



Optima Nutrition User Guide

Optima Consortium for Decision Science
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Glossary of Terms

AGA	Appropriate for gestational age
DHS	Demographic and health survey
FAO	Food and Agriculture Organization of the United Nations
GBD	Global Burden of Disease
HAZ	Height-for-age Z-score
IFA(S)	Iron and folic acid (supplementation)
IPTp	Intermittent preventative treatment of malaria during pregnancy
IYCF	Infant and young child feeding education
LiST	The Lives Saved Tool
LLINs	Long-lasting insecticide-treated bednets
LNS	Lipid-based nutrient supplement
MICS	Multiple indicator cluster surveys
MAM	Moderate acute malnutrition
MMS	Multiple micronutrient supplementation
MUAC	Mid-Upper Arm Circumference
OR	Odds ratio
ORS	Oral rehydration salts
PPCF	Public provision of complementary food
PW	Pregnant women
RRR	Relative risk ratio
SAM	Severe acute malnutrition
SGA	Small for gestational age
UNDP	United Nations Population Division
US\$	United States dollars
WASH	Water, sanitation and hygiene
WHO	World Health Organization
WHZ	Weight-for-height Z-score
WRA	Women of reproductive age

1. Introduction

This document is a step-by-step guide to setting up and running Optima Nutrition analyses. The skills and familiarity gained will allow users to customise and apply the software to a variety of epidemiological and policy contexts. The guide is structured into six modules:

- **Model description:** An overview of how the underlying model works, and how the costing framework links to interventions and impact.
- **Webapp instructions:** Step-by-step instructions for generating projects, and how to set up and run scenarios, optimisations, and multi-region analyses using the online graphic user interface.
- **Completing the databook:** A detailed description of the setting-specific data requirements, including available sources and information on how the data is used in the model.
- **Editing default parameters:** Instructions for how to edit default parameters.
- **Advanced options:** Additional options that can be used to restrict interventions or create dependencies for them.
- **Parameters:** Sources and notes on all of the parameters used in the model.

2. Model description

2.1. Main uses of the model

The Optima Nutrition model considers the allocative efficiency of spending across interventions that can impact malnutrition. The model has three main uses:

- **Optimising investment for best health and economic outcomes.** For example:
 - How can a fixed budget be allocated across interventions to minimise malnutrition and associated conditions?
 - Which interventions should receive priority additional funding, if it were available?
 - In a multi-region analysis: which geographical regions should receive priority additional funding, if it were available?
- **Projecting future scenarios.** For example:
 - How will trends in malnutrition change under different funding or intervention coverage scenarios?
- **Setting targets.** For example:
 - How close is a country likely to get to their nutrition targets (a) with the current volume of funding, allocated according to current expenditure? (b) with the current volume of funding, reallocated optimally?
 - What is the minimum funding required, and how should it be allocated, to meet the nutrition targets?

In addition, the model has secondary uses for assessing the impact of interventions on multiple malnutrition conditions, including: stunting in children; wasting in children; anaemia in children and women of reproductive age; and child and maternal mortality

2.2. Overview of populations and risk factors

The Optima Nutrition model tracks the number of women of reproductive age (15-49 years) in a population, who can become pregnant and give birth. After birth, children are tracked until five years of age across five age bands: <1 month, 1-5 months, 6-11 months, 12-23 months and 24-59 months.

Children in each age-band are categorised by height-for-age (stunting) status, weight-for-height (wasting) status, anaemia status, breastfeeding practice, and economic status (above or below the poverty line). Women of reproductive age are classified by anaemia status.

Children exit the model either when they reach the age of 60 months or by death, which can happen at any age. Children in the < 1 month age-band can die due to diarrhoea, pneumonia, meningitis, asphyxia, sepsis, prematurity and “other” causes, while children in all other age bands can die of diarrhoea, pneumonia, measles and “other” causes (“other” causes is used to capture, and match to, population statistics of known overall mortality rates for the given application context). The relative risks of dying from each cause are related to the child’s breastfeeding, height-for-age, weight for height, and anaemia

status. Mortality is also tracked for pregnant women, who can die from antepartum haemorrhage, intrapartum haemorrhage, postpartum haemorrhage, hypertensive disorders, sepsis, abortion, embolism, other direct causes and other indirect causes. The relative risks of pregnant women dying from haemorrhage are related to their anaemia status.

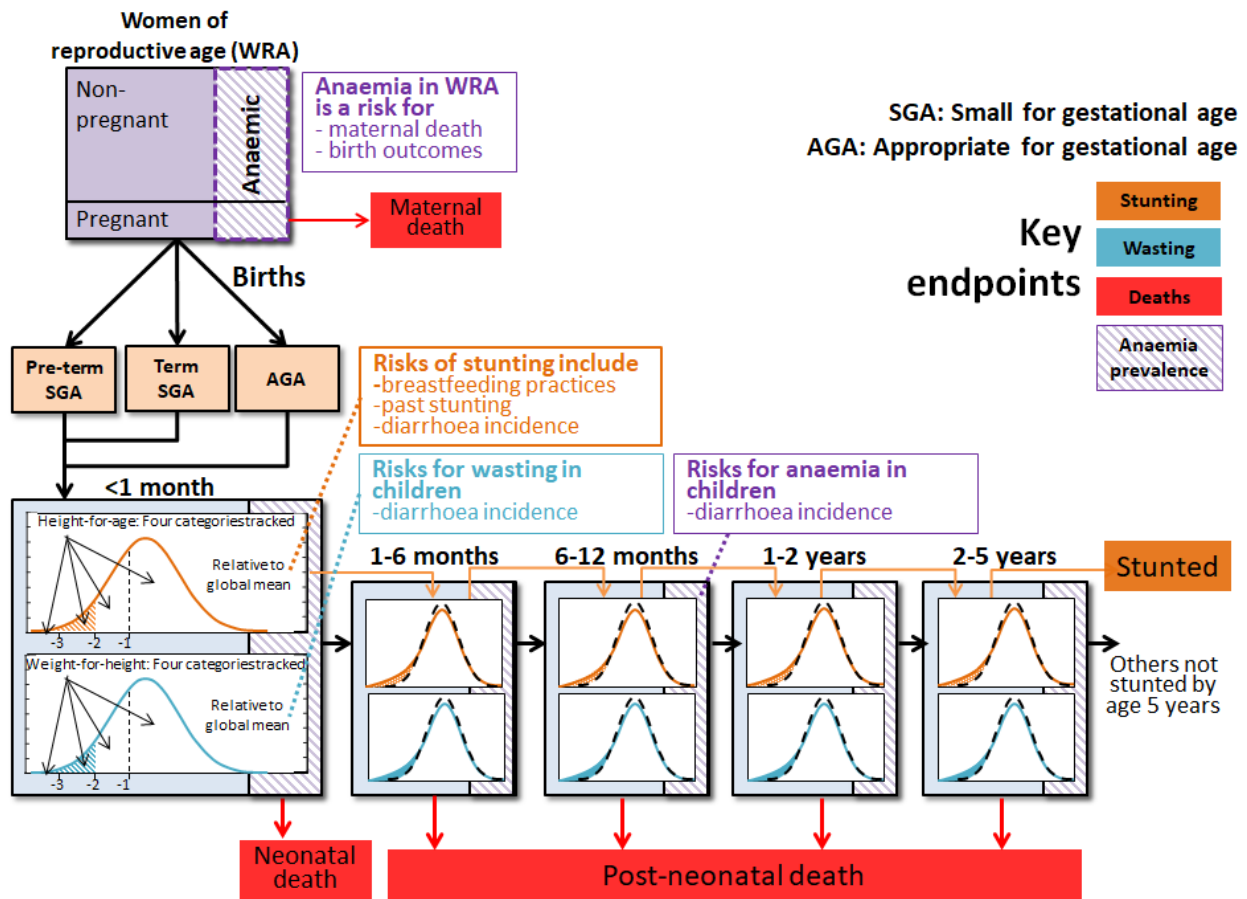


Figure 2.1: Populations within the Optima Nutrition model.

Several risk factors for stunting in children are modelled: birth outcomes (pre-term birth and/or a child being born small for gestational age [SGA]), stunting in a previous age-band, suboptimal feeding practices (age-appropriate breastfeeding and complementary foods), and incidence of diarrhoea (Figure 2.2). In addition, anaemia in women of reproductive age is modelled to be a risk factor for sub-optimal birth outcomes; birth outcomes and diarrhoea incidence are modelled to be risk factors for wasting; and sub-optimal breastfeeding is modelled to be a risk factor for diarrhoea incidence.

For example, Figure 2.2 shows that changes to breastfeeding practices, perhaps through better education, can directly reduce mortality and diarrhoea incidence. Moreover, in the model this will also lead to an indirect reduction in mortality because a reduction in diarrhoea incidence will lead to a reduction in stunting and wasting, which will subsequently further reduce mortality.

Optima Nutrition uses an economic model to translate the amount spent on an intervention to its estimated coverage. For each intervention, this requires a setting-specific input for the unit cost, and an assumption about the marginal costs with increasing intervention coverage (either linear, increasing due to saturation effects, decreasing due to economy of scale effects or S-shaped as a combination of both; details are provided in section 2.7). Each intervention is implemented so that when its coverage is changed, this will reduce/increase one or more risk factors or mortality cause (e.g. death from sepsis), according to effect size estimates from the literature.

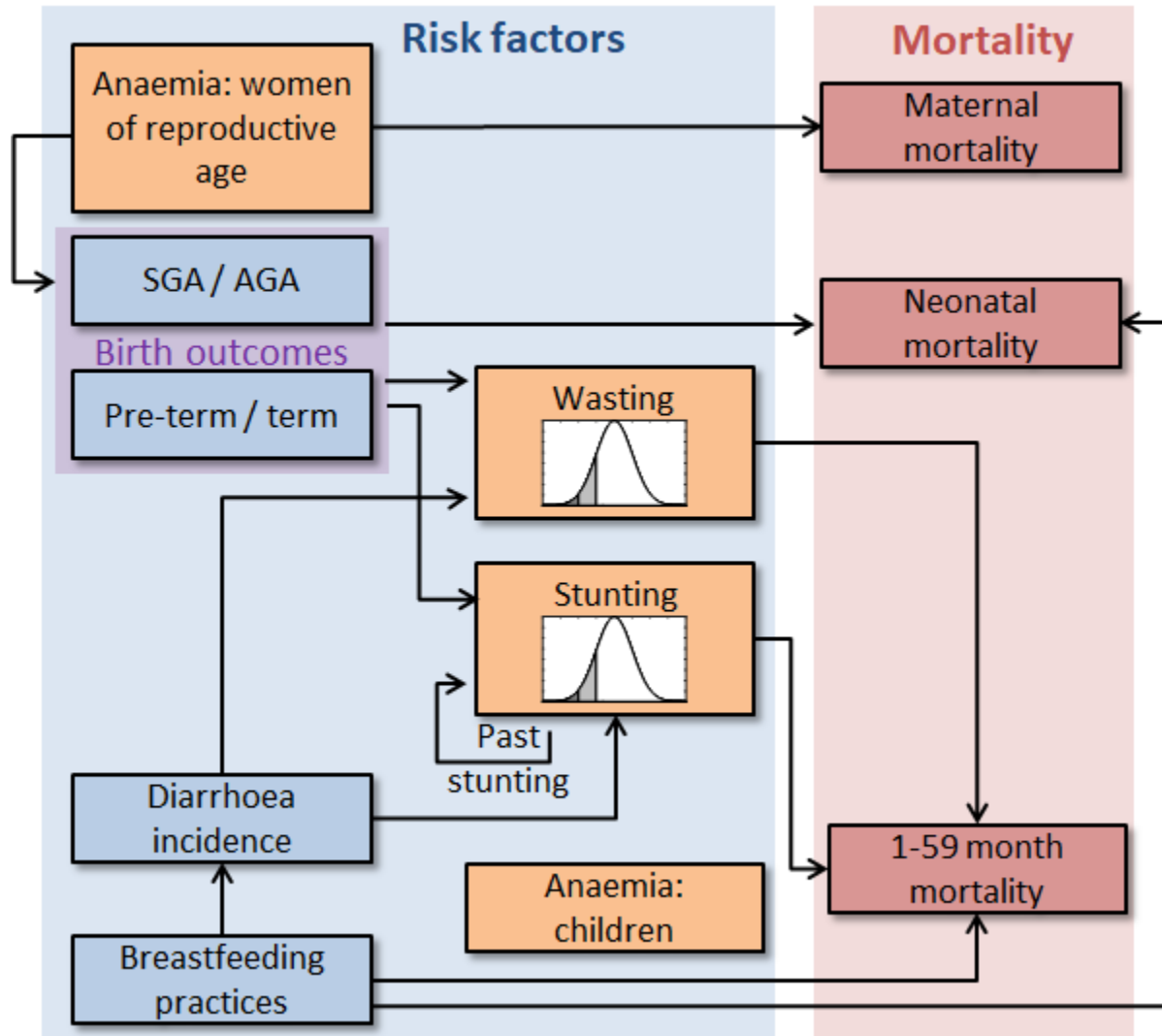


Figure 2.2: The relationship between risk factors and mortality. SGA, small for gestational age; AGA, appropriate for gestational age.

2.3. Modelling stunting using Optima Nutrition

- The model divides children in each age-band into four height-for-age categories, based on WHO criteria (Figure 2.3), with the two lowest categories (severe and moderate) being considered stunting:
 - Severe: < -3 standard deviations below the median height-for-age of the WHO reference population
 - Moderate: < -2 & ≥ -3 standard deviations below the median height-for-age of the WHO reference population
 - Mild: < -1 and ≥ -2 standard deviations below the median height-for-age of the WHO reference population
 - Normal: ≥ -1 standard deviation below the median height-for-age of the WHO reference population
- Risk factors for stunting are suboptimal birth outcomes (pre-term birth and/or a child being born SGA), stunting in a previous age-band, suboptimal feeding practices (age-appropriate breastfeeding and complementary foods), and incidence of diarrhoea (Figure 2.2).
- Stunting increases the risk of mortality for children who have diarrhoea, pneumonia, measles and other illnesses.
- Odds ratios and relative risks are model inputs, can be changed, and have defaults based on the literature.

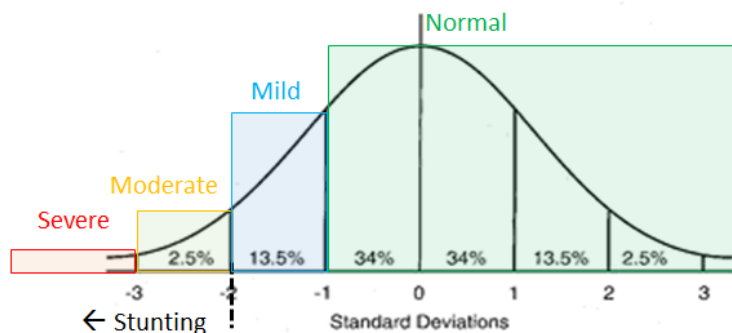


Figure 2.3: The model divides children in each age-band into four height-for-age categories, based on WHO criteria. Children in the two lowest categories (severe and moderate) are considered to be stunted.

2.4. Modelling wasting using Optima Nutrition

- The weight-for-height distribution is tracked for children in each age band (Figure 2.4, just like for stunting). Children are divided into four categories:

- Severe acute malnutrition (SAM): < -3 standard deviations below than the median weight-for-height of the WHO reference population
- Moderate acute malnutrition (MAM): < -2 and ≥ -3 standard deviations below than the median weight-for-height of the WHO reference population
- Mild acute malnutrition: < -1 and ≥ -2 standard deviations below than the median weight-for-height of the WHO reference population
- Normal: ≥ -1 standard deviation below than the median weight-for-height of the WHO reference population
- Children are considered to be “wasted” if they are in the SAM or MAM categories.
- Wasting is modelled as an incident (short-duration) condition:
 - As opposed to stunting, where being stunted in one age band increases the risk of being stunted in the next, wasting distributions are independent in each age band – this means that the distribution (i.e. prevalence) of wasting in a given time period does not affect the distribution of wasting in subsequent periods.
- Wasting increases the risk for mortality for children who have diarrhoea, pneumonia, measles and other illnesses
- Diarrhoea incidence and birth outcomes are risk factors for wasting (Figure 2.2):
 - Reducing diarrhoea incidence can lead to reductions in wasting
 - Improvements in birth outcomes (term/pre-term; appropriate for gestational age [AGA]/SGA) can lead to reduced wasting

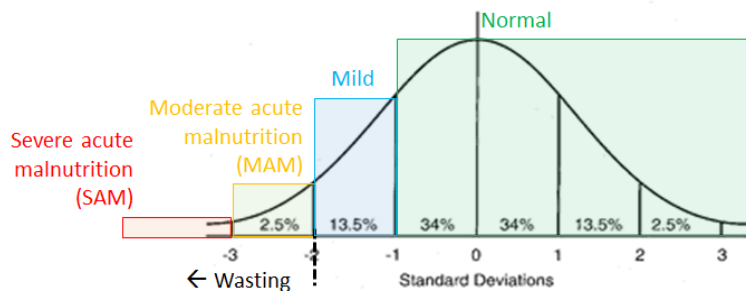


Figure 2.4: The model divides children in each age-band into four weight-for-height Z-score (WHZ) categories. Children in the two lowest categories (SAM and MAM) are considered to be wasted.

Figure 2.5 shows the dynamics of the wasting model within each age band:

- Children enter the age band (shown from the left), and will be classified as SAM, MAM, mild or normal according to the prevalence of these states from the data
- Children in the mild and normal categories can develop MAM (incidence of MAM)
- Children with MAM can deteriorate to SAM (incidence of SAM)
- When they are in MAM or SAM categories, children have increased risks of death
- Children can recover from the SAM and MAM categories due to treatment.

- The incidence rates, probabilities of death and average duration spent in SAM and MAM are calibrated to match country-specific data on prevalence, mortality and treatment numbers.

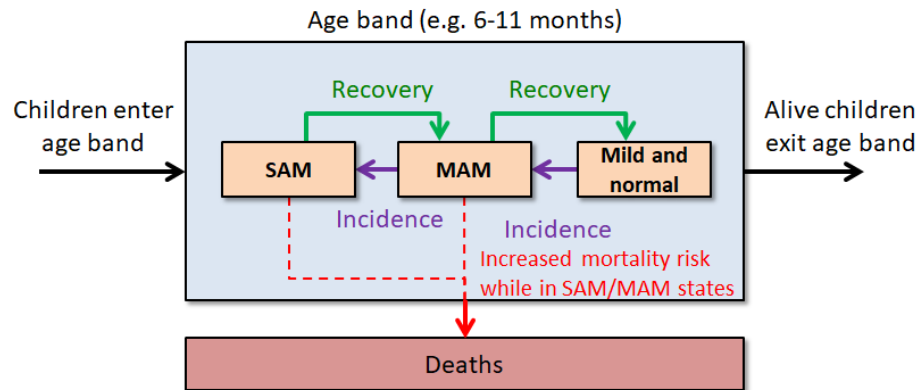


Figure 2.5: Wasting is considered to be an acute condition within the model. The model tracks the incidence of severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) within each age band, allowing children to cycle between categories.

2.5. Modelling anaemia using Optima Nutrition

Each population in the model is stratified by anaemia status: anaemic (mild, moderate or severe) or not anaemic (Figure 2.6). The model also includes a setting-specific input for the fraction of anaemia that is severe.

- Anaemia in pregnant women is modelled as a risk factor for maternal mortality (haemorrhage)
- Anaemia in pregnant women is also modelled to be a risk factor for suboptimal birth outcomes
 - This can affect stunting, which in turn can affect mortality in children.

Non-pregnant women of Reproductive Age (WRA)	15 - 19 years	Not anaemic	Anaemic
	20 - 24 years	Not anaemic	Anaemic
	25 - 29 years	Not anaemic	Anaemic
	30 - 39 years	Not anaemic	Anaemic
	40 - 49 years	Not anaemic	Anaemic
Pregnant women	15 - 19 years	Not anaemic	Anaemic
	20 - 29 years	Not anaemic	Anaemic
	30 - 39 years	Not anaemic	Anaemic
	40 - 49 years	Not anaemic	Anaemic
Children Also stratified by:	0 - 1 months	Not anaemic	Anaemic
	1 - 6 months	Not anaemic	Anaemic
	6 - 11 months	Not anaemic	Anaemic
	12 - 23 months	Not anaemic	Anaemic
	24 - 59 months	Not anaemic	Anaemic

Figure 2.6: Summary of model populations. Each population is stratified by anaemia status (anaemic or not anaemic).

2.6. Interventions

Interventions are implemented in the model so that each intervention targets one or more risk factors and/or causes of mortality.

2.6.1. *Interventions that impact stunting*

Table 2.1: Interventions that impact stunting, either directly or indirectly. RRR, relative risk ratio; OR, odds ratio.

Intervention	Target population	Effects	Source / effect size
Balanced energy protein supplementation	Pregnant women below the poverty line	Reduces risk of SGA birth outcomes	RRR = 0.79 [Ota et al. 2015, The Cochrane Library [1]]
Multiple micronutrient supplementation in pregnancy (MMS)	Pregnant women	Reduces risk of SGA birth outcomes	RRR = 0.77 [LiST [2]]
Public provision of complementary foods (PPCF)	Children 6-23 months below the poverty line	Reduces the odds of stunting	OR = 0.89 [Bhutta et al. 2008, The Lancet [3]; Imdad et al. 2011, BMC Public Health [4]]

Prophylactic zinc supplementation	Children 1-59 months	Reduces diarrhoea incidence Reduces diarrhoea and pneumonia mortality	Diarrhoea incidence RRR = 0.805 [Bhutta et al. 2013, The Lancet [5]; Yakoob et al. 2011, BMC Public Health [6]] Mortalities RRR = 0.85 [Bhutta et al. 2013, The Lancet [5]; Yakoob et al. 2011, BMC Public Health [6]]
Vitamin A supplementation	Children 6-59 months	Reduces diarrhoea incidence mortality	Incidence RRR = 0.87 [Imdad et al. 2011, BMC Public Health [7]] Mortality RRR = 0.82 [Imdad et al. 2011, BMC Public Health [7]]
Infant and young child feeding education (IYCF)	Children <23 months	See next section	

2.6.2. Infant and young child feeding education (IYCF) interventions

Correct (or incorrect) feeding practices have a different impact in the model depending on the age of the child (Table 2.2). Therefore, the model allows the user to choose what ages their education packages cover, accounting for the different impacts, in user-defined Infant and Young Child Feeding (IYCF) packages:

- IYCF packages can comprise different components for children of different ages, and can be delivered through different modalities
 - An IYCF package can target one (or more) of: pregnant women, children 0-5 months or children 6-23 months
 - An IYCF package can be delivered through one or more of: health facilities (coverage restricted by the fraction of the population who attend), community, or mass media.
 - If multiple delivery modes are selected, such as both health facility and community, then some parents will be exposed to multiple messages which can lead to greater impact.
- Users can design their own IYCF packages using the table below
- It is possible for users to define multiple IYCF packages, for example:
 - One package may only include health facility delivery, while another may include only community delivery

- These two packages could then be compared within scenario analyses.
- An example of an IYCF package is shown in Figure 2.7 (instructions on how to design and enter IYCF packages are provided in the Webapp and Databook sections).

IYCF package	Target population	Health facility	Community	Mass media
IYCF 1	Pregnant women	x		
	<1 month	x	x	
	1-5 months	x	x	
	6-11 months	x	x	
	12-23 months	x	x	
	All			x

Figure 2.7: An example of an IYCF package entered into the model (instructions provided in the Webapp section). In this example, the IYCF package might represent: Pregnant women—counseling for pregnant women attending health facilities; <6 months—visit from community health worker + counseling during facility child visits; > 6 months—community lectures + counseling during facility child visits; mass media—messages about advantages of exclusive breastfeeding 0-6 months.

Table 2.2: The impact of correct feeding practices on diarrhoea, stunting and mortality in the model, by age bracket.

Age group			Effect size / sources
< 6 months	Exclusive breastfeeding	Reduces diarrhoea Reduces mortality Indirectly reduces stunting and wasting (through decreased diarrhoea)	Diarrhoea incidence: compared to exclusive breastfeeding, OR = 1.26, 1.68, 2.65 for experiencing diarrhoea with predominant, partial or no breastfeeding [8] Diarrhoea mortality: compared to exclusive breastfeeding, OR = 2.28, 4.62, 10.53 for diarrhoea mortality and 1.66, 2.50, 14.97 for other causes with predominant, partial or no breastfeeding [9] Diarrhoea → stunting: OR for stunting = 1.04 for every additional diarrhoea episode compared to exclusively breastfed children [2]

6-23 months	Partial breastfeeding	Reduces diarrhoea Reduces mortality	OR = 2.07 for no breastfeeding compared to partial breastfeeding [8]
	Appropriate complementary feeding	Reduces odds of stunting	OR = 0.67 [4]

2.6.3. Treatment of severe acute malnutrition (SAM)

Treatment of SAM is an intervention in the model that targets all children experiencing SAM:

- Treated children are moved to the MAM category. This is based on the national and international treatment protocol which consider a child to recover from SAM once it reaches the moderate acute malnutrition status (based on weight for height Z-score ([WHZ] or MUAC).
- Scaling up treatment of SAM:
 - Increases recovery from SAM
 - Therefore reduces the prevalence of SAM
 - Reduces mortality
 - Increases the prevalence of MAM (indirectly increases mortality from MAM and incidence of SAM)

Note that scaling up treatment of SAM does not directly reduce the prevalence of wasting, since wasting is a combination of SAM and MAM and children recover from SAM to MAM (which is still considered wasting). In the model the treatment of SAM intervention has an option to include management of MAM. If selected, the treatment intervention will also shift children from MAM to mild acute malnutrition (Figure 2.8). This combined intervention will reduce the prevalence of wasting.

It is also possible to deliver treatment interventions through health facilities only, or health facilities + community (the coverage of health facility delivery is restricted by the fraction of the population who attend health clinics; details are provided in the databook section).

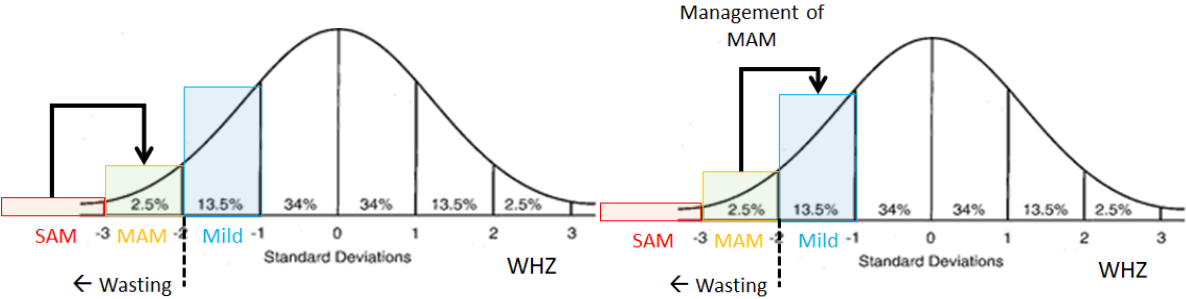


Figure 2.8: Impact of the treatment of SAM intervention. By default, the treatment intervention moves children from the SAM category to the MAM category (left). If the extension to management of MAM is selected, children are also moved from MAM to mild (right).

2.6.4. Prevention interventions for wasting

Table 2.3: Interventions that impact wasting, either directly or indirectly.

Intervention	Target population	Effects	Source / effect size
Public provision of complementary foods (PPCF)	Children 6-23 months old who live in households below the poverty line	Reduces the odds of stunting Reduces the incidence of SAM Reduces the incidence of MAM Indirectly reduces SAM mortality Indirectly reduces MAM mortality	Stunting: OR = 0.89 [Bhutta et al. 2008, The Lancet [3]; Imdad et al. 2011, BMC Public Health [4]] SAM / MAM incidence RRR = 0.913 [LiST [2]]
Lipid-based nutrition supplements (LNS)	Children 6-23 months old who live in households below the poverty line	Similar to PPCF but also impacts anaemia (see next session)	
Cash transfers	All children below the poverty line	Reduces the incidence of SAM Reduces the incidence of MAM Indirectly reduces SAM mortality Indirectly reduces MAM mortality	SAM incidence: RRR = 0.766 for 6-23 months, RRR = 0.792 for 24-59 months [Langendorf et al. 2014, PLoS Med [10]] MAM incidence: RRR = 0.719 for 6-23 months, RRR = 0.792 for 24-59 months [Langendorf et al. 2014, PLoS Med [10]]

2.6.5. Interventions that impact anaemia

Table 2.4: Interventions that impact anaemia, either directly or indirectly.

Intervention	Target population	Effects	Source / effect size
Iron and folic acid (IFA) supplementation	Pregnant women. Not given to women receiving MMS	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.33 [Pena-Rosas et al, Cochrane Database Reviews 2015 [11]]

for pregnant women			SGA RRR = 0.85 [Pena-Rosas et al, Cochrane Database Reviews 2015 [11]]
IFA supplementation for non-pregnant women of reproductive age	Non-pregnant women of reproductive age	Reduces anaemia	RRR = 0.73 [Fernandez-Gaxiola & De-Regil 2011, Cochrane Database Syst Rev [12]]
Multiple micronutrient supplementation (MMS)	Pregnant women	Reduces risk of SGA birth outcomes	RRR = 0.77 [LiST [2]]
Intermittent preventative treatment of malaria during pregnancy (IPTp)	Pregnant women in areas where there is malaria risk	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.83 [Radeva-Petrova et al. 2014, The Cochrane Library [13]] SGA RRR = 0.65 [Eisele et al. 2010, I J Epi [14]]
Food fortification	Everyone	Reduces anaemia Reduces neonatal mortality	Anaemia OR = 0.976 [RRR = 0.678 Barkley et al. 2015, B J Nutrition [15]] Neonatal mortality RRR = 0.678 [congenital defects; Blencowe et al. 2010, I J Epidemiology [16]]
Long-lasting insecticide-treated bed nets (LLINs)	Everyone in areas where there is malaria risk	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.83 [Eisele et al. 2010, Int J Epi [14]] SGA RRR = 0.65 [Eisele et al. 2010, Int J Epi [14]]
Lipid-based nutrition supplements (LNS)	Children 6-23 months old who live in households below the poverty line	Reduces stunting Reduces incidence of MAM/SAM Reduces anaemia	Stunting OR = 0.89 [assumed the same as PPCF] MAM/SAM incidence RRR = 0.913 [assumed to be the same as PPCF] Anaemia RRR = 0.69 for all-cause anaemia [assumed to be the same as micronutrient powders]
Micronutrient powders	Children 6-59 months, not already receiving LNS	Reduces anaemia	RRR = 0.69 [De-Regil et al. Cochrane review 2013 [17]]

Delayed cord clamping	Pregnant women (at birth, but impact is for children <1 month)	Reduces anaemia	RRR = 0.53 [Hutton and Hassan, 2007 Jama [18]]
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2.6.6. Delivery modalities for anaemia interventions

Intermittent iron supplementation for women of reproductive age can be delivered through four modalities (Figure 2.9-left):

- Schools (the only modality for 15-19 year olds who attend schools)
- Health facilities (available for those not at school and attending health facilities)
- Community (available for everybody)
- Retail (only available for the fraction of women of reproductive age above the poverty line)

Note that this intervention is different from iron supplementation in pregnancy. The fraction of the population who are likely to access each modality are entered by the user (see databook section).

Fortification of foods with iron and folic acid is modelled as three separate interventions: fortification of wheat, rice and maize flour.

- The coverage of each is restricted to the fraction of the population who eat each food as their staple, determined based on consumption data (Figure 2.9-right).
- Food fortification interventions are modelled not to reach the fraction of the population engaged in subsistence farming. This is because those populations consume the staples they grow rather than commercially produced staples that are fortified.

In addition, there is an intervention for double fortification of salt with iron and iodine:

- Targets entire population regardless of the staple food they consume (wheat, rice, or maize) and whether they engage in subsistence farming or not (Figure 2.9-right).
- Note that Optima Nutrition does not model the impact of salt iodisation on iodine deficiency or cognitive outcomes.

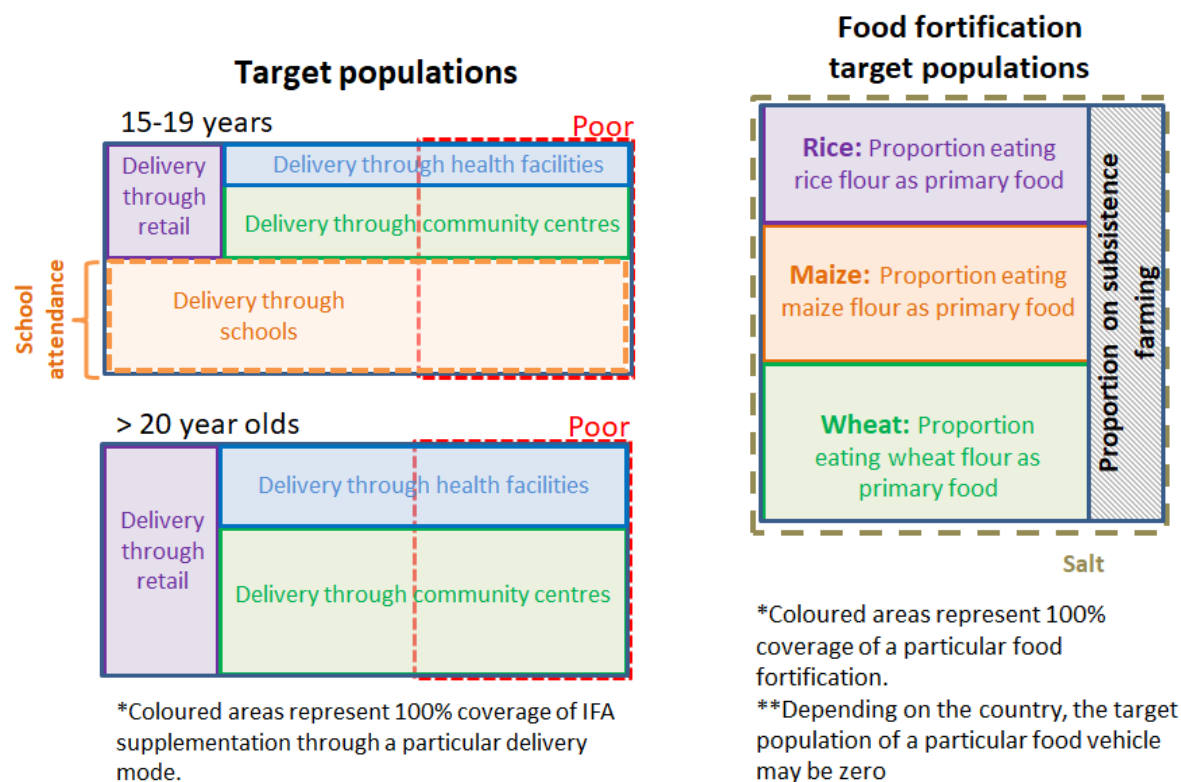


Figure 2.9: Target populations for the different delivery modalities of the iron and folic acid (IFA) supplementation (non-pregnant women of reproductive age) intervention (left) and for the different food fortification interventions (right).

2.6.7. Other supplement interventions

Table 2.5: Other supplement interventions that impact mortality, and indirectly impact other outcomes through changes in population size.

Intervention	Target population	Effects	Source / effect size
Oral rehydration salts (ORS)	Children 0-59 months (different quantity by age)	Reduces diarrhoea mortality	RRR = 0.18 [Munos, et al. 2010, I J Epi [19]; Walker & Black 2010, I J Epi [20]]
ORS + Zinc	Children 0-59 months (different quantity by age)	Reduces diarrhoea mortality	RRR = 0.14 [Munos, et al. 2010, I J Epi [19]; Walker & Black 2010, I J Epi [20]]
Calcium supplementation	Pregnant women	Reduces maternal mortality (hypertensive disorders)	Mortality RRR = 0.80 [Ronsmans et al. 2011, BMC Public Health [21]]

		Reduces pre-term births	Pre-term RRR = 0.78 [Imdad et al. 2011, BMC Public Health [22]]
MgSO4 for pre-eclampsia / eclampsia	Pregnant women	Reduces maternal mortality (hypertensive disorders)	RRR = 0.41 [Ronsmans et al. 2011, BMC Public Health [21]]

2.6.8. Family planning

Maternal age, birth order and time between successive births impact on birth outcomes (Figure 2.10). Birth outcomes subsequently impact stunting, wasting and mortality, and therefore changes to maternal age and birth spacing can indirectly impact on stunting, wasting and mortality.

When family planning services are scaled up this decreases the number of projected births (note that family planning service expansion is restricted by the level of unmet need in the population). Because scaling up family planning leads to fewer births, this means that the *total number* of the following will decrease:

- unfavourable birth outcomes
- total number of non-stunted children reaching age 5
- total number of maternal deaths
- total number of child deaths

The family planning intervention also decreases the odds of suboptimal birth spacing, meaning that mortality *rates* may change slightly when the intervention is scaled up, but not to the same extent as the total numbers of outcomes.

There is a need to be cautious when including the family planning intervention in optimisations, because it will reduce the number of stunted children but not necessarily stunting prevalence to the same extent.

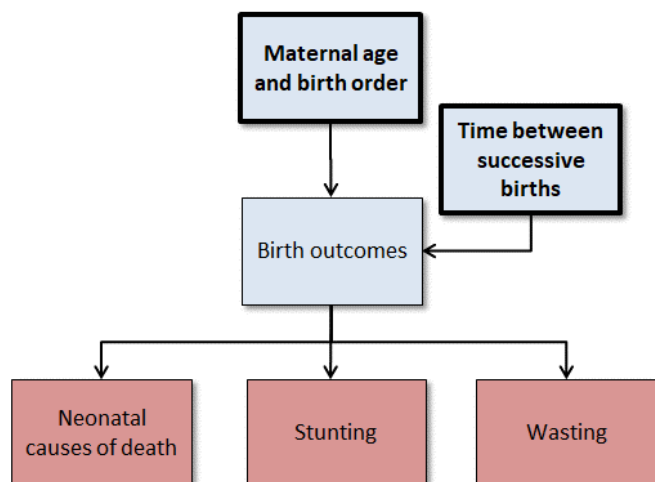


Figure 2.10: Maternal age, birth order and time between successive births impact on birth outcomes.

2.6.9. Water, sanitation and hygiene (WASH) interventions

Five WASH interventions are available in the model:

- Improved water source
- Piped water
- Improved sanitation
- Hygienic disposal of stools
- Handwashing with soap

However, evidence on the effectiveness of these interventions is mixed and unclear, in particular given some recent large studies (see WASH Benefits (Bangladesh, Luby et al. 2018 [23]; and Kenya, Null et al. 2018 [24]) and SHINE (Zimbabwe, Humphrey et al. 2019 [25]) studies). Therefore, the effect size of these interventions has been set to zero by default. If desired, this can be changed (see section 5 on editing default parameters).

2.7. Cost-coverage functions

The cost of expanding the coverage of interventions may not be linear. It may depend on the existing coverage of the intervention. Optima Nutrition allows users to specify interventions with costs that vary depending on coverage. This is done by defining a relationship between the total spending on an intervention and the intervention coverage (number of people reached). The possible options are:

- **Linear (red in Figure 2.11):** Marginal costs are constant. The cost of covering each additional person remains the same until saturation.

- **Increasing marginal costs (blue in Figure 2.11):** The cost of covering each additional person increases as the curve approaches saturation.
- **Decreasing marginal costs (green in Figure 2.11):** The cost of covering each additional person decreases as the curve approaches saturation.
- **S-shaped (purple in Figure 2.11):** The cost of covering each additional person first decreases then increases as we approach saturation.

Default curves are constant marginal costs. A note of caution: using non-linear cost curves has implications if the model is being used to estimate total spending on interventions based on their estimated coverage. This is because the cost curves that assume increasing and S-shaped marginal costs asymptote to the intervention’s saturation coverage (Figure 2.11); therefore, if an intervention has very high existing coverage that is close to its assigned saturation value, then the model will estimate that a very high existing spending is required to produce the observed coverage.

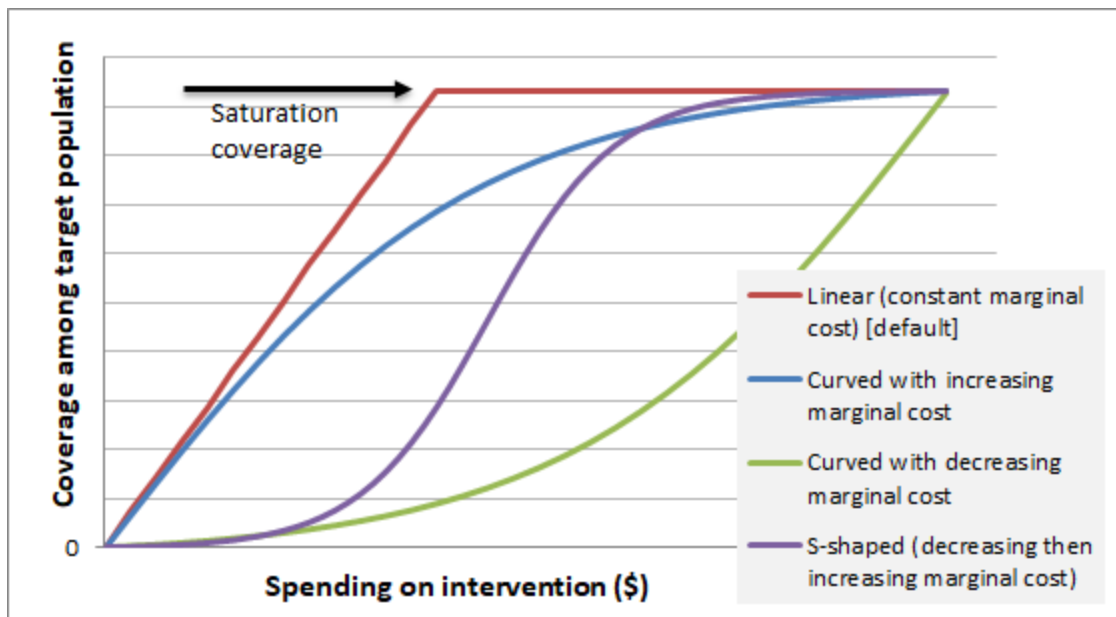


Figure 2.11: Possible shapes of cost curves that can be selected for each intervention.

2.8. Optimisation and choosing an objective function

2.8.1. *The objective function*

When the model is run with a given amount of money spent on each intervention, it produces a collection of outcomes for the number of stunted, wasted and anaemic children, the number of maternal and child deaths, and the prevalence of stunting, wasting and anaemia (in children and women of reproductive age). When the model is run with a different allocation of funding, it will produce a different set of outcomes. To run an optimisation, we need to define what is considered the best

outcome using an “objective function”. **An objective function takes some or all of the model outcomes and combines them into a single number.** For example, the default objective functions available in the model are:

- The number of alive, non-stunted children
- The number of child deaths
- The number of stunted children
- The number of wasted children
- The number of anaemic children
- The prevalence of stunting in children
- The prevalence of wasting in children
- The prevalence of anaemia in children
- The number of pregnant women deaths
- The number of anaemic pregnant women
- The prevalence of anaemia in pregnant women
- The number of anaemic non-pregnant women
- The prevalence of anaemia in non-pregnant women

Objective functions can also be created using combinations of outcomes. For example:

- The total number of alive, non-stunted, non-wasted and non-anaemic children leaving the model.
- The sum of maternal and child deaths.
- It is also possible to use weighted objective functions. For example, minimise X^* (the projected number of stunted children) + Y^* (the projected number of child deaths).

The optimisation can then iteratively shift funding around until it finds the allocation that produces the maximum (or minimum) value of the objective function. For different objective functions, the model is likely to suggest different sets of interventions. This is logical given the variety of interventions and outcomes in the model, but from a programming perspective requires consideration.

2.8.2. Deciding on which objective function to use

There are several ways of selecting the best interventions for a specific nutrition program:

- First, it is important to engage with nutrition planners to determine which interventions they are likely to consider feasible:
 - Which interventions are already implemented in a given country, which interventions may be implemented, and which interventions are unlikely to be implemented.
- Second, you should consider the objectives of your program, project, or plan for which you’re using Optima Nutrition.
- Third, strategic objectives of the national nutrition and health plans and programs can help define the outcomes that should matter. For example, the national strategic nutrition plan may prioritise stunting reduction over anaemia
- Fourth, we recommend that for a given setting, many different objective functions are tested:

- What are the interventions that are “optimal” for multiple choices of objective?
- What interventions can be eliminated because they are rarely or never considered “optimal”?

2.9. Multi-region analyses

2.9.1. Granularity

The burden of malnutrition can vary significantly in different parts of a country and decision-makers may need to decide how much money to allocate to different regions. These decisions are often made simply based on the number of people who reside in different regions; however, this is not necessarily the most efficient allocation of resources. Therefore, there is often a need to consider sub-national analyses. The granularity that a sub-national analysis occurs at should be determined by the availability of data:

- Ideally, if you want to carry out a geo-spatial analysis, all data that Optima Nutrition needs (all data in the data sheet) should be available for the geographies (e.g. all districts, all provinces) you want to conduct your analyses for.
- Often, some data points are available only at the national level. In those cases, you may need to use the national data.
- It is extremely important to remember that:
 - The more national-level data you are using in the geospatial analysis the less it will be different from the national analysis (the less useful it will be).
 - The more national level data you are using, the more the analysis will be affected by the data you have at the sub-national level. For example, if the only data element you have at the sub-national level is malaria prevalence (overall, not a very important parameter in the model), the only factor driving your analyses and determining allocations among different interventions among the provinces will be malaria prevalence.

2.9.2. Additional constraints

Once the regions are selected, possible constraints need to be considered both within each region and across regions:

- Within each region: are any interventions fixed (i.e. cannot be completely or partially defunded)?
- Across regions: is the total amount of funding movable across regions? For example, if individual regions provide their own funding to nutrition interventions, they are unlikely to shift it to support interventions in other states
- Is there any additional funding available?
- What is the objective function?

These constraints can be entered into the Webapp when running the analysis (see section 3).

2.9.3. Underlying methods used

For each region, an “investment staircase” is produced. This is the impact that can be achieved for a range of different funding volumes, if the money is allocated optimally—the impact can be measured as the objective function value. For example, the total number of alive and non-stunted children that could be achieved with \$1 million, \$2 million, etc. For each region, this can be used to construct a budget-impact curve (Figure 2.12-right): X-values are total amount available; Y-values are possible impact. When the budget-impact curves for each region are compared, we can see where the best value for money is. In the fictional example (Figure 2.13):

- The first ~\$4.5 million would have the best cost-per-outcome in region 3
- The next ~\$8 million is best spent in region 1
- After this, the cost-per-outcome (black tangent line) becomes worse than in region 2.

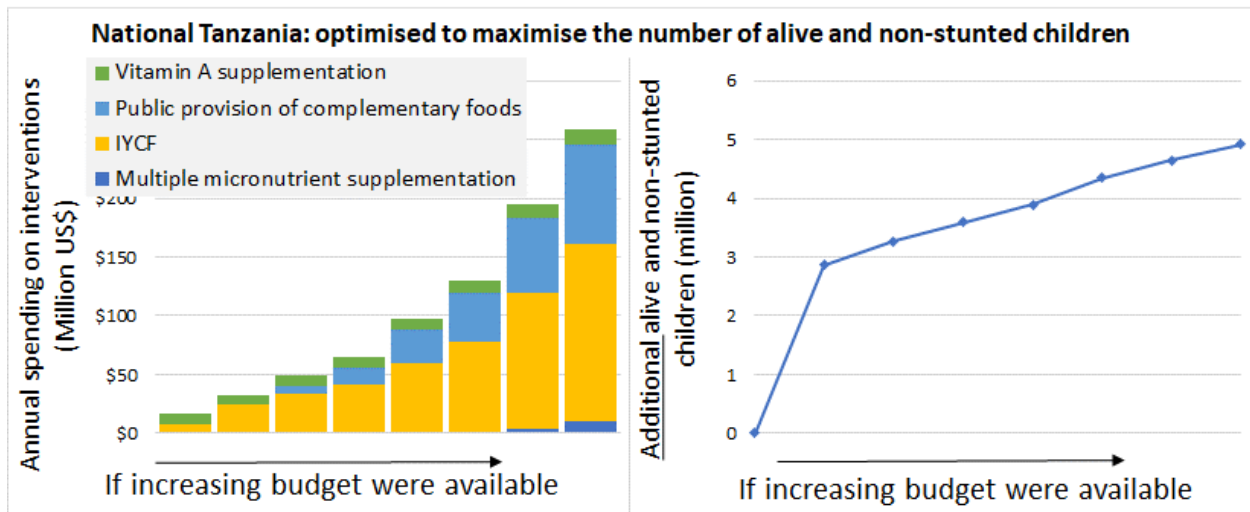


Figure 2.12: An example of an investment staircase. Left: For increasing amounts of budget available, the optimal allocation of funding. Right: the impact that can be achieved with the funding allocated optimally.

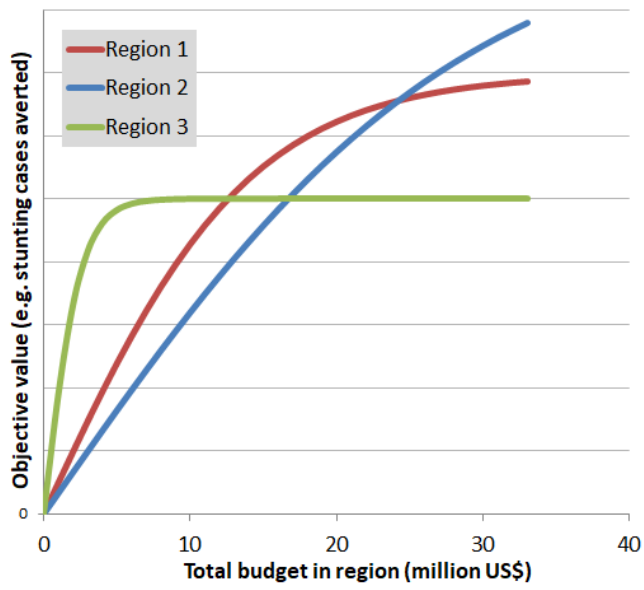


Figure 2.13: An example of smoothed investment staircases for three regions of a fictional country.

3. Webapp Instructions

3.1. Register and log-in

Enter <http://nutrition.ocds.co> into the browser, which will access the following page (Figure 3.1). It is recommended to use either Google Chrome or Firefox, as some issues may arise using Internet Explorer.

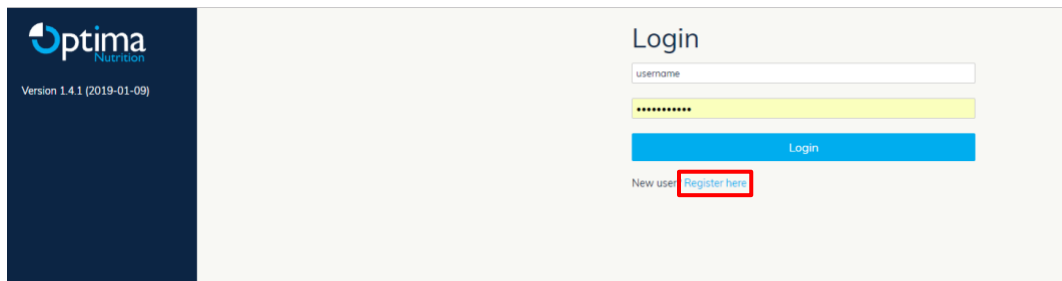


Figure 3.1: Login with an existing account or register for a new account.

Click “Register here” to create an account. Create a username and password and click “Register” (Figure 3.2). Afterwards you will be able to login with your username and password and access all your existing projects.

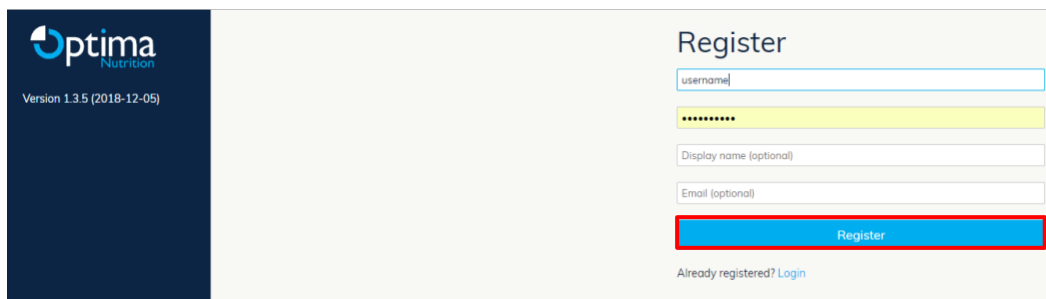


Figure 3.2: Registering for a new account requires you to create a username and password.

3.2. Projects page

Before any analyses can be conducted, a user must: (1) create a project; and (2) upload a databook that has been filled out completely and correctly.

3.2.1. Creating projects

Optima Nutrition analyses are grouped into **projects**. Therefore, to start an analysis using Optima Nutrition, a project must be created. This can be done in three ways (Figure 3.3):

- **Add a demo project:** A demonstration project will appear in the list of projects. The demo project includes a pre-filled databook and can be used to explore the features of the webapp.
- **Create a project from scratch:** A new line will appear in the list of projects. You will be asked to provide a project name and a blank databook will be automatically downloaded, for you to complete. Instructions on how to complete a databook are in section 4 and instructions for uploading the databook once it is complete are in section 3.2.3.
- **Upload a project file:** Projects that have been previously downloaded (as .prj files) may be uploaded directly. This option is useful when sharing work with collaborators. Clicking the button “Upload project from file” will bring up a file load dialog box. The uploaded project will then be added to the list of available projects associated with your account.

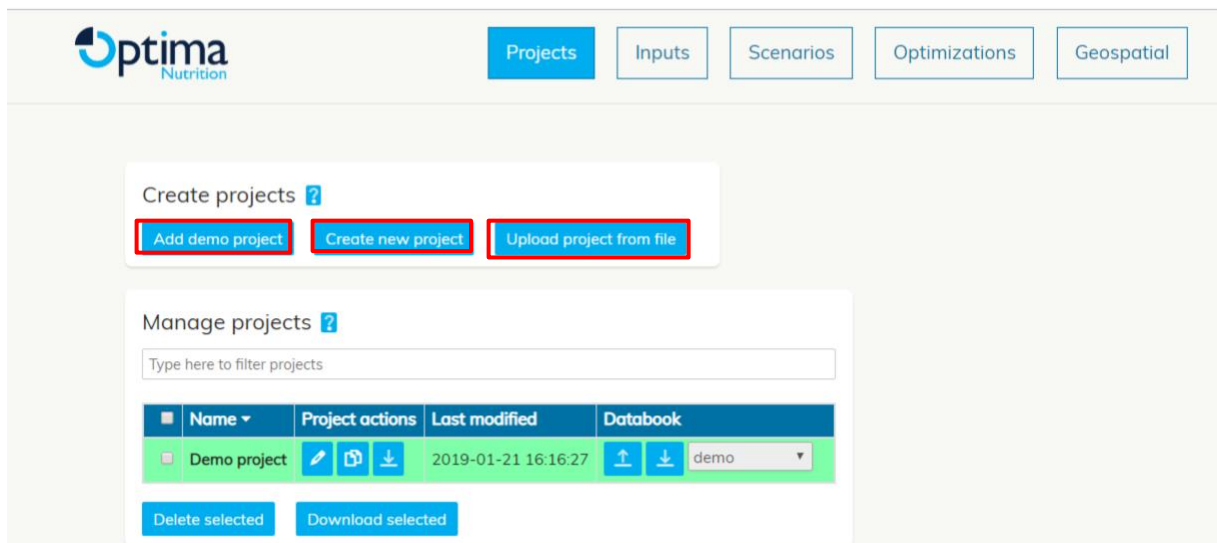


Figure 3.3: There are three ways to create a project: add a demo project, create a new project or upload a project from file.

3.2.2. Project options

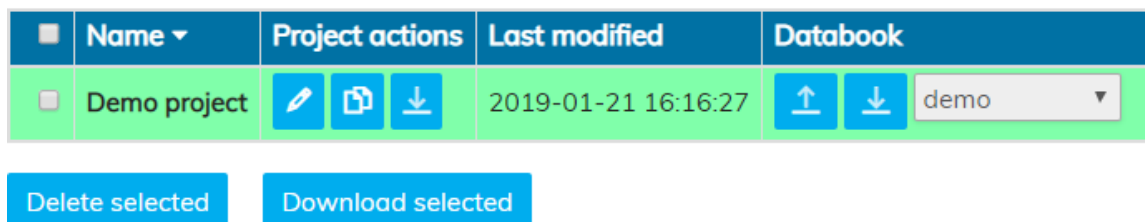









Figure 3.4: Options for managing each project in your account.


Each project loaded in your account will appear in the table on the projects page (Figure 3.4). Each row of the table corresponds to a single project. Here, you will find basic functions to copy, rename and delete projects. Hover your cursor over each icon for a description of its functionality.

-  **Rename a project:** This will bring up a dialogue box where you can specify a new name for the project.
-  **Copy a project:** This will create new row in the table, which is a copy of the project. This is useful if you need to perform different sub-analyses using the same data as the original project.
-  **Download a project:** To save one or more projects to your computer (as .prj files), either click the “Download” button next to each project, or check the boxes in the left-most column of multiple projects and click “Download selected” at the bottom of the table.
- **Delete a project:** Select the checkbox in the left-most column, then click the “Delete selected” button at the bottom of the table. You can also delete more than one project at a time by selecting multiple at once.

3.2.3. Uploading and managing databooks for a project

Each project contains a databook that has been completed by the user (or multiple databooks for multi-region projects). Detailed instructions on how to fill out the databook are contained in section 0.

To upload a completed databook, click on the  “Upload” icon in the “Databook” column of the project table. This will bring up a dialog box where you can select the Excel file you wish to upload. Multiple databooks can be uploaded one at a time for multi-region analyses, and you can rename, copy and delete databooks associated with a project using the    buttons. If you need to update a databook at any stage of the analyses, you can upload a databook with the same filename to overwrite the data.

To view the databook for a given project, click on the  “Download” button in the column “Databook” of the project table (Figure 3.4). This will bring up a dialog box to choose the location on your computer to save the file.

3.3. Inputs page

After uploading one or more completed databooks, clicking on *Inputs* in the top banner will take you to the next page. Five sheets of the databook can be edited directly in the webapp. This is a shortcut to avoid having to download, edit and then re-upload the databook. The sheets that can be edited in the webapp are: *Nutritional status distribution* (Figure 3.6), *breastfeeding distribution* (Figure 3.7), *IYCF packages* (Figure 3.8), *treatment of SAM* (Figure 3.9), and *programs cost and coverage* (Figure 3.10). The fields that can be edited are the same as in the databook, and details are contained in section 0.

If you have uploaded several databooks for a multi-region analysis, it is essential to check which dataset is currently being used (Figure 3.5) to ensure changes are being made in the correct region. As with the projects page, databooks can be renamed, copied, deleted, downloaded or uploaded.

After making any changes, remember to click “Save” at the bottom of the page.

Edit input data ?



Figure 3.5: The dataset tells you which databook is being edited, and databooks can be renamed, copied, deleted, downloaded or uploaded.

Percentage of population in each category in baseline year (2017)		Status	<1 month	1-5 months	6-11 months	12-23 months	24-59 months									
Stunting (height-for-age)	Normal (HAZ-score > -1)		54.5	54.5	49.0	24.5	23.3									
		Mild (HAZ-score between -2 and -1)	32.2	32.2	35.9	37.7	37.4									
		Moderate (HAZ-score between -3 and -2)	8.70	8.70	11.4	24.7	25.9									
		High (HAZ-score between < -3)	4.60	4.60	5.67	13.3	13.4									
Wasting (weight-for-height)	Normal (WHZ-score > -1)		62.4	62.4	68.4	73.2	81.2									
		Mild (WHZ-score between -2 and -1)	28.2	28.2	24.7	21.5	15.8									
		MAM (WHZ-score between -3 and -2)	5.40	5.40	5.40	4.20	2.23									
		SAM (WHZ-score < -3)	4.00	4.00	1.97	1.03	0.733									
Anaemia	Prevalence of anaemia		10.0	10.0	78.1	73.0	48.4	47.3	44.7	43.3	44.2	47.3	44.7	43.3	44.2	
		Prevalence of iron deficiency anaemia	4.20	4.20	32.8	30.6	20.3	19.9	18.8	18.2	18.6	19.9	18.8	18.2	18.6	

Figure 3.6: The nutritional status distributions sheet of a databook can be edited directly in the webapp.

Percentage of children in each category in baseline year (2017)		Status	<1 month	1-5 months	6-11 months	12-23 months	24-59 months
Breastfeeding	Exclusive		84.0	44.3	1.36	0	0
		Predominant	9.20	21.7	3.28	0.100	0
		Partial	5.80	31.6	93.5	72.1	0
		None	1.00	2.44	1.90	27.8	100

Figure 3.7: The breastfeeding distributions sheet of a databook can be edited directly in the webapp.

Edit input data [?](#)

Dataset: demo ✎ 📄 🗑️ ⬇️ ⬆️

Nutritional status distribution
Breastfeeding distribution
IYCF packages
Treatment of SAM
Programs cost and coverage

IYCF package	Target population	Health facility	Community	Mass media
IYCF 1	Pregnant women	<input type="checkbox"/>	<input type="checkbox"/>	
	<1 month	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	1-5 months	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	6-11 months	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	12-23 months	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	All			<input type="checkbox"/>
IYCF 2	Pregnant women	<input type="checkbox"/>	<input type="checkbox"/>	
	<1 month	<input type="checkbox"/>	<input type="checkbox"/>	
	1-5 months	<input type="checkbox"/>	<input type="checkbox"/>	
	6-11 months	<input type="checkbox"/>	<input type="checkbox"/>	
	12-23 months	<input type="checkbox"/>	<input type="checkbox"/>	
	All			<input type="checkbox"/>
IYCF 3	Pregnant women	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	<1 month	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	1-5 months	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	6-11 months	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	12-23 months	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	All			<input type="checkbox"/>

Save changes
Revert
⬇️
⬆️

Figure 3.8: The IYCF packages sheet of a databook can be edited directly in the webapp.

Edit input data [?](#)

Dataset: demo ✎ 📄 🗑️ ⬇️ ⬆️

Nutritional status distribution
Breastfeeding distribution
IYCF packages
Treatment of SAM
Programs cost and coverage

	Default	Extension	Add extension
Program	Treatment of SAM	Management of MAM	<input type="checkbox"/>
Delivery mode	Health facility	Community-based	<input type="checkbox"/>

Save changes
Revert
⬇️
⬆️

Figure 3.9: The treatment of SAM sheet of a databook can be edited directly in the webapp.

Edit input data [?](#)

Dataset: demo ↗ 📄 🗑️ 📥 📤

Nutritional status distribution
Breastfeeding distribution
IYCF packages
Treatment of SAM
Programs cost and coverage

Program	Baseline (2017) coverage	Saturation coverage of target population	Unit cost (US\$ per person per year)	Cost-coverage relationship
Balanced energy-protein supplementation	0	95.0	25.00	Linear (constant marginal cost) [default]
Calcium supplementation	0	95.0	1.00	Linear (constant marginal cost) [default]
Cash transfers	0	95.0	90.00	Linear (constant marginal cost) [default]
Delayed cord clamping	0	95.0	1.00	Linear (constant marginal cost) [default]
Family planning	0	95.0	0.82	Linear (constant marginal cost) [default]
IFA fortification of maize	36.0	95.0	0.25	Linear (constant marginal cost) [default]
IFA fortification of rice	0	95.0	0.75	Linear (constant marginal cost) [default]
IFA fortification of wheat flour	0	95.0	0.19	Linear (constant marginal cost) [default]
IFAS (community)	0	95.0	0.73	Linear (constant marginal cost) [default]
IFAS (health facility)	0	95.0	1.78	Linear (constant marginal cost) [default]
IFAS (retailer)	0	95.0	0.24	Linear (constant marginal cost) [default]
IFAS (school)	0	95.0	0.55	Linear (constant marginal cost) [default]
IFAS for pregnant women (community)	0	95.0	0.73	Linear (constant marginal cost) [default]
IFAS for pregnant women (health facility)	0	95.0	1.78	Linear (constant marginal cost) [default]
IPTp	34.6	95.0	2.06	Linear (constant marginal cost) [default]

Figure 3.10: The programs cost and coverage sheet of a databook can be edited directly in the webapp.

3.4. Scenarios page

Optima Nutrition allows you to perform custom simulations over a given time period, which are called **scenarios**. There are two types of scenarios, **budget** scenarios and **coverage** scenarios. A scenario allows a user to specify either the annual budgets or annual coverages for each intervention over the projection period, so that the model can estimate the impact that this would have on nutritional outcomes (e.g. stunting).

The scenarios page begins with a list of predefined scenarios in a table (Figure 3.11). Scenarios can be added by clicking either “Add coverage scenario” or “Add budget scenario” at the bottom of the table.

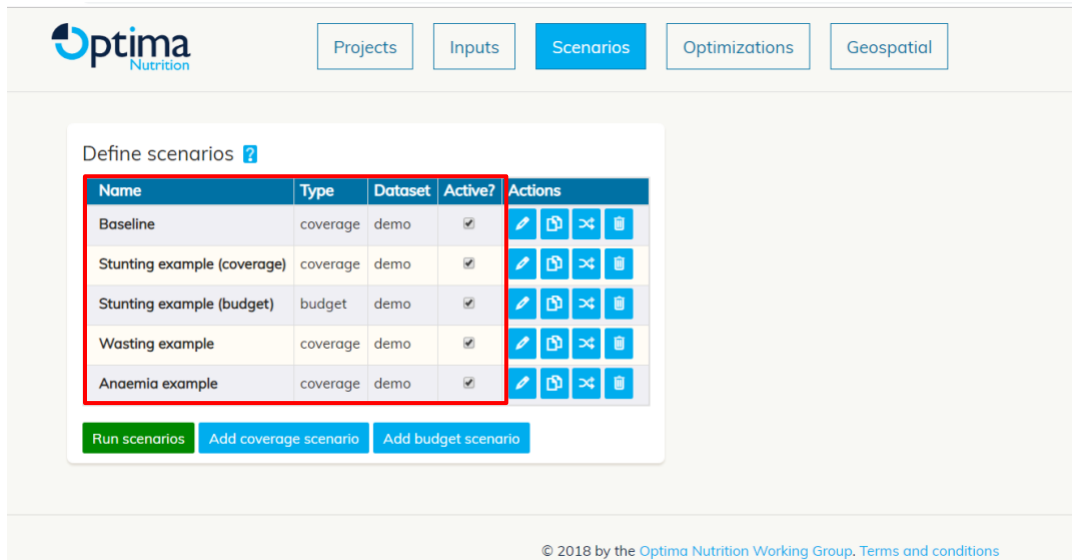


Figure 3.11: The Scenarios page contains a table with the name of each scenario that has been defined, some basic details and actions for editing.

3.4.1. Adding a coverage scenario

When adding a coverage scenario, users are asked to enter:

- A name for the scenario (e.g. “scaling-up vitamin A supplementation”)
- Which dataset to use (only applies when more than one is uploaded)
- The desired coverage of each intervention for each year of the projection period (Figure 3.12). **The values entered represent the percentage of the target population covered, and must be entered as numbers between 0 and 100.** For example, the intervention public provision of complementary foods is provided to children 6-59 months who are below the poverty line. Therefore, entering a value of 80 means that “80% of children 6-59 months who are below the poverty line will receive the intervention in that year”.

The baseline coverage of each intervention will appear in the first, non-editable column. This is what was entered in the databook (or inputs page). If all cells to the right are left blank, the model assumes that the coverage remains unchanged from this value.

If a coverage value is entered in some, but not all years for an intervention, then the model assumes that the coverage is linearly scaled for the years in-between, and remains constant from the final value entered until the end of the projection period. For example, if an intervention had 20% baseline coverage in 2017, and a user entered a coverage of 50 in 2020 and 60 in 2022, the model would assume the coverage over time was (20%, 2017), (30%, 2018), (40%, 2019), (50%, 2020), (55%, 2021), (60%, 2022), and then 60% from 2022 until 2030.

Each intervention has a checkbox “Include?” next to it:

- **Deselected interventions:** If an intervention is not selected for inclusion in the scenario, then the model assumes that its coverage remains fixed at the baseline value for the projection period (even if values are entered for each year). Deselecting an intervention means that the baseline spending and cost assessment for that intervention will be suppressed from the output plots.
- **Selected interventions:** Interventions that are selected for inclusion will appear in the output plots, with their coverages changing over time according to the input values.

Once you are done creating a scenario, click “Save” at the bottom of the menu.

Edit scenario

Scenario name:

Dataset:

Program coverages (%)															
Name	Include?	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Balanced energy-protein supplementation	<input checked="" type="checkbox"/>	0													
Calcium supplementation	<input checked="" type="checkbox"/>	0													
Cash transfers	<input checked="" type="checkbox"/>	0													
Delayed cord clamping	<input checked="" type="checkbox"/>	0													
Family planning	<input checked="" type="checkbox"/>	0													
IFA fortification of maize	<input checked="" type="checkbox"/>	36													
IFA fortification of rice	<input checked="" type="checkbox"/>	0													
IFA fortification of wheat flour	<input checked="" type="checkbox"/>	0													
IFAS (community)	<input checked="" type="checkbox"/>	0													
IFAS (health facility)	<input checked="" type="checkbox"/>	0													
IFAS (retailer)	<input checked="" type="checkbox"/>	0													
IFAS (school)	<input checked="" type="checkbox"/>	0													
IFAS for pregnant women (community)	<input checked="" type="checkbox"/>	0													
IFAS for pregnant women (health facility)	<input checked="" type="checkbox"/>	0													
IPTp	<input checked="" type="checkbox"/>	35													

Figure 3.12: When adding a coverage scenario, users must specify a scenario name, which dataset to use, which interventions to include, and the coverages of each intervention over time (entered as numbers between 0 and 100).

3.4.2. Adding a budget scenario

Budget scenarios are added analogously to coverage scenarios, except that the input values correspond to annual spending on an intervention rather than annual coverage. **Values must be entered as positive numbers or zero.**

Edit scenario

Scenario name:





Dataset:

Program spending															
Name	Include?	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Balanced energy-protein supplementation	<input type="checkbox"/>	0													
Calcium supplementation	<input type="checkbox"/>	0													
Cash transfers	<input type="checkbox"/>	0													
Delayed cord clamping	<input type="checkbox"/>	0													
Family planning	<input type="checkbox"/>	0													
IFA fortification of maize	<input type="checkbox"/>	1,775,401													
IFA fortification of rice	<input type="checkbox"/>	0													
IFA fortification of wheat flour	<input type="checkbox"/>	0													
IFAS (community)	<input type="checkbox"/>	0													
IFAS (health facility)	<input type="checkbox"/>	0													
IFAS (retailer)	<input type="checkbox"/>	0													
IFAS (school)	<input type="checkbox"/>	0													
IFAS for pregnant women (community)	<input type="checkbox"/>	0													
IFAS for pregnant women (health facility)	<input type="checkbox"/>	0													
IPTp	<input type="checkbox"/>	1,768,257													

Figure 3.13: When adding a budget scenario, users must specify a scenario name, which dataset to use, which interventions to include, and the annual amount spent on each intervention over time (entered as positive numbers or zero).

3.4.3. Actions column in the scenarios table

The main scenarios table contains an “**Actions**” column with different options for editing the scenarios (Figure 3.11):

- Clicking  “Edit” will bring up the original options when the scenario was created (Figure 3.12 and Figure 3.13).
- The  “Copy scenario” button creates a new line with the same scenario.
- The  “Convert scenario type” creates a new line that is a copy of the original scenario, but converted from coverage to budget or vice versa depending on the original scenario (using the cost-coverage relationships assigned to each intervention).
- The  “Delete scenario” will permanently delete a scenario from the list.

3.4.4. Running scenarios

The main scenarios table has a checkbox column “**Active?**” that allows the user to select which scenarios to run simultaneously and compare on the same output graphs. After selecting all desired scenarios, the “Run scenarios” button will run them together.

3.4.5. Results of scenarios: plots

Once scenarios are run, a series of plots will appear on the page, showing a variety of projected nutrition outcomes with all of the “active” scenarios together (Figure 3.14). These plots can be exported and the data can be downloaded in Excel format using the buttons in the top right corner.

The very bottom plot shows the average annual spending of each scenario. Note that:

- This only includes interventions that were selected for inclusion in each scenario.
- In cases where interventions are scaled up over time, this graph shows the average spending over the projection period. For year-by-year budget allocations, the Excel data should be exported.

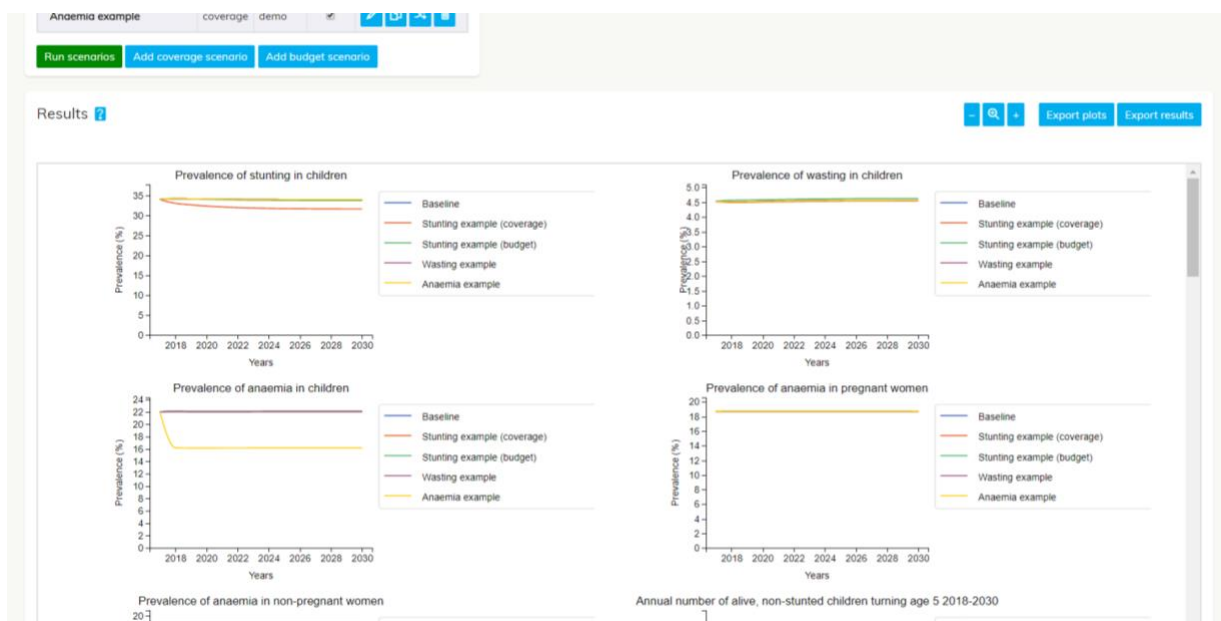


Figure 3.14: Once the active scenarios are run, plots will appear showing the projected nutrition outcomes. These can be exported as pdf or Excel files.

3.4.6. Results of scenarios: program cost-effectiveness

Once scenarios are run, a “Program cost-effectiveness” table will appear underneath the plots (Figure 3.15). This table contains the estimated cost-per-outcome of each scenario overall, as well as for each intervention within a scenario. These are calculated as follows:

- Scenario overall:** A counter-factual scenario is created that consists of all interventions scaled down to zero coverage¹. For each outcome (i.e. the table columns), the cost-per-outcome is calculated as:

$$(outcome\ in\ counter-factual - outcome\ in\ scenario) / (cost\ of\ scenario - cost\ of\ counter-factual)$$
- Interventions within a scenario:** A counter-factual scenario is created that consists of all interventions as per the original scenario, except for a single intervention which is scaled down to zero coverage². For each intervention, the cost-per-outcome is calculated as:

$$(outcome\ in\ counter-factual - outcome\ in\ scenario) / (cost\ of\ scenario - cost\ of\ counter-factual)$$

Program cost-effectiveness [?](#)

Scenario/program	Outcomes							
Baseline								
Programs	Number of alive, non-stunted children turning age 5	Number of child deaths	Number of stunted children turning age 5	Number of wasted children turning age 5	Number of anaemic children turning age 5	Number of pregnant women deaths	Number of anaemic pregnant women	Number of anaemic non-pregnant women
Scenario overall	\$228.19 per additional case	\$2,254.84 per case averted	\$245.25 per case averted	\$5,021.36 per case averted	\$173.47 per case averted	\$16,412.58 per case averted	\$44.79 per case averted	\$32.36 per case averted
Balanced energy-protein supplementation	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Calcium supplementation	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Cash transfers	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Delayed cord clamping	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Family planning	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
IFA fortification of maize	\$6,311.42 per additional case	\$2,304.62 per case averted	Negative impact	Negative impact	\$859.25 per case averted	\$230,882.22 per case averted	\$630.16 per case averted	\$126.87 per case averted
IFA fortification of rice	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact

Figure 3.15: Once the active scenarios are run, a table will appear showing the estimated cost-per-outcome of each scenario overall, as well as for each intervention within a scenario.

3.5. Optimisations page

Optimisations use a mathematical algorithm to determine how a total budget can be allocated to maximise or minimise a user-specified outcome, called an objective function. There are many inbuilt objective functions that can be used, including weighted combinations of different outcomes.

The optimisations page begins with a predefined example optimisation called *Maximize thrive*, where the objective is to reallocate existing resources to achieve the maximum number of alive and non-stunted children. Optimisations can be added by clicking the “Add optimisation” button at the bottom of the table (Figure 3.16).

¹ With the exception of reference programs (e.g. “WASH: piped water”—see section 6.2 for definition of reference programs), which are scaled down to baseline values.

² Baseline coverage for reference programs (see section 6.2).

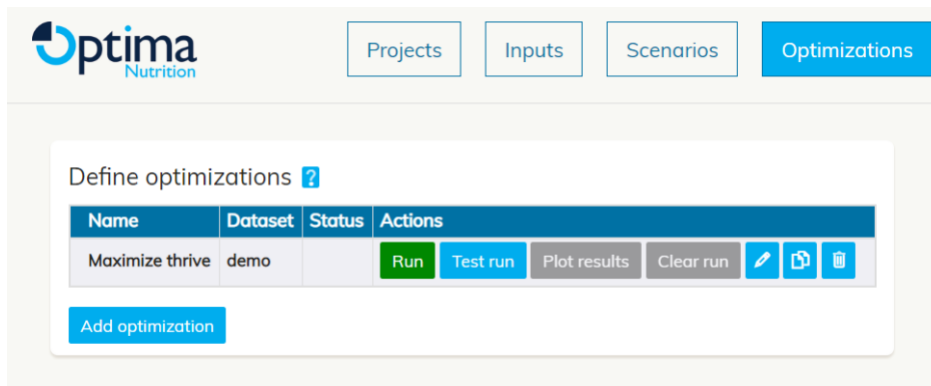


Figure 3.16: The optimisation page contains a table with the name of each optimisation that has been defined, some basic details and actions for editing.

3.5.1. Adding an optimisation

When adding an optimisation, users are asked to define (Figure 3.17):

- **Optimisation name**
- **Dataset to use** (for when multiple databooks are uploaded)
- **Optimisation objective:**
 - A positive number or zero must be entered next to each predefined option.
 - Weighted objectives can be created by adding non-zero values next to multiple options.
- **Budget multipliers:** More than one optimisation can be run simultaneously, by optimising multiples of the existing budget. For example:
 - Entering “1” in this field will only optimise existing spending.
 - Entering “1,2” will perform two optimisations that will appear side by side in the results; one where the total existing budget is optimally allocated across interventions, and a second where the available funding for allocation is equal to twice the current budget.
 - Entering “1,2,3,7”, for example, will perform four optimisations, where the total funding being optimised is 1,2,3 or 7 times the current budget. This is useful for assessing expansion pathways of financing.
 - **The more budget multiples that are included in an optimisation, the longer it will take to complete.**
- **Existing spending:** If “can be reallocated” is selected, then existing interventions are allowed to be defunded. If “cannot be reallocated” is selected, then existing interventions can be scaled up, but not down.
- **Additional funds to reallocate:** The additional money to be reallocated will be added to the total available funding in each optimisation. For example:
 - In a situation where 10,000,000 is added, existing spending can be reallocated, and budget multipliers of “1,3” are used, then the model will optimise for (a) current budget +10 million per annum, and (b) 3 times current budget + 10 million per annum.

- In a situation where 10,000,000 is added, existing spending cannot be reallocated and budget multipliers of “1,2” are used, then the model will optimise (a) with current program coverage unable to be reduced and 10 million per annum to allocate, and (b) current program coverage unable to be reduced and an additional amount to optimise equal to 10 million + current spending.
- In a situation where no additional funds are available, existing spending cannot be reallocated and budget multipliers of “1,4” are used, then the model will (a) optimise nothing (i.e. return current allocations), and (b) optimise 3 times the current budget, with existing programs unable to be scaled down.
- **Interventions to include:** Only the selected interventions will be able to be scaled up or down within the optimisation. Note that “existing spending” within an optimisation is determined from only the interventions that are selected. **The more interventions that are included in an optimisation, the longer it will take to complete.**

Once you are done creating an optimisation, click “Save” at the bottom of the menu.

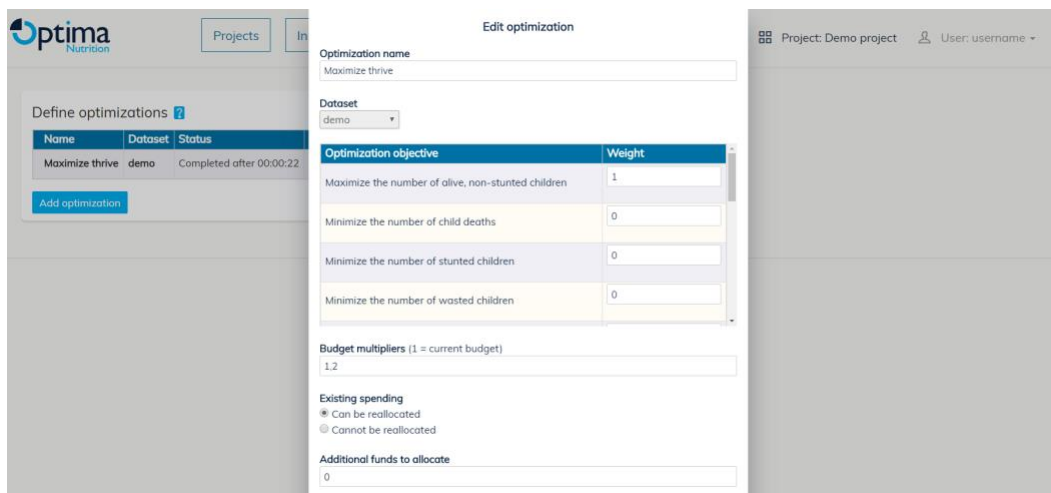






Figure 3.17: When adding an optimisation, users must specify an optimisation name, which dataset to use, the (possibly weighted) objective function, which budget multipliers to use, whether existing programs can be defunded, if there is any additional money to allocate, and which interventions to include.




3.5.2. Actions for an optimisation

The main optimisation table contains an “**Actions**” column with different options for editing the optimisations (Figure 3.18).

- The  “Edit” button allows the user to modify the optimisation options.
- The  “Copy optimisation” button creates a new line with the same optimisation.

- The  “Delete optimisation” button will permanently delete an optimisation from the list.
- The “Test run” button will run the optimisation algorithm for a short period (~20 seconds). This is sometimes useful because when optimisations include many budget multiples and interventions, they can take some time to complete. Doing a test run enables a user to quickly test if there are any errors due to incorrectly entered values.
- The “Run” button will start the optimisation running on the server.
- Once a run (or test run) is complete, the “Plot results” button will become active and clicking it will load the graphs showing the optimised budgets, the projected impact of this allocation of funding, and the resulting cost-effectiveness tables for each intervention.
- “Clear run” will erase all results if the user would like to re-run the optimisation with different settings.

Define optimizations 

Name	Dataset	Status	Actions						
Maximize thrive	demo	Completed after 00:00:22	Run	Test run	Plot results	Clear run			

[Add optimization](#)

Figure 3.18: The optimisations page contains a table with the name of each optimisation that has been defined, and actions for editing.

3.5.3. Results of optimisations

When the results of an optimisation are plotted, several projections appear:

- A baseline projection: This is essentially a scenario where annual spending and coverage of interventions remains unchanged for the projection period.
- The optimised budget: This is essentially a budget scenario, where in year 1 of the projection the spending on programs is as per the optimisation results. The model does not perform time-varying optimisation, and so this budget allocation is assumed to be fixed for the entire projection period
- If the optimisation contains more than one budget multiplier value (e.g. if “1,2” is entered in the budget multiplier options), then additional projections will appear for each one. Again these are budget scenarios with the year 1 spending on programs determined by the optimisation results, and spending fixed for the entire projection period.

The main nutrition outcomes that are projected and cost-effectiveness estimates that appear are the same as the scenario page, and can also be exported as pdf or Excel files.

3.6. Geospatial (multi-region) analyses

If multiple databooks are uploaded, multi-region analyses can be performed. Multi-region analyses enable the same optimisation to be performed across multiple regions, with the additional options of either (a) shifting existing funding between regions to improve overall outcomes; or (b) allocating additional funding optimally across multiple regions (and interventions within those regions).

The geospatial page begins with a predefined example that consists of three regions, and aims to maximise the number of alive and non-stunted children by reallocating all existing spending between interventions and regions. Multi-region optimisations can be added by clicking the “Add geospatial optimisation” button at the bottom of the table (Figure 3.19).



Figure 3.19: The geospatial page contains a table with the name of each geospatial optimisation that has been defined, some basic details and actions for editing.

3.6.1. Adding a geospatial optimisation

When adding a multi-region optimisation, users are asked to define similar options to single-region optimisations (Figure 3.20):

- **Optimisation name**
- **Dataset to use:** two or more databooks must be selected, that have been previously uploaded in either the projects page or inputs page.
- **Optimisation objective:**
 - A positive number or zero must be entered next to each predefined option.
 - Weighted objectives can be created by adding non-zero values next to multiple options.
- **Existing spending:** If “can be reallocated” is selected, then interventions are allowed to be defunded. If “cannot be reallocated” is selected, then existing interventions can be scaled up, but not down.
- **Regional spending:** If “can be reallocated between regions” is selected, then the total budget in each region is able to reduce within the optimisation, for example by taking funding away from one region and spending it in another. If “cannot be reallocated between regions” is selected, then the total funding in each region will always be at least the baseline value (note that within each region, spending may still be able to be reallocated between interventions, depending on the option above).

- **Additional funds to reallocate:** The additional money to be reallocated will be added to the total available funding in each optimisation. For example:
 - In a situation where 10,000,000 is added, existing spending cannot be reallocated, and spending cannot be reallocated between regions, then the model will keep all existing spending fixed, and optimise 10 million per annum across interventions and regions.
 - In a situation where 10,000,000 is added, existing spending can be reallocated, and spending cannot be reallocated between regions, then the model will first determine the optimal way to divide the 10 million across regions, and then within each region, optimise all spending across interventions.
- **Interventions to include:** Only the selected interventions will be able to be scaled up or down within the optimisation. Note that “existing spending” within an optimisation is determined from only the interventions that are selected.

Once you are done creating a multi-region optimisation, click “Save” at the bottom of the menu. **Note that the more regions and interventions that are included, the longer it will take to complete.**

The screenshot shows the 'Edit geospatial optimization' interface in the Optima Nutrition software. The interface is divided into several sections:

- Geospatial optimization name:** A text input field containing 'Geospatial optimization'.
- Select regions:** A list of regions with checkboxes: 'demo' (unchecked), 'demoregion1' (checked), 'demoregion2' (checked), and 'demoregion3' (checked).
- Optimization objective:** A table with two columns: 'Optimization objective' and 'Weight'.

Optimization objective	Weight
Minimize the prevalence of anaemia in children	0
Minimize the number of pregnant women deaths	0
Minimize the number of anaemic pregnant women	0
	0
- Existing spending:** Radio buttons for 'Can be reallocated' (selected) and 'Cannot be reallocated'.
- Regional spending:** Radio buttons for 'Can be reallocated between regions' (selected) and 'Cannot be reallocated between regions'.
- Additional funds to allocate:** A text input field containing '0'.

Figure 3.20: When adding an multi-region optimisation, users must specify a name, which datasets to include, the (possibly weighted) objective function, whether existing programs can be defunded, whether funding can be shifted between regions, if there is any additional money to allocate, and which interventions to include.

3.6.2. Results of multi-region optimisations

When the results of a multi-region optimisation are plotted, a projection will appear for each region. These projections are essentially budget scenarios (one using each region’s databook), where in year 1

the spending on programs is as per the optimisation results. The model does not perform time-varying optimisation, and so this budget allocation is assumed to be fixed for the entire projection period.

The main nutrition outcomes that are projected and cost-effectiveness estimates that appear are the same as the scenario page, and can also be exported as pdf or Excel files.

4. Completing the databook

When you create a new project a blank databook will be automatically downloaded. This book is designed to be populated with country or region specific data, and then uploaded to a project for analysis. All fields must be populated according to the below instructions to avoid errors. Where data is missing or unavailable, assumptions must be entered, based on “best guesses” or regional averages. The tables below outline what each data point does in the model, to assist with this process.

4.1. Baseline year population inputs

Population inputs include some miscellaneous data, usually obtained from Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), or other population surveys. Additional population characteristics that are not available from the DHS or MICS may need to be obtained from other sources, such as the national bureau of statistics, or other surveys (for example food consumption patterns may be available from FAO food balance sheets or consumption surveys).

For this worksheet, the input data should correspond as closely as possible to estimates for the initial year of the simulation period, called the “baseline year”. The green cells in the databook should be populated with data as described in the table below. Please note that no fields can be left blank.

Table 4.1: Data requirements for the "Baseline year population inputs" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
	Projection years			
C3	Baseline year	The year for which data has been collected.	Sets the start year for scenarios and optimisations.	Year (e.g. 2018)
C4	End year	The final year for the demographic projections.	Sets the end year for scenarios and optimisations.	Year (e.g. 2030)
	Population data			
C7	Children under 5 population	The total population of children under 5 years of age.	Sets the total under 5 population in the baseline year.	A positive number
C8	Percentage of population food insecure	The percentage of people who are food insecure, by default this can be equivalent to the percentage of the population living below the poverty line.	Used to determine the number of people eligible for the interventions: <ul style="list-style-type: none"> – cash transfers – balanced energy-protein supplementation – public provision of complementary foods – lipid-based nutrition supplements. 	A percentage, between 0% and 100%

C9	Percentage of population at risk of malaria	The percentage of the population who live in areas where malaria is present.	Used to determine the number of people eligible for malaria interventions (IPTp for pregnant women, LLINs). Can be used to restrict the delivery of interventions containing iron.	
C10	School attendance	The percentage of women 15-19 years of age who attend school.	Used to determine the number of people eligible for iron and folic acid (IFA) supplementation (school delivery) intervention.	
C11	Percentage of pregnant women attending a health facility	The percentage of pregnant women who could be reached by services if they were delivered solely through health facilities.	Used to determine the maximum number of people that can be reached by supplement interventions if they were delivered through health facilities.	
C12	Percentage of children attending health facility	The percentage of all children who could be reached by services if they were delivered solely through health facilities.	Used to determine the maximum number of people that can be reached by IYCF education if it was delivered through health facilities.	
C13	Unmet need for family planning	The percentage of women of reproductive age who are wanting to stop or delay childbearing but are not currently using any contraception.	Determines the maximum coverage of the family planning intervention.	
	Food			
C16	Fraction of subsistence farming		Fraction of the population who cannot be reached by rice, wheat or maize fortification interventions.	A percentage, between 0% and 100%
C17	Fraction eating rice as main staple food	The fraction of the population who eat rice as their <i>main</i> staple food.	Used to estimate the maximum coverage of the rice flour fortification intervention.	
C18	Fraction eating wheat as main staple food	The fraction of the population who eat wheat as their <i>main</i> staple food.	Used to estimate the maximum coverage of the wheat flour fortification intervention	
C19	Fraction eating maize as main staple food	The fraction of the population who eat maize as their <i>main</i> staple food.	Used to estimate the maximum coverage of the maize flour fortification intervention.	
C20	Fraction eating other staples as main staple food	The remaining fraction of the population who do not eat rice, wheat or maize flour as their main staple.	Calculated to ensure cells $C17+C18+C19+C20 = 100\%$	
	Age distribution of pregnant women			

C23 to C26	Percentage of pregnant women in age bands	Defines the age distribution of pregnant women in the baseline year.	Pregnant women of different ages have different odds of pre-term birth.	A percentage, between 0% and 100%. Cells C23 to C26 must add up to 100%.
Birth spacing				
C29	First birth	The percentage of children who were first born.	Children born with different birth spacing have different odds of being born SGA or pre-term.	A percentage, between 0% and 100%. Cells C29 to C32 must add up to 100%.
C30	Less than 18 months	The percentage of children born within 18 months after birth of their mother's previous child.		
C31	18-23 months	The percentage of children born 18-23 months after birth of their mother's previous child.		
C32	24 months or greater	The percentage of children born more than 24 months after birth of their mother's previous child.		
Mortality				
C37	Neonatal mortality	For every 1,000 live births, the number of children who died before reaching 1 month old.	Defines the mortality rate of children less than 1 month of age.	A positive number. Units must be per 1,000 live births
C38	Infant mortality	For every 1,000 live births, the number of children who died before reaching 23 months old.	Used with C37 to calculate the mortality rates of children 6-23 months.	
C39	Under 5 mortality	For every 1,000 live births, the number of children who died before reaching 5 years.	Used with C38 and C39 to calculate the mortality rates of children 2-5 years.	
C40	Maternal mortality	The number of pregnant women who died per 1,000 live births.	Defines the mortality rate of pregnant women.	A positive number. Units must be per 1,000 live births
C41	Fraction of pregnancies ending in spontaneous abortion		Used with C42 to calculate the number of pregnant women.	Percentage between 0-100%
C42	Stillbirths	The number of stillbirths per 1000 total births.	Used with C41 to calculate the number of pregnant women.	A positive number.

				Units must be per 1,000 total births.
	Birth outcome distribution			
C45	Pre-term SGA	The fraction of births that are pre-term and small for gestational age.	Defines the baseline year birth outcome distribution. C45 to C48 must add to 100%.	A percentage, between 0% and 100%
C46	Pre-term AGA	The fraction of births that are pre-term and appropriate for gestational age.		
C47	Term SGA	The fraction of births that are term and small for gestational age.		
C48	Term AGA	The fraction of births that are term and appropriate for gestational age.		
	Diarrhoea incidence			
C51 to C55	Average episodes of diarrhoea per year	The average number of diarrhoea episodes experienced by children in an age band in a year.	Defines the incidence of diarrhoea for each age band.	A positive number
	Other risks			
C58	Percentage of diarrhoea that is severe	The percentage of all diarrhoea which is severe.	Used to determine the fraction of diarrhoea episodes that may increase the risk of anaemia (note: default no impact, see parameters).	A percentage, between 0% and 100% and units required
C59	Percentage of anaemia that is iron deficient	The percentage of all anaemia that is iron deficient as opposed to other causes (e.g. malaria).	Used to determine the fraction of anaemic women and children in the model who are able to be affected by iron supplementation.	

4.2. Demographic projections

Demographic data is required to project the expected number of births and changes in the number of women of reproductive age. This is important to inform projections of number of deaths (and other outcomes). Common sources for this data include the UN population division (<https://esa.un.org/unpd/wpp/>), and national population projections from the bureau of statistics.

Table 4.2: Data requirements for the "Demographic projections" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
B3 down	Number of births	The projected number of births for each year of the specified simulation period.	Determines the number of children who are born into the neonatal age band each year.	A positive number
C3 down	WRA: 15-19 years	The projected number of women aged 15-19 years, for each year of the specified simulation period.	Determines the age-specific population sizes for women of reproductive age.	A positive number
D3 down	WRA: 20-29 years	The total number of women aged 20-29 years, for each year of the specified simulation period.		
E3 down	WRA: 30-39 years	The total number of women aged 30-39 years, for each year of the specified simulation period.		
F3 down	WRA: 40-49 years	The total number of women aged 40-49 years, for each year of the specified simulation period.		

4.3. Causes of death

These inputs describe the fraction of mortality attributable to various causes within each age band. This is important to appropriately model the impact of interventions; for example, ORS + zinc lowers the relative risk of mortality due to diarrhoea (but not other causes), and so the model only applies this to the fraction of diarrhoea-attributable deaths. Common sources for this data include the Global Burden of Disease (GBD) project, WHO Global Health Observatory data repository (<http://apps.who.int/gho/data/node.main.ChildMort3002015?lang=en>), and the national bureau of statistics.

4.4. Nutritional status distribution

Stunting, wasting and anaemia status are important for setting up risks factors, in the absence of any changes to interventions. It is important that these are entered for each age group. For wasting and anaemia, if there are no differences between age groups then the same value may be entered. However, due to the chronic nature of stunting, it would be typical for the prevalence of stunting to increase from younger to older age bands.

A common source for this data is DHS reports. Note that age-specific prevalence often needs to be recalculated because Optima uses smaller age bands than those commonly reported in DHS reports. This

can be done either by re-analysing the DHS data (which are publicly available) or by calculating weighted averages based on the data in the DHS table.

Table 4.3: Data requirements for the "Nutritional status distribution" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
	Stunting			
C4 to G4	Moderate (HAZ-score ≥ -3 and < -2)	The age-specific percentage of children who have a height-for-age Z-score between -3 (inclusive) and -2.	Determines the number of moderately and severely stunted children in the baseline year	A percentage, between 0% and 100%. Note that each column must add to 100%.
C5 to G5	High (HAZ-score < -3)	The age-specific percentage of children who have a height-for-age Z-score less than -3.		
C2 to G3	Normal (HAZ-score ≥ -1); and mild (HAZ-score ≥ -2 and < -1)	The age-specific percentage of children who have a height-for-age Z-score greater than -1 (inclusive), or between -2 (inclusive) and -1, respectively	Note that these should be automatically calculated in the databook. The automatic calculations assume that the overall height-for-age distribution is approximately normal; however this can be overwritten by manually editing the cells if desired.	
	Wasting			
C10 to G10	MAM (WHZ-score ≥ -3 and < -2)	The age-specific percentage of children who have a weight-for-height Z-score between -3 (inclusive) and -2	Determines the number of moderately and severely wasted children in the baseline year	A percentage, between 0% and 100%. Note that each column must add to 100%.
C11 to G11	SAM (WHZ-score < -3)	The age-specific percentage of children who have a weight-for-height Z-score less than -3		
C8 to G9	Normal (WHZ-score ≥ -1); and mild (WHZ-score ≥ -2 and < -1)	The age-specific percentage of children who have a height-for-age Z-score greater than -1 (inclusive), or between -2 (inclusive) and -1, respectively	Note that these should be automatically calculated in the databook. The automatic calculations assume that the overall weight-for-height distribution is approximately normal; however this can be	

			overwritten by manually editing the cells if desired.	
	Anaemia			
C14 to O14	Prevalence of anaemia	The prevalence of all anaemia in each age band.	Along with the “Percentage of iron deficiency anaemia”, determines the prevalence of iron deficiency anaemia	A percentage, between 0% and 100%

4.5. Breastfeeding distribution

Breastfeeding distributions are important for capturing the impact of IYCF interventions. A common source for this data is DHS reports. As with the prevalence of wasting and stunting, this is often not captured directly in the format Optima Nutrition needs (e.g. exclusive, predominant, partial, none) and may need to be recalculated. For example, breastfeeding practice indicators available in DHS by age group are often (“exclusive”; “breastfeeding + liquids” = predominant; “breastfeeding + solids” = partial; or “none”).

Table 4.4: Data requirements for the "Breastfeeding distribution" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
C2 to G2	Exclusive	The percentage of children in each age band who are exclusively breastfed, in the baseline year.	Used to determine the number of exclusively breastfed children.	A percentage, between 0% and 100%
C3 to G3	Predominant	The percentage of children who are predominantly breastfed, in the baseline year.	Used to determine the number of predominantly breastfed children.	
C4 to G4	Partial	The percentage of children who are partially breastfed, in the baseline year.	Used to determine the number of partially breastfed children.	

4.6. Infant and young child feeding (IYCF) packages

An infant and young child feeding (IYCF) package is specified by its target population(s) and delivery modalities:

- Users select a population/age band and a modality by putting a character (such as an ‘x’ or ‘TRUE’) into the desired fields and leaving the others blank.

- Delivering IYCF packages through health facilities means that their maximum coverage is equal to the fraction of the population who attend health facilities (see section 4.1).
- Up to three IYCF packages can be defined.
- IYCF packages can also be edited in the web-based graphic user interface, after the databook is uploaded.

4.7. Treatment of severe acute malnutrition (SAM)

Treatment of severe acute malnutrition (SAM) may be provided at a health facility or at the community level and may include the management of moderate acute malnutrition (MAM).

- By default, the intervention is delivered through health facilities only, and does not include the management of MAM.
- Users can select expansion to community-based delivery or management of MAM by placing a character in cells D2 and D3 respectively.
- The treatment of SAM package can also be edited in the web-based graphic user interface, after the databook is uploaded.

4.8. Programs cost and coverage

Table 4.5: Data requirements for the "Programs cost and coverage" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
B2 down	Baseline coverage	The percentage of the intervention's target population that is covered in the baseline year. The value entered should be the percentage of eligible people; for example, public provision of complementary foods is only provided to the fraction of the population below the poverty line. Therefore, the baseline coverage entered should be the percentage of people below the poverty line who are receiving the intervention (50% = 50% of people below the poverty line are receiving = 50% of the target population).	Determines initial coverages, and used to calculate model parameters	A percentage, between 0% and 100%
C2 down	Saturation coverage of target population	The maximum percentage of the target population that can be covered by the intervention. For example, 95% (the default value) means that even with a very large amount of money, the intervention is unlikely	Determines the maximum allowable coverage of	A percentage, between 0% and 100%

		to reach more that 95% of the target population for logistic/other reasons.	an intervention	
D2 down	Unit cost	<p>The marginal cost of an intervention; the cost of covering one additional person for a year (or the cost per pregnancy for interventions relating to pregnant women).</p> <p>For the ORS and Zinc + ORS interventions, the cost per child per year can be estimated as $= (\text{cost per treatment}) * (\text{average annual diarrhoea incidence in children under 5}).$</p> <p>For the treatment of SAM intervention, the cost per child per year can be estimated as $= (\text{cost per treatment episode}) * (\text{SAM prevalence}) * 2.6.$ The value 2.6 is the estimated ratio (incidence/prevalence). If the management of MAM or community-based delivery modalities are selected, the cost per treatment episode should be an all-inclusive average over delivery modalities.</p>	Determines the slope of the cost-coverage curves.	US\$
E2 down	Cost-coverage relationship	<p>The shape of the cost-coverage curve: the options are</p> <ul style="list-style-type: none"> – Linear (constant marginal cost) [default] – Curved with increasing marginal cost – Curved with decreasing marginal cost – S-shaped (decreasing then increasing marginal cost) 	Determines the relationship between spending on the intervention and the intervention coverage among its target population	One of the named options provided in the drop-down menu

4.9. Infant and young child feeding cost

In order to calculate the average unit cost of an IYCF package, the costs of delivery education to different target populations and through different delivery modalities must be provided. Cells C2 to E6 should have individual costs entered (in US\$), which in some instances may be the same. If the average unit cost for an existing IYCF package is already known (but the individual components are not), then this average value can be entered in the “Programs cost and coverage” worksheet to overwrite these calculations.

5. Editing default parameters

The databook contains a number of hidden sheets with the underlying model parameters, connecting interventions effects with risk factors and causes of mortality. By unhiding the following sheets in the databook, these can be edited directly before it is uploaded into the online project file. Sources for parameter values are provided in section 7.

5.1. Programs for pregnant women and programs for children

These worksheets are used to define the effect sizes of interventions targeting pregnant women and children of different ages. For both worksheets:

- Column A: lists the interventions
- Column B: list the conditions that the interventions have a direct impact on.
- Column C: each of the listed interventions have an affected fraction and an effectiveness.
 - The affected fraction is the (estimated) proportion of the population that could potentially benefit from the intervention; for example, the affected fraction for vitamin A supplementation represents the fraction of the population who are vitamin A deficient.
 - The effectiveness value is the estimated effectiveness of the intervention on the proportion of the population for whom it can affect. For example, the effectiveness of vitamin A supplementation for children who are vitamin A deficient. In the model, the affected fraction and effectiveness are multiplied to create a “population average” intervention effectiveness, which is the value that is used in calculations.

5.2. Programs for wasting, anaemia and birth outcomes

Being covered by wasting and anaemia interventions reduces the odds (or relative risk, as labelled) of experiencing those conditions, relative to those who do not receive the interventions. These odds ratios (or relative risks) are entered for each age group.

5.3. Programs for birth outcomes

Some interventions for pregnant women can have an impact on the odds of experiencing pre-term or SGA birth outcomes. The effectiveness and affected fraction (see section 5.1 for definitions) for these interventions can be entered in this worksheet.

5.4. Odds ratios and relative risks and birth outcome risks

These sheets contain the effect sizes for many of the interactions between risk factors and mortality types, as well as some specific interventions. For the relative risks, the reference category is denoted with a “1”. The “Odds ratios” worksheet contains:

- Odds of stunting given previous stunting
- Link between diarrhoea and stunting, wasting and anaemia
- Odds of stunting if covered by public provision of complementary foods, lipid-based nutrition supplements or zinc supplementation
- Odds of optimal birth spacing if covered by the family planning intervention
- Odds of correct breastfeeding if covered by the kangaroo mother care intervention

The “Relative risks” worksheet contains:

- Relative risks of specific causes of death, by stunting, wasting, anaemia and breastfeeding status
- Relative risk of diarrhoea by breastfeeding status

The “Birth outcome risks” worksheet contains:

- the effect sizes for birth spacing and maternal anaemia on birth outcomes; and
- the effect sizes for birth outcomes on stunting, wasting and neonatal causes of death.

5.5. IYCF odds ratios

This worksheet contains the effect sizes of the different components of an IYCF package. This allows the effectiveness of the intervention to differ depending on the target population and delivery modality. Components of an IYCF package can have an effect on breastfeeding (odds of correct breastfeeding) and a direct effect on stunting (odds of stunting).

By default, IYCF only has an effect for the population that it is targeted to. For example, providing IYCF to children 1-5 months will not directly impact children 6-11 months. However, this can be changed if desired, by adjusting the odds ratios. For example, if a user wants an education program that is targeted to pregnant women to improve breastfeeding for the first 12 months of the child’s life, they would set cells D2, E2 and F2 to be greater than 1.

6. Advanced options

6.1. Program dependencies

There are two types of restrictions that can be applied to interventions: exclusion dependencies and threshold dependencies. Exclusion dependencies prevent interventions from being given simultaneously, while threshold dependencies mean that some interventions can only be given at the same time as another. For example:

- Public provision of complementary foods is not given to children already receiving lipid-based nutrition supplements (exclusion dependency, Figure 6.1-left)
- Iron supplementation in pregnancy and multiple micronutrient supplementation in pregnancy are not given to the same pregnant women (exclusion dependency).
- Iron and folic acid (IFA) supplementation may only be given to pregnant women if they are taking IPTp (threshold dependency, Figure 6.1-right; based on WHO recommendation, because being anemic lowers the risk of malaria).

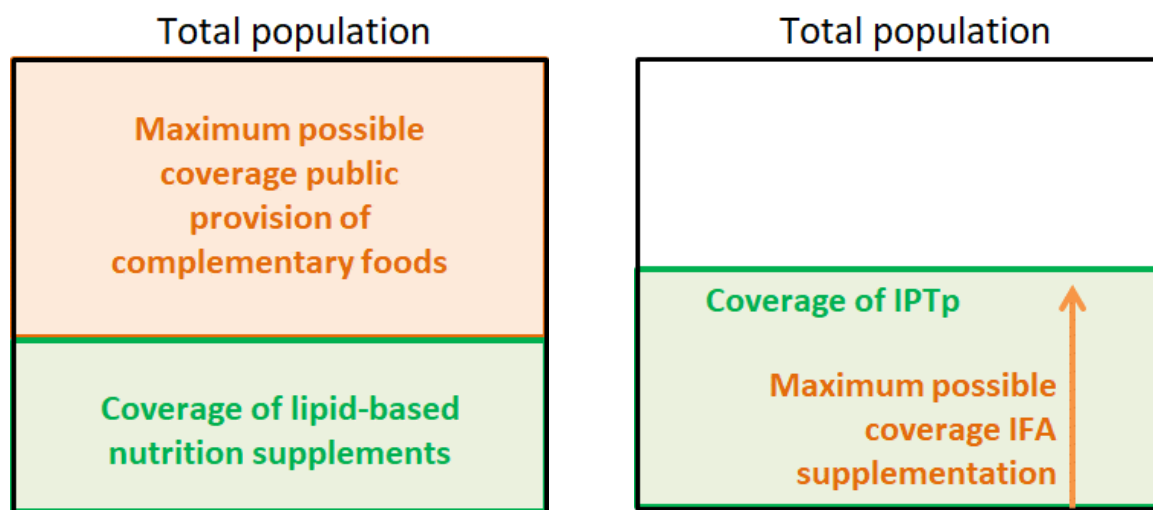


Figure 6.1: Examples of an exclusion dependency (left) and a threshold dependency (right)

The list of dependencies can be extended by adding rows. To avoid errors, ensure that the correct spelling is used for any interventions, corresponding to the intervention name in the “Programs cost and coverage” worksheet.

Table 6.1: Data requirements for the "Program dependencies" worksheet

Cell	Parameter	Description of parameter	What the parameter does in the model	Format and units required
A2 down	Program	The name of the intervention that will be restricted by the dependency.	Used to determine the interventions that are subject to dependencies within scenarios and optimisations.	Name of an intervention, formatted as per the 'Programs cost and coverages' sheet
B2 down	Exclusion dependency	The dependent intervention, typically the intervention that already contains the supplement in column A.	The intervention in column A cannot be given to people already receiving the intervention in column B.	A list of intervention names formatted as per the 'Programs cost and coverages' sheet, separated by commas
C2 down	Threshold dependency	The intervention that must be given in conjunction with the featured program.	The intervention in column A cannot be given to people unless they are already receiving the intervention in column C.	A list of intervention names formatted as per the 'Programs cost and coverages' sheet, separated by commas

6.2. Reference programs

Reference programs are interventions that cannot be defunded in scenarios or optimisations, but (may) have their funding increased. Default examples include WASH interventions, malaria interventions (IPTp, LLINs) and family planning. This is because generally their budget does not come from nutrition.

If there are other interventions, which for logistic, political or budgetary reasons cannot be defunded, they can be added to this list. Doing so will mean that the intervention can be expanded in scenarios and optimisations, but not shrunk. It is important that the intervention names are formatted as per the 'Programs cost and coverages' sheet.

7. Parameters

7.1. Mortality risk factors

7.1.1. *Birth outcomes*

Table 7.1: Relative risk ratios for neonatal mortality types by birth outcome (term / pre-term and appropriate for gestational age [AGA] / small for gestational age [SGA])

Birth outcome	Neonatal sepsis	Neonatal pneumonia	Neonatal asphyxia	Neonatal prematurity
Term AGA	Ref	Ref	Ref	Ref
Term SGA	2.07	2.07	2.07	1
Pre-term AGA	8.02	8.02	8.02	999.99
Pre-term SGA	11.54	11.54	11.54	999.99

Source: Katz et al. 2013 [26]

7.1.2. *Stunting*

Table 7.2: Relative risk ratios for 1-59 month old mortality types, by height-for-age Z-score (HAZ) category

Age group	HAZ-status	Diarrhoea	Pneumonia	Meningitis	Measles	Other
1-59 months	None (HAZ-score ≥ -1)	Ref	Ref	Ref	Ref	Ref
	Mild (HAZ-score ≥ -2 and < -1)	1.67	1.55	1	1	1
	Moderate (HAZ-score ≥ -3 and < -2)	2.38	2.18	1.86	2.79	1.86
	Severe (HAZ-score < -3)	6.33	6.39	3.01	6.01	3.01

Source: Olofin et al. 2013 [27]

7.1.3. *Wasting*

Table 7.3: Relative risk ratios for 1-59 month old mortality types, by weight-for-height Z-score (WHZ) category

Age group	Status	Diarrhoea	Pneumonia	Meningitis	Measles	Other
1-59 months	None (WHZ-score ≥ -1)	Ref	Ref	Ref	Ref	Ref
	Mild (WHZ-score ≥ -2 and < -1)	1.6	1.92	1.65	1	1.65
	MAM (WHZ-score ≥ -3 and < -2)	3.41	4.66	2.73	2.58	2.73

	SAM (WHZ-score < -3)	12.33	9.68	11.21	9.63	11.21
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Source: Olofin et al. 2013 [27]

7.1.4. Breastfeeding practices

Table 7.4: Relative risk ratios for mortality types, by breastfeeding practices and age group

Age group	Status	Neonatal diarrhoea / sepsis / pneumonia*	Diarrhoea†	Pneumonia^	Meningitis / measles / pertussis^
<1 month	Exclusive	Ref			
	Predominant	1.35			
	Partial	1.35			
	None	5.40			
1-5 months	Exclusive		Ref	Ref	
	Predominant		2.28	1.66	1.48
	Partial		4.62	2.50	2.84
	None		10.53	14.97	14.40
6-11 months	Partial		Ref	Ref	Ref
	None		1.47	1.92	3.69
12-23 months	Partial		Ref	Ref	Ref
	None		2.57	1.92	3.69

Sources: * NEOVITA Study Group 2016 [28] with predominant / partial assuming late initiation; † Lamberti et al. 2011 [8]; ^ Lamberti et al. 2013 [29].

7.1.5. Anaemia

Table 7.5: Relative risks of maternal mortality types by anaemia status.

Pregnant women age in years	Status	Antepartum haemorrhage	Intrapartum haemorrhage	Postpartum haemorrhage
15-49	Not anaemic	Ref	Ref	Ref
15-49	anaemic	10.675	10.675	10.675

Source: LiST [2].

Applies only to the fraction who are severely anaemic

7.2. Birth outcomes

7.2.1. Impact of birth outcomes on stunting, wasting and anaemia

Table 7.6: Odds ratios for stunting (HAZ-score <-2) and wasting (WHZ-score <-2), by birth outcome.

	Odds ratio for condition if born:			
Condition	Term AGA	Term SGA	Pre-term AGA	Pre-term SGA
Stunting	Ref	5	6.4	46.5
Wasting	Ref	2.52	1.96	4.19

Sources: stunting LiST [2]; wasting Christian et al. 2013 [30] for low and middle income countries.

7.2.2. Odds of birth outcomes with maternal anaemia

Table 7.7: Odds ratios for being born term / pre-term and appropriate for gestational age [AGA] / small for gestational age [SGA] if mother is anaemic.

Condition	Term SGA [^]	Pre-term AGA [†]	Pre-term SGA [^]
No maternal anaemia	Ref	Ref	Ref
Maternal anaemia	1.53	1.32	1.53

Sources: [^] Child Health Epidemiology Reference Group 2011 [31]; [†] Xiong et al. 2015 [32].

7.3. Impact of diarrhoea on stunting, wasting and anaemia

Table 7.8: Odds ratios for stunting, wasting and anaemia as diarrhoea incidence increases.

Condition	Age band	Odds ratio for every additional episode	Source
Stunting	0-59 months	1.025	LiST [2]
Wasting	0-59 months	1.025	Assumed the same as stunting

7.4. Impact of past stunting on stunting

Table 7.9: Odds ratios for continued stunting (<-2 HAZ-score) if stunted in a prior age band

Age in months	OR
1-5	45
6-11	361.6
12-23	174.7
24-59	174.7

Source: LiST [2].

7.5. Interventions

7.5.1. Breastfeeding promotion

Table 7.10: Odds ratio for correct breastfeeding with promotion

Pregnant women age in years		< 1 month	<6 months	6-23 months
Odds ratio for exclusive breastfeeding	Health system	2.03	3.07	--
	Community	2.17	2.48	--
	Health system and community	2.33	6.80	--
Odds ratio for partial breastfeeding	Health system			1.00
	Community			1.00
	Health system and community			1.82

Source: Sinha et al. 2015 [33], re-analysis done for LiST

7.5.2. Direct prevention of stunting

Table 7.11: Odds ratios for stunting when covered by directly impacting interventions

Age group	Complementary feeding education†	Public provision of complementary foods (PPCF)†	Lipid-based nutrition supplements (LNS)^
6-11 months	0.77	0.89	0.89
12-23 months	0.77	0.89	0.89

Sources: † Bhutta et al 2008, Imdad et al. 2011 [3, 4]; ^Assumes LNS has equivalent impact as PPCF. Assumes PPCF / LNS are provided with feeding education

7.5.3. Wasting treatment

Table 7.12: Odds ratios for moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) prevalence for the fraction of the population covered by treatment

Age group	Effectiveness of treatment of MAM on MAM recovery rate	Effectiveness of treatment of SAM on SAM recovery rate
<1 months	1	1
6-59 months	0.84	0.78

Source: Bhutta et al. 2013, Lenters et al. 2013 [5, 34]

7.5.4. Wasting prevention

Table 7.13: Relative reduction in the incidence of moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) prevalence for the fraction of the population covered by interventions

Age group	Public provision of complementary foods (PPCF)†		Lipid-based nutrition supplements (LNS)^		Cash transfers*	
	MAM	SAM	MAM	SAM	MAM	SAM
< 1 month	0.915	0.915	0.915	0.915		
6-23 months	0.913	0.913	0.913	0.913	0.766	0.792
24-59 months	1	1	1	1	0.719	0.712

Sources: † LiST [2]; ^ assumes LNS has the same impact as PPCF; * Langendorf et al. 2014 [10]

Assumes PPCF, LNS and cash transfers only given to fraction below the poverty line

7.5.5. Anaemia reduction

Table 7.14: Relative risk ratio for anaemia for the fraction of the population covered by interventions

Intervention	0-6 months	6-23 months	23-59 months	Pregnant women	Women of reproductive age
Delayed cord clamping	0.53	--	--	--	--
Iron and folic acid (IFA) fortification (wheat, maize, rice)	--	0.976	0.976	0.976	0.976
Iron and iodine fortification of salt	--	0.9	0.9	0.9	0.9
Micronutrient powders	--	0.69	0.69	--	--
Lipid-based nutrition supplements (LNS)	--	0.69	--	--	--
Long-lasting insecticide treated bednets (LLINs)	0.83	0.83	0.83	0.83	0.83
IFA supplementation	--	--	--	0.33	0.73
Multiple micronutrient supplementation (MMS)	--	--	--	0.33	--
IPTp	--	--	--	0.83	--

Sources (by row): Delayed cord clamping: Hutton et al. 2007 [18];

Food fortification: Barkley et al. 2015 [15] for wheat, assumes the same for maize and rice;

Micronutrient powders: De-Regil et al. 2013 [17];

Lipid-based nutrition supplements: assumed to have the same impact as micronutrient powders;

LLINs: Eisele et al. 2010 [14], assumes impact of LLINs for children is the same as for women of reproductive age;

IFA supplementation pregnant women: Peña-Rosas et al. 2015 [11];

IFA supplementation non-pregnant women: Fernández-Gaxiola et al. 2011 [12];

MMS: Peña-Rosas et al. 2015 [11];
IPTp: Radeva-Petrova et al. 2014 [13].

7.5.6. Mortality risk reduction

Table 7.15: Relative risk ratio[†] for mortality types for the fraction of the population covered by interventions

Intervention	Type of mortality	< 1 month	1-6 months	6-59 months	Pregnant women
Vitamin A supplementation	Diarrhoea			0.822	--
ORS	Diarrhoea	0.1816	0.1816	0.1816	--
ORS + zinc	Diarrhoea	0.14	0.14	0.14	--
Prophylactic zinc supplementation	Diarrhoea	0.85	0.85	0.85	--
	Pneumonia	0.85	0.85	0.85	--
Iron and folic acid fortification	Neonatal congenital anomalies	0.678	--	--	--
Calcium supplementation		--	--	--	0.80
Magnesium Sulphate for pre-eclampsia	Hypertensive disorders	--	--	--	0.41
Magnesium Sulphate for eclampsia	Hypertensive disorders	--	--	--	0.40
Long-lasting insecticide treated bednets (LLINs)	Malaria	--	0.45	0.45	

[†] Effectiveness and affected fraction converted to relative risk ratios, see notes (section 7.6.1)

Sources: Vitamin A: Imdad et al. 2011 [7];

ORS: Munos et al. 2010 [19];

ORS + Zinc: Munos et al. 2010, Walker et al. 2010 [19, 20];

Prophylactic Zinc supplementation: Bhutta et al. 2013, Yakoob et al. 2011 [5, 6];

Iron and folic acid fortification: Blencowe et al. 2010 [16];

Magnesium sulphate: Jabeen et al. 2011 [22];

Calcium supplementation Ronsmans et al. 2011 [21];

LLINs: Eisele et al. 2010 [14].

7.5.7. Birth outcome risk reduction

Table 7.16: Relative risk ratio for small for gestational age (SGA) birth outcome for the fraction of pregnant women covered by interventions

Intervention	Relative risk ratio
Balanced energy protein supplementation	0.79
Multiple micronutrient supplementation (MMS)	0.77

IFA supplementation (pregnant women)	0.85
IPTp	0.65
Long-lasting insecticide treated bednets (LLINs)	0.65

Sources: Balanced energy protein supplementation: Ota et al. 2015 [1];

MMS LiST [2];

IFA supplementation: Peña-Rosas et al. 2015 [11];

IPTp: Eisele et al. 2010 [14];

LLINs: Eisele et al. 2010 [14]

7.5.8. *Diarrhoea incidence reduction*

Table 7.17: Relative risk ratios for diarrhoea incidence for the fraction covered by interventions.

Intervention	< 1 month	1-6 months	6-59 months
Vitamin A supplementation	--	--	0.871
Prophylactic zinc supplementation	0.805	0.805	0.805
WASH: improved water source	1 ^{^*}	1 ^{^*}	1 ^{^*}
WASH: water connection in home	1 [†]	1 [†]	1 [†]
WASH: improved sanitation	0.61 [^] /1 [*]	0.61 [^] /1 [*]	0.61 [^] /1 [*]
WASH: hygienic disposal of stools	1 [†]	1 [†]	1 [†]
WASH: handwashing with soap	0.60/1 [*]	0.60/1 [*]	0.60/1 [*]

Sources: Vitamin A: Imdad et al. 2011 [7];

Prophylactic Zinc supplementation: Bhutta et al. 2013, Yakoob et al. 2011 [5, 6]

WASH: [†][35]; [^]WASH Benefits study Bangladesh: Luby et al. 2018 [23]; ^{*}WASH benefits study Kenya: Null et al. 2018 [24]; SHINE study Zimbabwe: Humphreys et al. 2019 [25].

Table 7.18: Relative risk ratios for diarrhoea incidence at different levels of breastfeeding

Status	<6 month	6-23 months
Exclusive	Ref	--
Predominant	1.26	--
Partial	1.68	Ref
None	2.65	2.07

Source: Lamberti et al. 2011 [8]

7.5.9. *Family planning*

Table 7.19: Relative risks of birth outcomes for age, birth order and birth spacing

Age and birth order	Pre-term SGA RR	Pre-term AGA RR	Term SGA RR
Less than 18 years			

First birth	3.14	1.75	1.52
Second and third births	1.6	1.4	1.2
Greater than third birth	1.6	1.4	1.2
18 - 34 years old			
First birth	1.73	1.75	1.52
Second and third births	1	1	1
Greater than third birth	1	1	1
35 - 49 years old			
First birth	1.52	1.75	1.52
Second and third births	1	1.33	1
Greater than third birth	1	1.33	1
Birth intervals ^a			
First birth	1	1	1
less than 18 months	3.03	1.49	1.41
18-23 months	1.77	1.1	1.18
24 months or greater	1	1	1

Source: Kozuki et al. 2013 [36]

Table 7.20: Impact of interventions of birth spacing

Intervention	Odds of women without contraception achieving 24 months or greater birth spacing
Family planning	0.66

Source: de Bocanegra et al. 2014 [37]

7.6. Notes

7.6.1. Converting effectiveness / affected fraction to relative risk ratios

The impacts of interventions on cause-specific mortality or condition incidence are stated as affected fractions and intervention effectiveness. These two quantities are defined as:

- Affected fraction: the proportion of cause-specific mortality that is considered susceptible to that intervention; and
- Effectiveness: a percentage that reflects the degree or extent to which an intervention is capable of reducing mortality attributed to a specific cause of death.

For consistency, these values were converted to relative risk ratios via the following formula:

$$relative_risk = (1 - affected_fraction) + (1 - effectiveness) * affected_fraction$$

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