $1.58 per working day based on 20 working days per month. An hourly shadow wage was derived from the daily shadow wage and a seven-hour working day. The 13 OTP centers have a combined total of 185 active volunteers. Data were collected for 132 volunteers across all 13 OTP sites. Annex B3 shows the method for calculating the total community volunteer costs.
- **Caregivers at OTP and SC:** The same shadow wage for community volunteers (above) was used (see Annexes B4a and B4b).
- **Delivery costs (UNICEF):** UNICEF provided a detailed Excel™ file containing all CMAM supplies and consumables (with costs) delivered to the district in 2018. The total cost was

adjusted by a factor of 13/40 (representing the share of the 13 target OTP centers). The rationale is that SC admissions are referrals from OTP sites and that the ratio 13/40 reflects the probable SC workload from the 13 OTP study sites.

- **Concern's costs:** Costs were adjusted by a factor of 13/40 as above.

3.4.2. Effectiveness

Cure rates and the number cured for the 13 target OTP centers were estimated from routine program monitoring data. The concept of cure rate is not relevant for SC, as children who are stabilized return to their OTP site for continued treatment. Deaths, onward referrals, default from SC and/or failure to return to OTP were treated as not-cured.

The number of deaths averted (number of lives saved) by the program was calculated by multiplying the number cured by the expected mortality estimated using data from four historical cohort studies of untreated cases of SAM [3,11,12,13,14,21] at the average admission MUAC and correcting for background mortality of 1 /10,000 / day (i.e. the approximate average under five-years mortality rate for the locations and times of the four cohorts).

The number of DALYs averted by the program was calculated using both years of life lost (YLL) and years living with disability (YLD) components (see Annex B5):

- YLL was calculated using the estimated number of deaths averted (see above), age at admission, time to death for an untreated SAM episode (minimum = 0 months; median = 2 months; maximum = 7.5 months) and the sex-combined Niger life-expectancy at birth 60.42 years from the World Bank data [15].
- YLD was calculated using the number cured, an assumed average duration of an untreated SAM episode (min = 3.5 months; median = 6 months; maximum = 7.5 months), the observed length of stay of SAM cases, and the disability weight for severe acute malnutrition (SAM) was taken from the 2010 Global Burden of Disease (GBD) study [16].

The 'No-frills' approach was used (i.e. age-weighting and discounting were not used) for both YLL and YLD calculations [15]. This approach reflects the current thinking and practice in CEA and global burden of disease work. DALYs were calculated as the sum of the YLL and YLD components.

In this study, uncertainty was accounted for by the use of fuzzy triangular numbers (informed by literature review and analysis of the collected data) and propagated through calculations using fuzzy (interval) arithmetic. Estimates of results with 95% confidence intervals were made using a geometric method to find the central 95% of the triangular distribution represented by a fuzzy triangular number [17,18]. See Annex C for further details.

3.4.3. Cost-effectiveness analysis

Our measures of cost-effectiveness (CE) are defined as:

$$CE = \frac{cost}{outcomes}$$

They are calculated by dividing the total cost by the number children cured, the number of deaths averted (number of lives saved), and the number of DALYs averted.

4. Results

4.1. Costs

The total cost of the CMAM program with Surge components in the 13 OTP sites, as detailed in **Table 6**, is estimated at $249,154.60.

Table 6. Institutional and societal costs (US$)

Type	Cost (Lowest, Middle, Highest)
1. Institutional costs	
MOH - OTP sites[a]	($46,246.64, $51,385.16, $56,523.67)
MOH – Districts[a]	($3,934.42, $4,371.58, $4,808.74)
Concern[b]	($112,252.60, 112,252.60, $112,252.60)
UNICEF[b]	($64851.95, $64,851.95, $64.851.95)
Total institutional costs[c]	***($227,285.60, $232861.30, $238436.90)***
2. Societal costs	
Caregivers at OTP[d]	($3,139.63, $4,029.41, $4,976.76)
Caregivers at SC[d]	(6,243.32, $6,928.12, $7,612.91)
Community volunteers[d]	($4,467.08, $5,335.76, $6,204.44)
Total societal costs[c]	***($13,850.04, $16,293.29, $18,794.12)***
Total costs[c]	**($241,135.60, $249,154.60, $257231.10)**

[a]Uncertainty incorporated as ± 10% of the point estimate.

[b]Assumed to be measured without error

[c]Sums calculated using fuzzy (interval) arithmetic to model uncertainty

[d]Uncertainty incorporated using fuzzy triangular numbers of the form:

$$(median(cost) - 2 \times SE(cost), median(cost), median(cost) + 2 \times SE(cost))$$

where:

$$SE(x) = \frac{median\ absolute\ deviation(cost)\ \times\ 1.4826}{\sqrt{sample\ size}}$$

for each parameter in the cost equation.

4.2. Effectiveness

Effectiveness outcomes are presented in **Table 7**. These estimates are used as the denominator for the cost-effectiveness outcomes.

Table 7. Effectiveness outcomes

Outcome	(Lowest, Middle, Highest)
Number of children cured	(1,495, 1,511, 1,527)
Number of deaths averted	(89, 159, 220)
Number of DALYs averted	(6,187, 9,493, 12,334)

4.3. Cost-effectiveness

Cost-effectiveness results are shown in Table 8.

Table 8. Cost-effectiveness results

Result	Point estimate	95% Confidence interval
Cost per child cured	$164.89	[$157.91 ; $172.06]
Cost per death averted	$1567.01	[$1096.07; $2890.24]
Cost per DALY averted	**$26.25**	**[$19.55; $41.57]**

5. Discussion

Cost-effectiveness estimates are usually interpreted by comparison with other programs and/or against commonly used standard or threshold values [21,22]. Table 9 shows the cost per child cured, cost per death averted and cost per DALY averted for the current program and five other CMAM programs. Typically, CEA concentrates on the cost per DALY averted metric since this allows comparisons to be made across a wide range of interventions.

Simple comparisons are not straightforward as results are influenced by both methods (e.g. the disability weighs used, whether age-weighting and discounting were used, which life-expectancy (LE) was used, and the extent of the costs-base used) and by settings (e.g. local life-expectancy, MUAC at admission, program cure rates, and miscellaneous program factors) [23].

Table 9. Cost-effectiveness results from other studies

Study	Country	Cost per child cured	Cost per death averted	Cost per DALY averted
Current study, 2018	Niger	$165	$1,567	$26
Rogers et al., 2018 [2]	Mali	$214	Not available	
Frankel et al., 2015 [4]	Nigeria	$219	$1,117	$30
Puett et al., 2012 [3]	Bangladesh	$180	$869	$26
Wilford et al., 2011 [19]	Malawi	$185	$1,365	$42
Bachmann, 2009 [20]	Zambia	$203	$1,760	$53

The use (or not) of age-weighting and discounting and the choice of local life-expectancy or the standard expected years of life lost (SEYLL) have large effects of DALY calculations [21]. The choice of disability weight used is of much less importance for acute conditions, such as SAM, that are associated with short durations of disease with low levels of disability and high levels of mortality [21].

The current study uses the following model specification:

- No-frills (i.e. no age-weighting and no discounting)
- Local life-expectancy (LE)
- Global burden of diseases 2010 disability weights

The CEA studies listed in Table 9 used the following models:

- Bachmann, 2009 (Zambia): Age weighting and discounting, local LE
- Wilford et al., 2011 (Malawi): Age weighting and discounting, local LE
- Puett et al., 2012 (Bangladesh): Age weighting and discounting, local LE
- Frankel et al., 2015 (Nigeria): Age weighting and discounting, local LE

These studies used the following costs-base:

- Bachmann, 2009 (Zambia): Institutional costs only
- Wilford et al., 2011 (Malawi): Institutional costs only
- Puett et al., 2012 (Bangladesh): Institutional and societal costs
- Frankel et al., 2015 (Nigeria): Institutional and societal costs

We expect the ratio of DALYs between a CEA using age-weighting and discounting and a CEA using the 'No frills' approach to be about 0.5 [21]. Applying this to the cost per DALY averted results show in Table 9 gives:

- Bachmann, 2009 (Zambia): Drops from $53 to $27
- Wilford et al., 2011 (Malawi): Drops from $42 to $21
- Puett et al., 2012 (Bangladesh): Drops from $26 to $13
- Frankel et al., 2015 (Nigeria): Drops from $30 to $15

CMAM programs are usually designed to minimize societal costs. In this study we found societal costs to be about 6% of total costs. Adjusting for this give:

- Bachmann, 2009 (Zambia): Increase from $27 to $29
- Wilford et al., 2011 (Malawi): Increased from $21 to $22

The adjusted (i.e for DALY calculation model and to standardize the cost-base) cost per DALY averted becomes:

- Bachmann, 2009 (Zambia): $29
- Wilford et al., 2011 (Malawi): $22
- Puett et al., 2012 (Bangladesh): $13
- Frankel et al., 2015 (Nigeria): $15

CEA studies tend to use the US dollar as a benchmark currency. The value of a US$ changes over time. It is possible to account for inflation using local consumer price index (CPI). This adjustment does not, however, account for place to place variation in the purchasing power of US dollars. A crude measure of relative wealth is gross domestic product (GDP) per-capita. It is possible to present results as the proportion of GDP per capita needed to avert a DALY. The World Bank publishes GDP time series and these enable the use the local (i.e. in time and space) GDP per capita to calculate the proportion of GDP per capita needed to avert one DALY. The adjusted outcomes are presented in Table 10.

Table 10. Adjusted cost per DALY averted from other studies

Country	Study year	GDP per capita (year)[a]	Adjusted cost per DALY averted[b]	Proportion of GDP per capita required to avert one DALY
Niger	2018	$378 (2017)	$26	0.0694
Nigeria	2014	$3222 (2014)	$15	0.0047
Bangladesh	2009	$681 (2009)	$13	0.0191
Malawi	2007	$320 (2007)	$22	0.0688
Zambia	2008	$1369 (2008)	$29	0.0212

[a]World Bank data for 'GDP per capita (current US$)'

[b]Adjusted for DALY calculation model and to standardize the costs-base (see text)

It is common to use standard (threshold) values. Two standards are commonly used:

- **A single fixed standard for cost per DALY averted**: Interventions achieving a cost per DALY averted of less than US$100 at the time of analysis are classified as being very cost-effective [22]. The cost per DALY averted achieved by the current program was US$26.25. This program would, therefore, be classified as being very cost-effective.
- **Variable standard per DALY averted**: The most commonly-used standard in the public health nutrition field is one proposed by the WHO [23]. This compares the cost per DALY averted by an intervention with the per capita GDP of the country in which the intervention is implemented:
  - Highly cost-effective interventions avert a DALY for less than a country's GDP per capita.
  - Cost-effective interventions avert a DALY for between one and three times a country's GDP per capita.
  - Intervention that are <u>not</u> cost-effective avert a DALY for more than three times a country's GDP per capita.

  The proportion of GDP required to avert one DALY by the current program is 0.0694 (i.e. 6.94% of GDP). The current program can, therefore, be considered to be highly cost-effective.

Limitations

Limitations of CEAs overall are well documented [24]. A limitation specific to the current study should also be acknowledged. We applied a factor of 13/40 to the program management (Concern) and supplies/consumables (UNICEF) to reflect our focus on 13 OTP centers out of a total of 40 in the district. The idea of using the share of CMAM admissions was explored, but was deemed less relevant given that not all costs can be assumed to be proportionate to the number of admissions at OTP sites. For Concern's internal support costs (e.g. Nutrition Advisor and field-based staff) it is possible that the adjustment of 13/40 of total salary is overestimating some costs, as these staff support more than just CMAM Surge activities.

6. Conclusion

The Niger CMAM Surge program appears to be a very cost-effective strategy. The cost-effectiveness of the CMAM services, including CMAM Surge within the 13 OTP sites is still acceptable in relation to global benchmarks/standards and in comparison to CMAM programs without CMAM Surge.

7. Annexes

7.1. Annex A: Data collection tools

7.2. Annexes B: Data analysis methods

7.3. Annexes C: Operations between triangular fuzzy numbers

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Appendix A1: Tahoua Health District

CEA of CMAM SURGE Approach in Niger

Tool #1

Nutrition Focal Point Questionnaire, Tahoua Health District

ID	**District:** ……1 (Commune) 2 (Department)……	
1	Date (dd/mm/yy) – Western Calendar	_____/_____/_____
2	Start time (use 24-hr clock) – Western Time	_____:_____

Hello, my name is …….. I represent **EVIHDAF**, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the CMAM program here in Niger. The results of the study will be used to improve the quality of the CMAM program in this Health District.

I am going to ask you a few questions about the CMAM program in this health district. The topics I'd like to cover include: 1) Time spent on various CMAM activities; 2) Costs related to supervision and community visits; 3) Logistics and supply delivery costs; and 4) Costs associated with reporting CMAM statistics.

3	Respondent's name: _____
4	Sex : 1 Male 2 Female
5	Respondent's email address or phone:

CMAM Human Resources – District level

We would like to establish the level of effort of staff working on CMAM activities. I am going to ask you some questions about <u>all staff who perform CMAM activities</u>, namely, [list of CMAM activities for district level].

Have I missed any activities? If yes, ascertain if the activities are indeed part of CMAM and update the list.

	Staff Name, Position	**1-Contractal 2- Civil servant *(if Civil servant answer the last three questions, if not skip to the last question)***	**Grade level**	**Number of years at present grade**	**Number of hours per week, on average, spent on CMAM**
6	_____, Nutrition FP				
7					
8					
9					
10					

11					
12					
13					
14					

Supervision & Community Visits, Mobilization and Sensitization –District level

We'd like to discuss the costs of supervision or community visits undertaken by the Tahoua Health Office.

16	In the last three months, how many CMAM supervision/community visits have taken place?	|__|__|	
17	Let's focus now on the last visit. We'd like to know the total costs for the entire period and for all the staff involved, and whether the costs were reimbursed (e.g. by CONCERN). Staff costs are excluded.		
		Total cost	**Reimbursed?**
a	Transportation (car/taxi, fuel, driver …)	|__|__|__|__|__|__|	0 No 1 Yes
b	Accommodation, per diem, food, drink and related	|__|__|__|__|__|__|	0 No 1 Yes
c	Communications and related	|__|__|__|__|__|__|	0 No 1 Yes
d	Other [Specify] _____	|__|__|__|__|__|__|	0 No 1 Yes

CMAM Supply Delivery Costs – District level

In this section, we'd like to discuss the logistics and delivery costs to bring CMAM consumables such as RUTF, drugs (Amoxicillin, Vitamin A …), therapeutic milks and related items from a higher level to this District, and to deliver these consumables to Integrated Health Center/Health Box. Staff costs are excluded.

18	Who pays for the delivery costs to bring CMAM consumables from a higher level to this district?	1-This District 2- Higher level 3-Concern or Others *(if answer 2 or 3 skip to question 20)*
19	In last 3 months, what has been the average monthly cost to bring CMAM consumables from a higher level to this District?	|__|__|__|__|__|__|
20	Who pays for the delivery costs to deliver these CMAM consumables to Integrated Health Center/Health Box?	1-This District 2- Higher level 3-Concern or Others *(if answer 2 or 3 skip to question 22)*
21	In last 3 months, what has been the average monthly cost to deliver these CMAM consumables Integrated Health Center/Health Box?	|__|__|__|__|__|__|

CMAM-Related Health Management Information System (HMIS) Costs

I am now going to ask you some questions about CMAM-related HMIS costs. Please provide the amounts this facility has spent in the last 30 days on collecting and transferring CMAM information, including transport, media (internet or sms-Frontline) and telephone (call charges) costs. Also indicate whether the costs were reimbursed (e.g. by Concern or region). Staff costs are excluded.

		Cost in last 30 days	**Reimbursed?**
22	Data collection (transport, media, telephone …)	|__|__|__|__|__|__|	0 No 1 Yes
23	Data transmission (transport, media, telephone …)	|__|__|__|__|__|__|	0 No 1 Yes

24	End time (use 24-hr clock) – Western Time	**_____:_____**

Thank you for your answers! Do you have any questions for me?

Name and Signature of the Interviewer _____

Appendix A2: Health Center (HC)/Health Post (HP)

CEA of CMAM SURGE Approach in Niger

Tool #2

In Charge at Health Center (HC)/Health Post (HP) Questionnaire

ID	**District:** …….. 1 (Commune)……2 (Department)……. **Integrated Health Center:** _____ Code: |__| |__||__| **Health Box:** _____ Code: |__| |__||__|	
1	Date (dd/mm/yy)	_____/_____/____
2	Start time (use 24-hr clock) – Western Time	_____:_____

Hello, my name is …….. I represent **EVIHDAF,** an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the CMAM program here in Niger. The results of the study will be used to improve the quality of the CMAM program in your community.

I am going to ask you a few questions about the CMAM program in this HC/HP. The topics I'd like to cover include: 1) Time spent on various CMAM activities; 2) Costs related to supervision and community visits; 3) Logistics and supply delivery costs; and 4) Costs associated with reporting CMAM statistics.

3	Respondent's name: _____
4	Sex : 1 Male 2 Female
5	Respondent's email address or phone:

CMAM Human Resources – HC/HP level

We would like to establish the level of effort of staff working on CMAM activities. I am going to ask you some questions about <u>all staff who perform CMAM activities</u>, namely, [list of CMAM activities at HC/HP level].

Have I missed any activities? If yes, ascertain if the activities are indeed part of CMAM and update the list.

	Staff Name, Position	**1-Contractual 2-Civil Servant *(if Civil servant answer the last three questions, if not skip to the last question)***	**Grade level**	**Number of years at present grade**	**Number of hours per week, on average, spent on CMAM**
6	_____, In Charge				
7					
8					

9					
10					
11					
12					
13					
14					

Supervision & Community Visits, Mobilization and Sensitization – HC/HP level

We'd like to discuss the costs of supervision or community visits undertaken by the HC/HP.

16	In the last three months, how many CMAM supervision/community visits have taken place?	|__|__|	
17	Let's focus now on the last visit. We'd like to know the total costs for the entire period and for all the staff involved, and whether the costs were reimbursed (e.g. by CONCERN). Staff costs are excluded.		
		Total cost	**Reimbursed?**
a	Transportation (car/taxi, fuel, driver …)	|__|__|__|__|__|__|	0 No 1 Yes
b	Accommodation, per diem, food, drink and related	|__|__|__|__|__|__|	0 No 1 Yes
c	Communications and related	|__|__|__|__|__|__|	0 No 1 Yes
d	Other [Specify] _____	|__|__|__|__|__|__|	0 No 1 Yes

CMAM Supply Delivery Costs – HC/HP level.

In this section, we'd like to discuss the logistics and delivery costs to bring CMAM consumables such as RUTF, drugs (Amoxicillin, Vitamin A …), therapeutic milks and related items from a higher level (District) to this HC/HP. Staff costs are excluded.

18	Who pays for the delivery costs to bring CMAM consumables from a higher level to this facility?	1-This HC/HP 2- Higher level *(if answer 2 or 3 skip to question 20)*
19	In the last three months, What is the average monthly delivery costs to bring CMAM consumables from a higher level to this facility?	|__|__|__|__|__|__|
20	Who pays for the delivery costs to deliver these CMAM consumables to this HC/HP?	1 - This HC/HP 2- Higher level 3 -Concern or Others *(if answer 2 or 3 skip to question 22)*
21	In the last 3 months, what was the average monthly cost to deliver these CMAM consumables to this HC/HP?	|__|__|__|__|__|__|

CMAM-Related Health Management Information System (HMIS) Costs

I am now going to ask you some questions about CMAM-related HMIS costs. Please provide the amounts this facility has spent in the last 30 days on collecting and transferring CMAM information, including transport, media (internet or SMS-Frontline) and telephone (call charges) costs. Also indicate whether the costs were reimbursed (e.g. by CONCERN or District). Staff costs are excluded.

		Cost in last 30 days	**Reimbursed?**
22	Data collection (transport, media, telephone...)	|__|__|__|__|__|__|	0 No 1 Yes
23	Data transmission (transport, media, telephone...)	|__|__|__|__|__|__|	0 No 1 Yes
24	End time (use 24-hr clock) – Western Time	_____:_____	

Thank you for your answers! Do you have any questions for me?

Name and Signature of the Interviewer _____

Appendix A3: Community-based Volunteers (CVs)

CEA of CMAM SURGE Approach in Niger

Tool #3

Community Volunteers Questionnaire

ID	**District:** ……1 (Commune) 2 (Department)……	
1	Date (dd/mm/yy) – Western Calendar	_____/_____/_____
2	Start time (use 24-hr clock) – Western Time	_____:_____

Hello, my name is …….. I represent **EVIHDAF**, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the CMAM SURGE program here in Niger. The results of the study will be used to improve the quality of the CMAM program in your community.
I am going to ask you a few questions about the work you do as a community volunteer, focusing on your CMAM activities in the previous week (last seven days).

3	Respondent's name: _____		
4	Sex : 1 Male 2 Female		
5	In the last 7 days, how much time did you spend each day on ALL CMAM activities, both in the communities you serve and at Health Centers? To conduct these activities, how much did you spend each day on transport, including trips to and from the communities you serve, and to and from IHC/HB? (list CVs activities)		
		Total time spent	**Total transport cost**
5a	Yesterday [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5b	Day before [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5c	Day before [name of day]	Hour |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5d	Day before [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5e	Day before [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5f	Day before [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
5g	Day before [name of day]	Hour: |__|__| Minute: |__|__|	|__|__|__|__|__|__|
6	<u>In the last 12 months</u>, have you attended any training related to CMAM program??		0 No PROBE (the investigator has to dig for that answer) 1 Yes
7	How many training days in total, including travels, did you have in the last 12 months?		Days : |__|__|
8	End time (use 24-hr clock) – Western Time		:

Thank you for your answers! Do you have any questions for me?

Name and Signature of the Interviewer _____

Appendix A4a: Caregivers at OTP

CEA of CMAM SURGE Approach in Niger

Tools #4a

Caregivers at OTP Questionnaire

ID	**District:** ……..1 (Commune)……2 (Department)…… **Health Center :** _____ Code : |__| |__||__| **Health Box :** _____ Code : |__| |__||__|	
1	Date	**……/ …./ ……**
2	Start time of the interview	_____:_____

Hello, my name is …….. I represent **EVIHDAF**, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the accessing care for your child suffering from malnutrition. The results of the study will be used to improve the quality of care in your community.

I am going to ask you a few questions about this visit for the treatment of your child at this health facility.

3	How long did you spend in the health facility today, from the time you arrived to the time you received all services, RUTF, drugs, etc. and could leave?	Hours : |__|__| Minutes: |__|__|
4	How long was the trip from your house to arrival at the health center?	Hours : |__|__| Minutes : |__|__|
5	Did you or your household members pay anything for, or during your trip from your home to the health facility, or while waiting to be seen today? This may include transport costs, water, food, etc.	0 No PROBE *(the investigator must check for this answer), if that's the answer, skip to question 7* 1 Yes
6	If Yes, how much money in FCFA was spent for your trip from home to arrival at the health center today?	|__|__|__|__|__|__|
7	Did you or your household members pay for any health care services received at this facility today for SAM treatment?	0 No PROBE *(the investigator has to dig for that answer)* 1 Yes
8	If Yes, how much money in FCFA did you spend on these services?	Consultation fees |__|__|__|__|__|__| Drugs |__|__|__|__|__|__| Lab tests |__|__|__|__|__|__| PPN |__|__|__|__|__|__| _____ |__|__|__|__|__|__| _____ |__|__|__|__|__|__|
9	End time of the interview	_____: _____

Thank you for your answers! Do you have any questions for me?

Name and Signature of the Interviewer _____

Appendix A4b: Caregivers at SC

CEA of CMAM SURGE Approach in Niger

Tool #4b

Caregivers at SC Questionnaire

ID	**SC :** _____ Code: |__| |__||__|	
1	Date	**……/ …./ ……**
2	Start time of the interview	_____:_____

Hello, my name is …….. I represent **EVIHDAF**, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the accessing care for your child suffering from malnutrition. The results of the study will be used to improve the quality of care in your community.

I am going to ask you a few questions about your experience during the treatment of your child at this heath facility, and the expenses you and your household members have incurred since this time yesterday.

3	How long was the trip from your house to arrival at this CRENI (Hospital)?	Hours: |__|__| Minutes: |__|__|
4	Did you or your household members pay anything for, or during your trip from your home to this CRENI (Hospital) or while waiting to be seen the day of arrival? This may include transport costs, water, food, etc.	0 No ⍰⍰PROBE 1 Yes
5	If Yes, how much money in FCFA was spent on your trip from home to this CRENI (Hospital)?	|__|__|__|__|__|__|
6	Since this time yesterday, did you or your household members pay for any health care services received at this CRENI (Hospital) for your child's SAM treatment?	0 No ⍰⍰PROBE 1 Yes
7	If Yes, how much in did you spend in F CFA? (remind period =24h)	Registration |__|__|__|__|__|__| Drugs |__|__|__|__|__|__| Bed rental |__|__|__|__|__|__| X-Rays |__|__|__|__|__|__| Lab tests |__|__|__|__|__|__| RUFT |__|__|__|__|__|__| Therapeutic milk |__|__|__|__|__|__| Others |__|__|__|__|__|__|
8	What is the approximate value of food, drinks and related items you and your child have consumed at this CRENI (Hospital) since this time yesterday?	If None: →PROBE
9	End time of the interview	_____:_____

Thank you for your answers! Do you have any questions for me?

Name and Signature of the Interviewer _____

Appendix A5a: Outpatient Episodes - OTP

CEA of CMAM SURGE Approach in Niger

Tool #5a

OTP Episode data form

ID	**District:** …….. 1 (Commune)……2 (Department)…… **Integrated Health Center :** _____ Code: |__| |__||__| **Health Box :** _____ Code: |__| |__||__|	
1	Date (dd/mm/yy)	_____/_____/_____
2	Start time (use 24-hr clock) – Western Time	_____:_____

Hello, my name is …….. I represent **EVIHDAF**, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the CMAM program here in Niger. The results of the study will be used to improve the quality of the CMAM program in this community.

I would like to retrieve routine CMAM data on date of admission and date of exit or discharge, age, weight and MUAC at admission, and attendance rate.

3	Facilitator's name & position (Reception) : _____
4	Facilitator's phone number:_____

Age at admission (months)	**MUAC at admission (mm)**	**Weight at admission (kg)**	**Size at admission (cm)**	**Date of admission (…../…./….)**	**Date of exit/discharge (…../…./….)**	**Number of weeks attended**	**Exit type (1=Cured ; 2=Other)**

Note: *if additional rows are needed, use a separate sheet.*

8	Data collection period (from beginning to end) (dd/mm/yy)	/____/____/____/ to /____/____/____/
8	End time of the interview (use 24-hr clock)	_____:_____

Name and Signature of the Data Collector _____

Appendix A5a: Inpatient Episodes - SC

CEA of CMAM SURGE Approach in Niger

Tool #5b

SC Episode data form

ID	**CRENI of :** _____ Code: |__| |__||__|	
1	Date	**……/ …./ ……**
2	Start time of the interview	_____:_____

Hello, my name is …….. I represent EVIHDAF, an Evaluation organization that has been commissioned by Concern to conduct a study on the costs associated with the CMAM SURGE program here in Niger. The results of the study will be used to improve the quality of the CMAM program in this community.

I would like to retrieve routine CMAM data on age, weight, size at admission, MUAC at admission, and length of stay.

3	Facilitator's name & position (Reception) : _____
4	Facilitator's phone number: _____

Age in months	**MUAC at admission (mm)**	**Weight (Kg)**	**Size (Cm)**	**Length of stay (days)**

Age in months	**MUAC at admission (mm)**	**Weight (Kg)**	**Size (Cm)**	**Length of stay (days)**

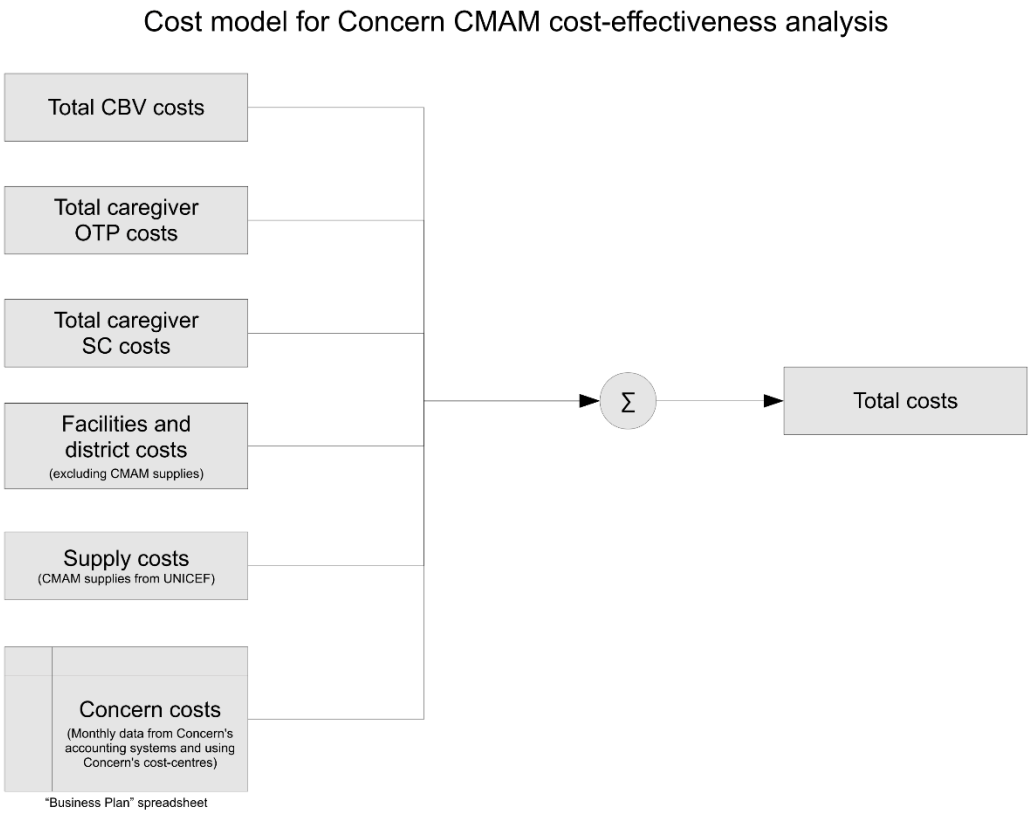
Note: *if additional rows are needed, use a separate sheet.*

8	Data collection period (from beginning to end) (dd/mm/yy)	/____/____/____/ to /____/____/____/
8	End time of the interview	_____:_____

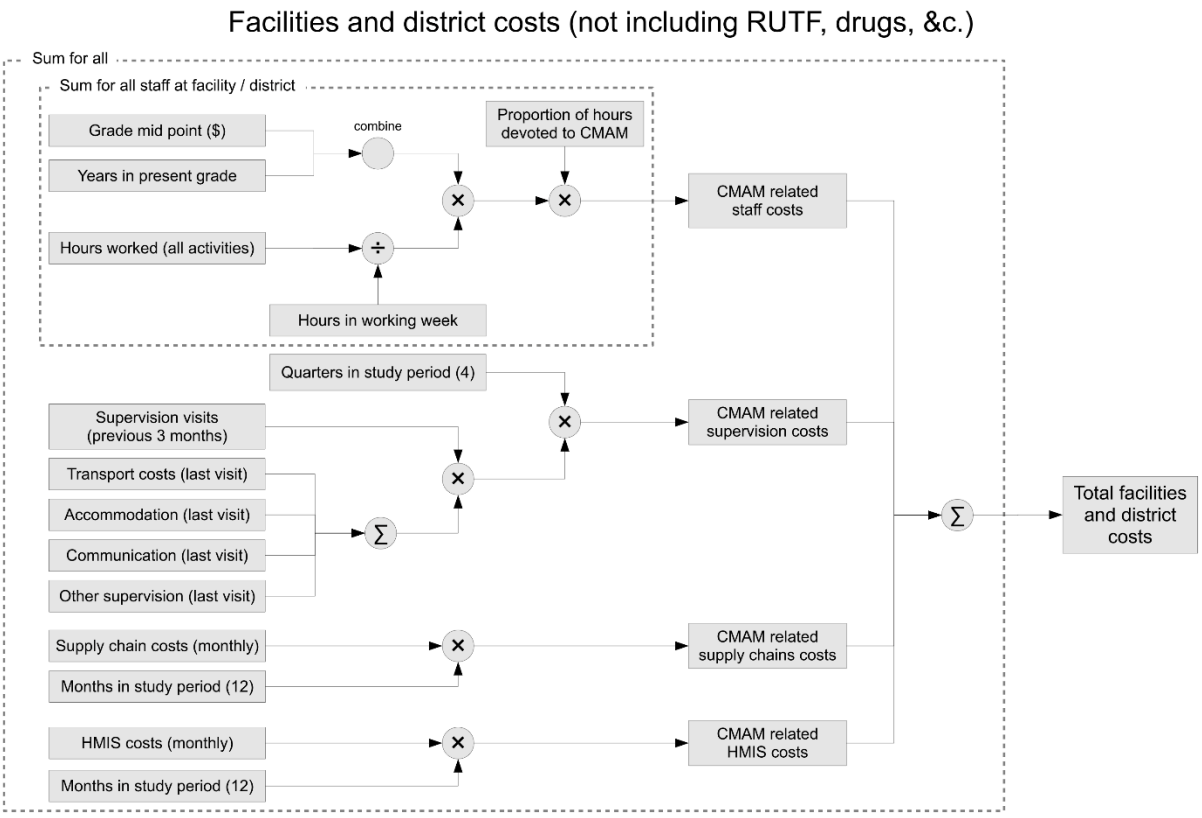
Name and Signature of the Data Collector _____

Annexes B

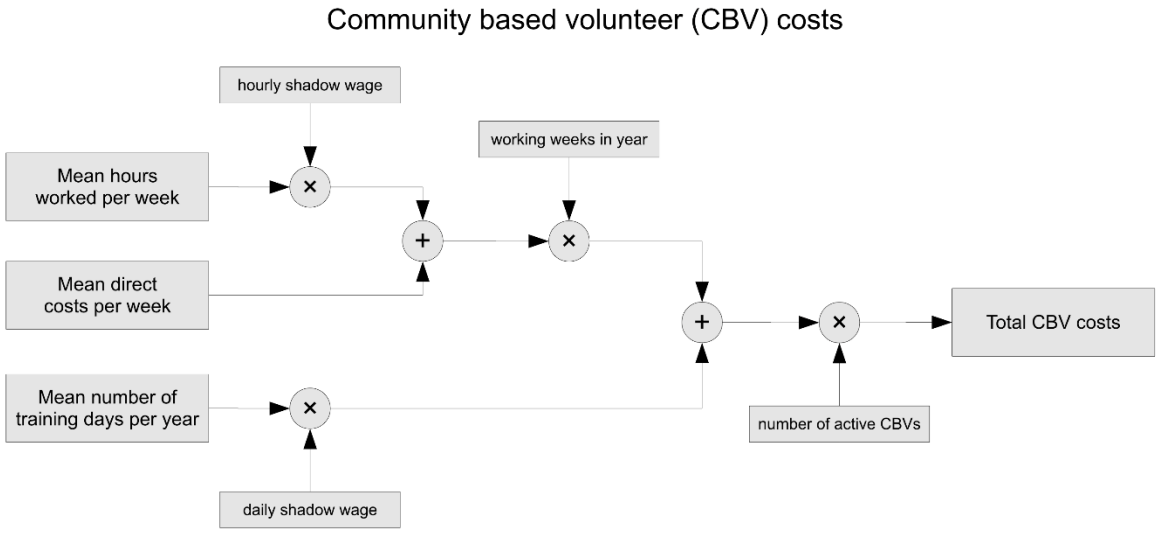
Appendix B1. Diagrammatical Presentation of Cost Centers



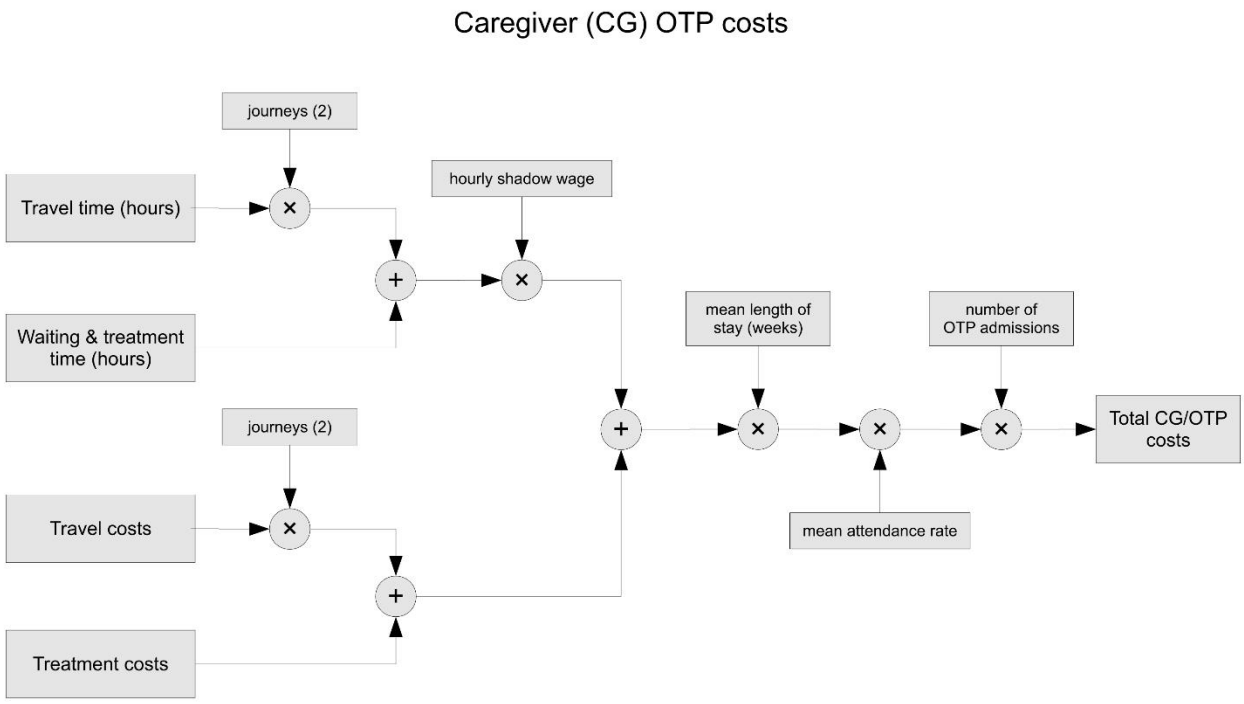
Annex B2: District and Health Center/Post Cost



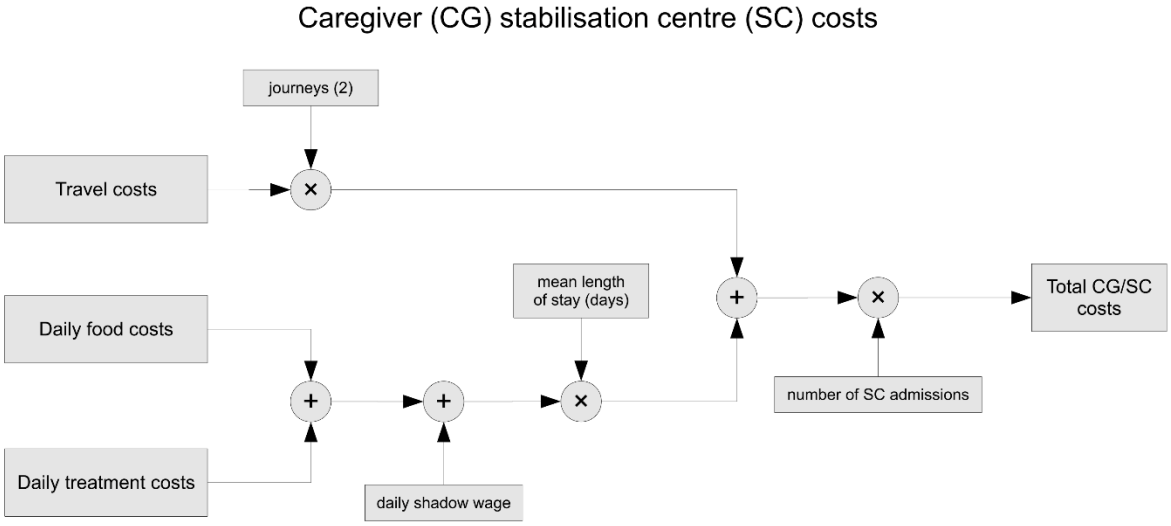
Annex B3: Community volunteer costs



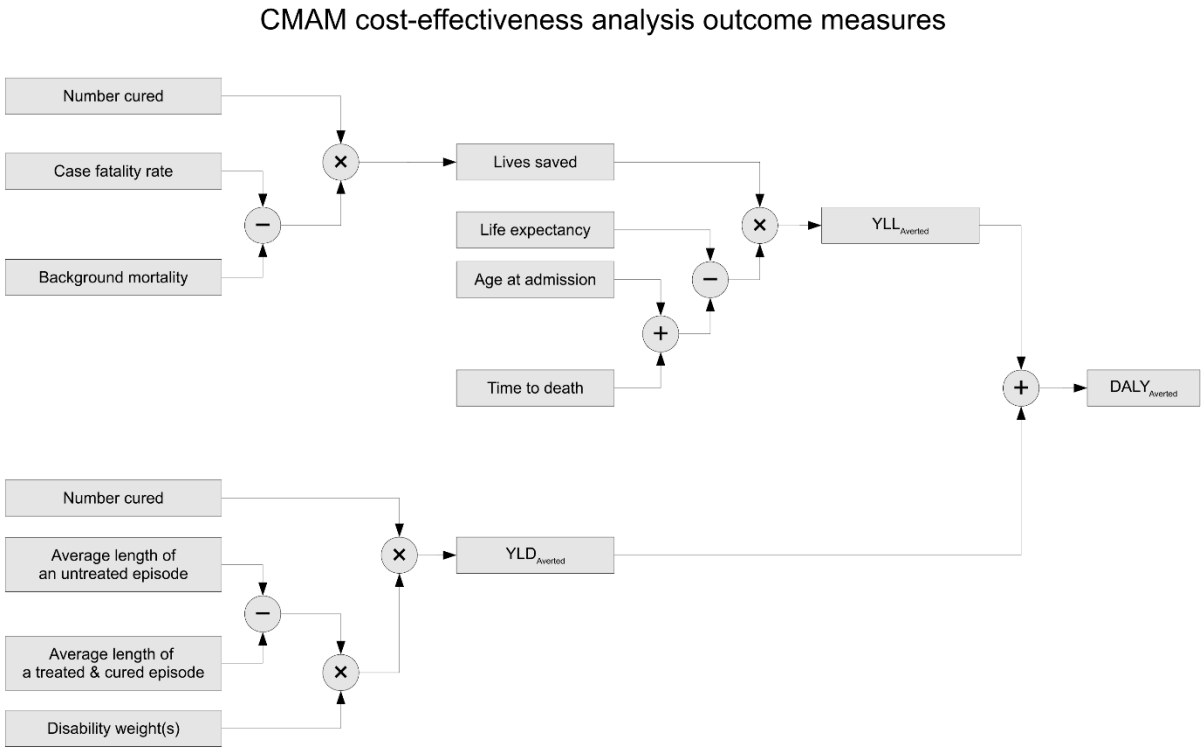
Annex B4a: Caregivers at OTP costs



Annex B4b: Caregivers at SC costs

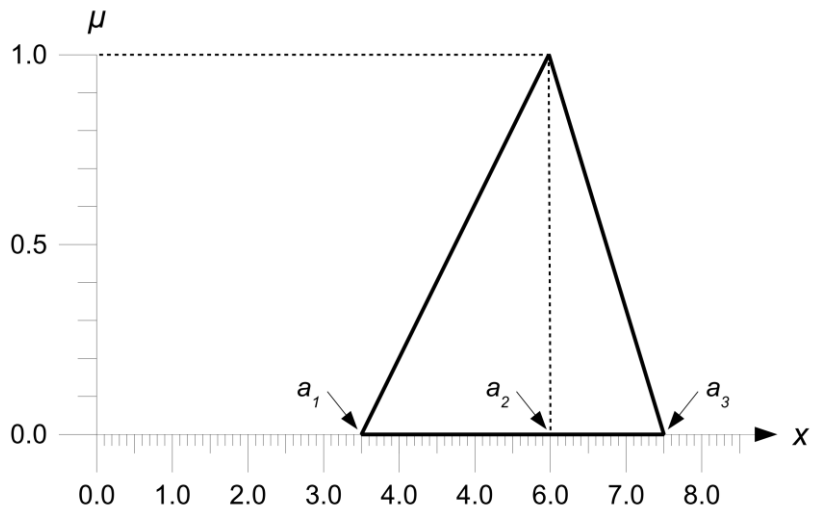


Annex B5. Diagrammatical Overview of DALYs Calculations



Annex C: Operations between triangular fuzzy numbers

A triangular fuzzy number consists of three "crisp" numbers which define the positions on the number line of the vertices of the triangular fuzzy number. For example:



This is represented using the triangular fuzzy number:

$$A = (a_1, a_2, a_3) = (lowest\ value, most\ likely\ value, highest\ value) = (3.5, 6.0, 7.5)$$

Probability is replaced by a measure of membership (μ) in the set of possible values.

Operations on triangular fuzzy numbers are performed using a mixture of simple arithmetic for the central values and interval arithmetic for the lowest and highest values. Given two triangular fuzzy numbers:

$$A = (3, 6, 8) \text{ and } B = (1, 2, 3)$$

then:

$$\begin{aligned} A + B &= (a_1 + b_1, a_2 + b_2, a_3 + b_3) \\ &= (3 + 1, 6 + 2, 8 + 3) \\ &= (4, 8, 11) \end{aligned}$$

$$\begin{aligned} A - B &= (a_1 - b_3, a_2 - b_2, a_3 - b_1) \\ &= (3 - 3, 6 - 2, 8 - 1) \\ &= (0, 4, 7) \end{aligned}$$

$$\begin{aligned} A \times B &= (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3) \\ &= (3 \times 1, 6 \times 2, 8 \times 3) \\ &= (3, 12, 24) \end{aligned}$$

$$\begin{aligned} A \div B &= (a_1 \div b_3, a_2 \div b_2, a_3 \div b_1) \\ &= (3 \div 3, 6 \div 2, 8 \div 1) \\ &= (1, 3, 8) \end{aligned}$$

Operations involving constants (or non-fuzzy numbers) are simple. For example:

$$\begin{aligned} A + 12 &= (a_1 + 12, a_2 + 12, a_3 + 12) \\ &= (3 + 12, 6 + 12, 8 + 12) \\ &= (15, 18, 20) \end{aligned}$$

The approach is the same for all operations involving constants (or non-fuzzy numbers). For example:

$$\begin{aligned} A \div 12 &= (a_1 \div 12, a_2 \div 12, a_3 \div 12) \\ &= (3 \div 12, 6 \div 12, 8 \div 12) \\ &= (0.2500, 0.5000, 0.6667) \end{aligned}$$

Operations are a little more complicated when dealing with zero and / or negative numbers. In this case a minimum / maximum rule is used:

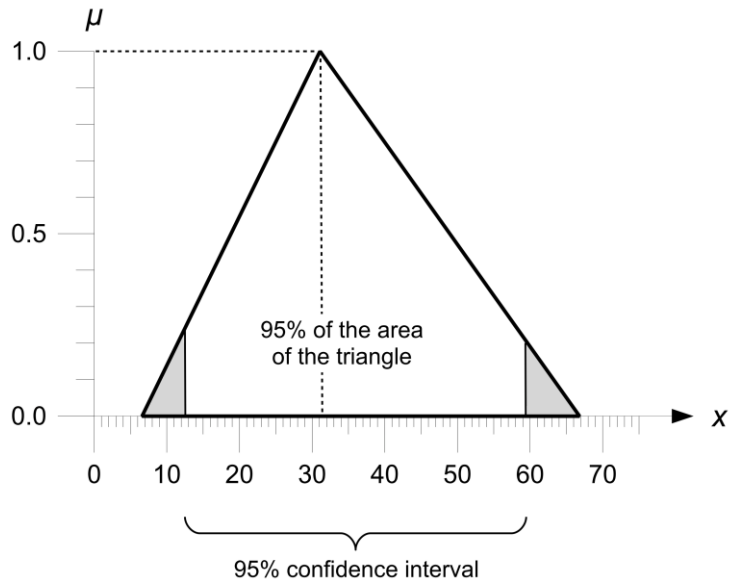
$$\begin{aligned} A \odot B = \min(a_1 \odot b_1, a_1 \odot b_3, a_3 \odot b_1, a_3 \odot b_3)\,, a_2 \\ \odot\, b_2, \max(a_1 \odot b_1, a_1 \odot b_3, a_3 \odot b_1, a_3 \odot b_3) \end{aligned}$$

where $\odot$ is the operation (i.e. addition, subtraction, multiplication, or division) required.

Confidence limits for a triangular fuzzy number

A triangular fuzzy number expresses the most likely value and the range of possible values for a quantity. We can think of the upper and lower limits of a triangular fuzzy number as an approximate 100% confidence interval since it should contain all, or nearly all, possible values of the quantity of interest. We usually want to present 95% confidence intervals.

The 95% CI contains the central 95% of the area of the triangle:



Given a triangular fuzzy number:

$$A = (a_1, a_2, a_3)$$

The point estimate is a_2.

The 95% confidence limits for a_2 is calculated as:

$$Lower\ confidence\ limit = a_1 + \sqrt{(a_3 - a_1)\ \times\ (a_2 - a_1)\ \times\ 0.025}$$

$$Upper\ confidence\ limit = a_3 - \sqrt{(a_3 - a_1)\ \times\ (a_3 - a_2)\ \times\ 0.025}$$

If (e.g.) we calculate $YLD_{Averted}$ using triangular fuzzy numbers and find:

$$YLD_{Averted} = (6.4, 31.1, 66.9)$$

then the 95% confidence limits on $YLD_{Averted}$ are:

$$Lower\ confidence\ limit = 6.4 + \sqrt{(66.9 - 6.4)\ \times\ (31.1 - 6.4)\ \times\ 0.025} = 12.5$$

$$Upper\ confidence\ limit = 66.6 - \sqrt{(66.9 - 6.4)\ \times\ (66.9 - 31.1)\ \times\ 0.025} = 59.5$$

We would report our findings as "$YLD_{Averted}$ = 31.1 (95% CI = 12.5 – 59.5)".