Optima Nutrition

World Bank Group, in collaboration with the Burnett Institute and the Bill and Melinda Gates Foundation

February 13-15, 2019

Financial support for the training was provided by the Government of Japan through the Japan Trust Fund for Scaling Up Nutrition.
Rationale for efficiency analysis

Day 1 – Session 1
How much it will cost?
What will we buy with this investment?
- Nutrition
- Health/lives saved
- Economy

How can it be financed?

How can these analytics generate national political commitment? And how can we maximize the “bang for the buck”? 
Using Data Analytics To Improve Efficiency

Estimating the costs

Cost effectiveness analyses

Benefit-cost analyses

Annual Public Sector Cost of Scaling-up Nutrition-specific Interventions (USD million)

$1 invested = $22 returns

Cost-effectiveness map: Regions with the lowest cost per case of stunting averted

One key question we could not answer: what is the optimal allocation of resources across interventions?
Using Data Analytics To Improve Efficiency

Technical efficiency – maximizing outputs at given cost.

Allocative efficiency – maximizing outputs by allocating resources across different activities

Intervention A
Different nutrition interventions
Different health programs
Different sectors

Better Nutrition

Optima Nutrition
What is a model

• Modelling is a process:

  Problem → Gather data / observations → Simplify / filter relevant information → Consider constraints

  Make decision

• We all use models everyday without realising it. For example, how are you going to travel to work?
  • Data: timetables, costs, weather
  • Simplify: maybe we don’t care if a train could be 5 minutes late
  • Constraints: what are we prepared to pay and how fast do we need to get there?

• Sometimes there is too much information to consider, so we need to use a computer

• Models can help us to make decisions by organising all of the relevant data in a way that is useful for us
Existing tools for impact and economic analyses for nutrition

Multiple interventions:

- FANTA
- CMAM
- WBCi

Single intervention:

- IBFAN
- WBCi
- FANTA
- CMAM
- MINIMOD

One Health

PROFILES
Where does Optima Nutrition fit in the mix

Optima Nutrition has two main uses:

• Optimising investment for best health and economic outcomes

• Projecting future scenarios: how will trends in malnutrition change under different funding scenarios?

The model has secondary uses for:

• Assessment of the impact of interventions on multiple malnutrition conditions:
  • Stunting in children
  • Wasting in children
  • Anaemia in children and women of reproductive age
  • Child and maternal mortality
How does Optima Nutrition work?

1. Burden of malnutrition
   - Data synthesis
   - Model projections

2. Programmatic responses
   - Identify interventions & delivery modes
   - Costs and effects

3. Objectives and constraints
   - Strategic goals
   - Ethical, logistic & economic constraints

4. Optimization algorithm
Key questions addressed by Optima Nutrition

• 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 sub-national analysis: which geographical regions should receive priority additional funding, if it were available?

• How might trends in undernutrition change under different funding scenarios?

• How close is a country likely to get to their nutrition targets:
  • with the current allocation of funding?
  • with the current volume of funding, but reallocated optimally?

• What is the minimum funding required, if allocated optimally, to meet the nutrition targets?
Health outcomes addressed by Optima Nutrition

• For different funding levels, how should resources be allocated across a mix of nutrition interventions and what impact is achievable?

• Optimal outcomes can be measured as:
  • minimised stunting cases
  • minimised stunting prevalence
  • minimised wasting prevalence
  • minimised anaemia prevalence
  • minimised maternal or child deaths or
  • A combination of the above, e.g. maximising the number of alive non-stunted children (“alive and thrive”).
Tour of the graphic user interface (GUI)
Modelling stunting using Optima Nutrition

Day 1 – Session 2
Objectives of session

• The objective of this module is to understand the underlying model framework, using the stunting model as an example

• We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface we showed you earlier this morning

• At the end of this module and exercises you should be able to:
  • Project status-quo / baseline scenarios
  • Estimate the impact of scaling up and down stunting interventions
  • Create and model different infant and young child feeding education packages
Overview of the Optima Nutrition model

• The underlying model is a reproduction of the LiST framework
  • Tracks the under-5 population over a given period (e.g. 2018-2030)
• The model includes risk factors that contribute to stunting and mortality (among other things)
• The model includes a range of interventions
  • For example: balanced energy protein supplementation, multiple micronutrient supplementation, vitamin A supplementation, prophylactic zinc supplementation, infant and young child feeding education and public provision of complementary foods.
• Key outcomes for this session include the number of deaths and stunting cases, and the prevalence of stunting
• An optimisation algorithm is used to allocate a given budget across the nutrition interventions to minimise a chosen objective
  • For example, maximise the number of alive and non-stunted children
Definition of stunting in the model

• Height-for-age distribution is classified into four Z-score (HAZ) categories, based on WHO criteria

• Risk factors for stunting are:
  • Birth outcomes OR = 5 for term SGA; OR = 6.4 for pre-term AGA; OR = 46.5 for pre-term SGA [LiST]
  • Diarrhoea incidence OR = 1.04 for every additional episode [LiST]
  • Past stunting OR = 45; 361.6; 174.7 and 174.7 for 1-6 month, 6-12 month, 12-23 month and 23-59 month categories respectively [LiST]

• Stunting increases the risk of mortality for children who have diarrhoea, pneumonia, measles and other illnesses:
  • Odds ratios / relative risks come from available literature: E.g. OR for measles mortality = 6.01 if severely stunted Olofin et al 2013, PLoS One
Model populations and ageing process

Risks of stunting include:
- breastfeeding practices
- past stunting
- diarrhoea incidence

SGA: Small for gestational age
AGA: Appropriate for gestational age

Risk factors for mortality:
- Diarrhea
- Sepsis
- Pneumonia
- Prematurity
- Asphyxia
- Other

Risk factors for mortality:
- Diarrhea
- Pneumonia
- Measles
- Other

Births

Pre-term SGA
Term SGA
AGA

<1 month

1-6 months
6-12 months
1-2 years
2-5 years

Height-for-age: Four categories tracked
Relative to global mean

Stunting
Deaths

Stunted
Others not stunted by age 5 years

Neonatal death
Post-neonatal death
Relationship between interventions, risk factors, stunting and mortality

**Interventions**
- Balanced energy protein supplementation
- Multiple micronutrient supplementation
- Public provision of complementary foods
- Prophylactic zinc supplementation
- Vitamin A supplementation
- Infant and young child feeding education

**Risk factors**
- SGA / AGA
- Pre-term / term

**Stunting**
- Diarrhoea incidence
- Breastfeeding practices
- Past stunting

**Mortality**
- Neonatal mortality
- 1-59 month mortality
<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target population</th>
<th>Effects</th>
<th>Source / effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced energy protein supplementation</td>
<td>Pregnant women below the poverty line</td>
<td>Reduces risk of SGA birth outcomes</td>
<td>RRR = 0.79 [Ota et al. 2015, The Cochrane Library]</td>
</tr>
<tr>
<td>Multiple micronutrient supplementation in pregnancy</td>
<td>Pregnant women</td>
<td>Reduces risk of SGA birth outcomes</td>
<td>RRR = 0.77 [LiST]</td>
</tr>
<tr>
<td>Public provision of complementary foods</td>
<td>Children 6-23 months below the poverty line</td>
<td>Reduces the odds of stunting</td>
<td>OR = 0.89 [Bhutta et al. 2008, The Lancet; Imdad et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td>Prophylactic zinc supplementation</td>
<td>Children 1-59 months</td>
<td>Reduces diarrhoea incidence</td>
<td>Diarrhoea incidence RRR = 0.805 [Bhutta et al. 2013, The Lancet; Yakoob et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces diarrhoea and pneumonia mortality</td>
<td>Mortalities RRR = 0.85 [Bhutta et al. 2013, The Lancet; Yakoob et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td>Vitamin A supplementation</td>
<td>Children 6-59 months</td>
<td>Reduces diarrhoea incidence mortality</td>
<td>Incidence RRR = 0.87 [Imdad et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td>Infant and young child feeding education (IYCF)</td>
<td>Children &lt;23 months</td>
<td>See next slide</td>
<td>Mortality RRR = 0.82 [Imdad et al. 2011, BMC Public Health]</td>
</tr>
</tbody>
</table>
Modelling feeding practices and their impact

- Correct (or incorrect) feeding practices have a different impact in the model depending on the age of the child
- Therefore the model allows the user to choose what ages their education packages cover, and accounts for the different impacts.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Exclusive breastfeeding</th>
<th>Partial breastfeeding</th>
<th>Appropriate complementary feeding</th>
<th>Effect size / sources</th>
</tr>
</thead>
</table>
| < 6 months       | Reduces diarrhea                        | Reduces diarrhea                    | Reduces odds of stunting                           | Diarrhoea incidence: compared to exclusive breastfeeding, OR = 1.26, 1.68, 2.65 for experiencing diarrhoea with predominant, partial or no breastfeeding\(^a\)  
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\(^b\)  
Diarrhoea → stunting: OR for stunting = 1.04 for every additional diarrhoea episode compared to exclusively breastfed children\(^c\) |
| 6-23 months      | Partial breastfeeding                    | Appropriate complementary feeding    |                                                    | OR = 2.07 for no breastfeeding compared to partial breastfeeding\(^a\)  
OR = 0.67\(^d\)                                                                                                     |

Combining education delivery in an infant and young child feeding (IYCF) package

- Breastfeeding promotion and complementary feeding education interventions are combined in the model, as user-defined (IYCF) packages
- 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 (GP, hospital): coverage is restricted by the fraction of the population who attend
  - Community health workers: reaches all women and can therefore have much higher coverage
  - Mass media: can cover all groups, depending on the message, with high coverage possible
  - 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.
User defined IYCF packages in the GUI

- Users can design their own IYCF packages using the table below.
- Multiple IYCF packages can be designed and used in an optimisation.
- For example, below might reflect an IYCF package that includes:
  - **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>
<thead>
<tr>
<th>IYCF package</th>
<th>Target population</th>
<th>Health facility</th>
<th>Community</th>
<th>Mass media</th>
</tr>
</thead>
<tbody>
<tr>
<td>IYCF 1</td>
<td>Pregnant women</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;1 month</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>1-5 months</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>6-11 months</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12-23 months</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
The spending on interventions is linked to their coverage

For each intervention, increasing investment:
- Increases the number of people receiving the intervention
- Leads to reductions in stunting and deaths according to estimated effectiveness
- Has a saturation effect when scaling up interventions

The model is given inputs on how much to spend on each intervention, and produces estimates for stunting and mortality (among other things).
Tanzania’s 2016 nutrition funding was estimated at US$19.1 million\textsuperscript{a}:

- IYCF (53%)
- Vitamin A supplementation (31%)
- Multiple micronutrient supplementation (pregnant women) (16%)

\textsuperscript{a} Note: this is an estimated expenditure based on estimates of national intervention coverages and unit costs.
Tanzania’s National Multisectoral Nutrition Action Plan (NMNAP)

- Tanzania’s NMNAP includes 2021 national coverage targets:
  - 65% IYCF
  - 58% for micronutrient supplementation (pregnant women)
  - 90% for vitamin A supplementation

- Estimated to cost a total US$64.8 million per annum

- If maintained to 2030 could result in a cumulative:
  - 949,000 (4.9%) additional alive and non-stunted children, compared to continued estimated 2016 spending
To maximise the number of alive and non-stunted children, funding should be optimally targeted towards:

- IYCF (63%);
- public provision of complementary foods (23%); and
- vitamin A supplementation (14%).

Compared to the NMNAP scenario, optimisation is estimated to:

- Increase the number of alive, non-stunted children by 192,000 (0.9%) between 2017 and 2030
- 20% higher impact than current NMNAP
Exercises

• See worksheet

In Google Chrome: nutrition.ocds.co
Modelling wasting using Optima Nutrition

Day 1 – Session 3
Objectives of session

- Previously we covered stunting and stunting interventions in Optima Nutrition.
- This session will cover how wasting is incorporated in Optima Nutrition.
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface.
- At the end of this module and exercises you should be able to:
  - Understand the wasting component of the model, including prevention (incidence-reducing) interventions and treatment
  - Compare the impact of prevention and treatment interventions for reducing wasting
  - Understand how adding management of moderate acute malnutrition to a treatment intervention impacts its effects in the model
  - Be able to run budget scenarios in the model
Definition of wasting in the model

- The weight-for-height distribution is tracked for children in each age band
- Split according to weight-for-height Z-scores (WHZ) as four categories (similar to stunting)
  - Categories: severe acute malnutrition [SAM], moderate acute malnutrition [MAM], mild acute malnutrition, normal
  - Wasting considered to be SAM + MAM categories
- Wasting is modelled as an incident (short-duration) condition
  - Independent distributions / burden is allowed for each age group
Dynamics of wasting as an acute condition

Wasting is modelled as a short-duration condition

- **Incidence** (purple arrows): children develop SAM/MAM
- **Deaths** (red arrows): children are at greater risk of death while in the SAM/MAM compartments
- **Recovery** (green arrows): scale-up of SAM/MAM treatment reduces the duration spent in those compartments

---

**Age band** (e.g. 6-11 months)

- **Children enter age band**
- **Alive children exit age band**

**SAM** → **Incidence** → **MAM** → **Recovery** → **Mild and normal** → **Recovery** → **Deaths** → **Recovery** → **SAM**

- **Increased mortality risk while in SAM/MAM states**
Risk factors for wasting

- Wasting is a risk factor for several causes of death in children > 1 month: [Olofin et al. 2013, PLoS One]
  - Diarrhoea $RRR = 1.60, 3.41, 12.33$ for mild, moderate and severe WHZ categories compared to normal
  - Pneumonia $RRR = 1.92, 4.66, 9.68$ for mild, moderate and severe WHZ categories compared to normal
  - Measles $RRR = 2.58, 9.63$ for moderate and severe WHZ categories compared to normal
  - Other $RRR = 1.65, 2.73, 11.21$ for mild, moderate and severe WHZ categories compared to normal

- Risk factors for wasting are:
  - Diarrhoea incidence $OR = 1.025$ for every additional episode; assumed the same OR as for stunting, from LiST
  - Preterm / term and SGA / AGA birth outcomes $OR$ for wasting $=1.65$ for pre-term AGA, $2.58$ for term SGA, $3.50$ for pre-term SGA [Christian et al. 2013, International Journal of Epidemiology]

- Wasting and stunting modelled as independent
  - This is the approach taken in LiST
Wasting: risk factors, outcomes and interventions

Risk factors:
- SGA / AGA
- Birth outcomes
- Pre-term / term
- Wasting
- Stunting
- Diarrhoea incidence
- Breastfeeding practices
- Past stunting
- Mortality:
  - Neonatal mortality
  - 1-59 month mortality

Interventions:
- Treatment of SAM
- Cash transfers
- Public provision of complementary foods
- Lipid-based nutrition supplements
Treatment of wasting reduces episode duration

- Treatment of SAM reduces the duration of the condition. Effectiveness = 0.78 for SAM if covered, OR = 0.84 for MAM [Lenters et al. 2013]

- This translates to a reduction in cross-sectional prevalence estimates.
Interventions: treatment of SAM

- Treatment of severe acute malnutrition (SAM)
  - Target population is all children experiencing SAM
  - Treated children are moved to the MAM category

- Scaling up treatment of SAM:
  - Increases recovery from SAM  Effectiveness on recovery rate = 0.78 [Lenters et al. 2013]
  - Therefore reduces the prevalence of SAM  (i.e. RRR= 0.22)
  - Reduces mortality
  - Increases the prevalence of MAM  (indirectly increases mortality from MAM and incidence of SAM)
Extending treatment of SAM to include MAM

• Scaling up treatment of SAM does not directly reduce wasting prevalence, since children recover to MAM

• 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

• Note that this will make the cost of the treatment intervention more expensive (by a user defined amount)

![Diagram showing the transition from SAM to MAM and then to Mild based on WHZ (Wasting Height Z-score) values. The diagram illustrates the distribution of children across WHZ categories: -3 to -2, -2 to -1, 0 to 1, 1 to 2, and 2 to 3. The transition from SAM to MAM is represented by a horizontal arrow, and the shift from MAM to Mild is shown with a vertical arrow. The diagram highlights the 2.5% and 13.5% thresholds for WHZ categories.]
Extending treatment of SAM to include multiple delivery modes

- 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
  - The cost of each delivery mode can be different, based on setting-specific data

<table>
<thead>
<tr>
<th>Program</th>
<th>Default</th>
<th>Extension</th>
<th>Add extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment of SAM</td>
<td>Management of MAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery mode</td>
<td>Health facility</td>
<td>Community-based</td>
<td></td>
</tr>
</tbody>
</table>

Save changes Revert ▼ ▲
# Wasting prevention interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target population</th>
<th>Effects</th>
<th>Source / effect size</th>
</tr>
</thead>
</table>
| **Public provision of complementary foods (PPCF)** | Children 6-23 months 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; Imdad et al. 2011, BMC Public Health]  
SAM / MAM incidence  
RRR = 0.913 [LiST] |
| **Lipid-based nutrition supplements (LNS)**  | Children 6-23 months 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]  
MAM incidence: RRR = 0.719 for 6-23 months,  
RRR = 0.792 for 24-59 months [Langendorf et al. 2014, PLoS Med] |

*OR = Odds Ratio, RRR = Relative Risk Ratio*
Exercises

• See worksheet
Modelling anaemia using Optima Nutrition

Day 1 – Session 4
Objectives of session

• The previous sessions covered how stunting and wasting are modelled in Optima Nutrition.

• This session will cover how anaemia is incorporated in Optima Nutrition.

• We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface.

• At the end of this module and exercises you should be able to:
  • Understand the anaemia component of the model, including additional population groups (women of reproductive age, by age category).
  • Understand different delivery modalities for iron and folic acid supplementation interventions, and different food fortification vehicles.
  • Understand the two kinds of intervention dependencies, threshold and exclusion.
Model populations: overview of stratifications

**Non-pregnant women of Reproductive Age (WRA)**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Not anaemic</th>
<th>Anaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>20 - 24 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>25 - 29 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
</tbody>
</table>

**Pregnant women**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Not anaemic</th>
<th>Anaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>20 - 29 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
</tbody>
</table>

**Children**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Not anaemic</th>
<th>Anaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1 months</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>1 - 6 months</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>6 - 11 months</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>12 - 23 months</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
<tr>
<td>24 – 59 months</td>
<td>Not anaemic</td>
<td>Anaemic</td>
</tr>
</tbody>
</table>

Also stratified by:
- Stunting
- Wasting
- Breastfeeding
Anaemia: risk factors and effects

- Anaemia in pregnant women is modelled as a risk factor for maternal mortality (haemorrhage)
  - Anaemia increases relative risk of death due to haemorrhage \( \text{RRR} = 10.675 \) antepartum; intrapartum; and postpartum for the estimated fraction who are severely anaemic [LiST]

- Anaemia in pregnant women is modelled to be a risk factor for suboptimal birth outcomes \( \text{OR} = 1.32 \) for pre-term AGA [Xiong et al. 2000, Am J Perinatology]; \( \text{OR} = 1.53 \) for term SGA; \( \text{OR} = 1.53 \) for pre-term SGA [Kozuki et al. 2012, J. Nutrition]
  - This can affect stunting, which in turn can affect mortality in children
Anaemia: risk factors, outcomes and interventions

Risk factors
- Anaemia: women of reproductive age
- SGA / AGA
- Pre-term / term

Birth outcomes
- Wasting
- Stunting
- Diarrhoea incidence
- Breastfeeding practices

Mortality
- Maternal mortality
- Neonatal mortality
- 1-59 month mortality

Interventions
- IFA supplementation
- Multiple micronutrient supplementation
- IPTp
- Food fortification
- LLINs
- Lipid-based nutrition supplements
- Micronutrient powders
- Delayed umbilical cord clamping
## Anaemia interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target population</th>
<th>Effects</th>
<th>Source / effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFA supplementation for pregnant women</td>
<td>Pregnant women. Not given to women receiving MMS</td>
<td>Reduces anaemia</td>
<td>Anaemia RRR = 0.33 [Pena-Rosas et al, Cochrane Database Reviews 2015]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces SGA birth outcomes</td>
<td>SGA RRR = 0.85 [Pena-Rosas et al, Cochrane Database Reviews 2015]</td>
</tr>
<tr>
<td>IFA supplementation for non-pregnant WRA</td>
<td></td>
<td>Reduces anaemia</td>
<td>RRR = 0.73 [Fernandez-Gaxiola &amp; De-Regil 2011, Cochrane Database Syst Rev]</td>
</tr>
<tr>
<td>Multiple micronutrient supplementation</td>
<td>Pregnant women</td>
<td>Reduces risk of SGA birth outcomes</td>
<td>RRR = 0.77 [LiST]</td>
</tr>
<tr>
<td>IPTp</td>
<td>Pregnant women in areas where there is malaria risk</td>
<td>Reduces anaemia</td>
<td>Anaemia RRR = 0.83 [Radeva-Petrova et al. 2014, The Cochrane Library]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces SGA birth outcomes</td>
<td>SGA RRR = 0.65 [Eisele et al. 2010, IJEpi]</td>
</tr>
</tbody>
</table>
## Anaemia interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target population</th>
<th>Effects</th>
<th>Source / effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food fortification</td>
<td>Everyone</td>
<td>Reduces anaemia</td>
<td>Anaemia OR = 0.976 [RRR = 0.678 Barkley et al. 2015, BJ Nutrition]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces neonatal mortality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neonatal mortality RRR = 0.678 [congenital defects; Blencowe et al. 2010, IJEpidemiology]</td>
</tr>
<tr>
<td>Long-lasting insecticide-treated bed nets</td>
<td>Everyone in areas where there is malaria risk</td>
<td>Reduces anaemia</td>
<td>Anaemia RRR = 0.83 [Eisele et al. 2010, Int J Epi]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces SGA birth outcomes</td>
<td>SGA RRR = 0.65 [Eisele et al. 2010, Int J Epi]</td>
</tr>
<tr>
<td>Lipid-based nutrition supplements (LNS)</td>
<td>Children 6-23 months below the poverty line</td>
<td>Reduces stunting</td>
<td>Stunting OR = 0.89 [assumed the same as PPCF]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces incidence of MAM/SAM</td>
<td>MAM/SAM incidence RRR = 0.913 [assumed to be the same as PPCF]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces anaemia</td>
<td>Anaemia RRR = 0.69 for all-cause anaemia [assumed to be the same as micronutrient powders]</td>
</tr>
<tr>
<td>Micronutrient powders</td>
<td>Children 6-59 months, not already receiving LNS</td>
<td>Reduces anaemia</td>
<td>RRR = 0.69 [De-Regil et al. Chochrane review 2013]</td>
</tr>
<tr>
<td>Delayed cord clamping</td>
<td>Pregnant women (at birth, but impact is for children &lt;1 month)</td>
<td>Reduces anaemia</td>
<td>RRR = 0.53 [Hutton and Hassan, 2007 Jama]</td>
</tr>
</tbody>
</table>
IAF supplementation: non-pregnant women of reproductive age

• Delivered through four modalities:
  • Schools (the only modality for 15-19 year olds who attend school)
  • Health facilities (available for those not at school and attending health facilities)
  • Community (available for everybody)
  • Retail (only available for the fraction who are not poor)

• The fraction of the population who are likely to access each modality are entered by the user

*Coloured areas represent 100% coverage of IFA supplementation through a particular delivery mode.
Interventions: fortification of foods

- Women of reproductive age (pregnant and non-pregnant) and children >6 months can be impacted by food fortification

- **Fortification with iron and folic acid is modelled as three separate interventions:**
  - Fortification of wheat, rice and maize flour
  - Coverage restricted to fraction who eat each food as their staple, based on consumption data
  - Does not reach the fraction on subsistence farming

- Double fortification of salt (iron + iodine)
  - Targets entire population

*Coloured areas represent 100% coverage of a particular food fortification.

**Depending on the country, the target population of a particular food vehicle may be zero**
Exclusion dependencies in the model

Two types of restrictions can be applied to interventions

- **Exclusion dependencies**, to prevent interventions from being given simultaneously
  - For example, by default the model restricts some interventions so that:
    - Lipid-based nutrition supplements and public provision of complementary foods are not given to the same children
    - Iron supplementation in pregnancy and multiple micronutrient supplementation in pregnancy are not given to the women
    - Multiple micronutrient powders and lipid-based nutrition supplements are not given to the same children because LNS is already fortified with micronutrients
• **Threshold dependencies**, where an intervention can only be given at the same time as another intervention.

• For example, it is possible to apply restrictions so that in areas at risk of malaria:
  • IFA supplementation may only be given to pregnant women if they are taking IPTp (WHO recommendation, because being anemic lowers the risk of malaria).
  • Micronutrient powders may only be given to children who have a bed net (for the same reason).
Turning dependencies on and off

- Default dependencies are shown below
  - These can be removed by deleting them in the input sheet
  - More dependencies can be added by adding rows to the input sheet
Exercises

• See worksheet
Nutrition-sensitive interventions
Family planning, WASH

Day 2 – Session 1
Objectives of session

• The previous sessions have covered Optima Nutrition’s main outcomes (stunting, wasting and anaemia).

• This session will cover:
  • Family planning and WASH interventions
  • Other interventions that have not been covered in previous sessions

• We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface

• At the end of this module and exercises you should be able to:
  • Understand how to interpret model outcomes associated with family planning (specifically its impact on mortality rather than mortality rates)
  • Understand how family planning impacts birth outcomes through birth spacing
  • Change default parameter values in the model
Fertility risks

• Maternal age, birth order and time between successive births impact on birth outcomes
  • *Note: birth outcomes are also influenced by anaemia prevalence and the coverage of supplementation interventions in pregnant women*

• This impacts stunting, wasting and mortality
Fertility risks

Illustrates that children have a greater risk of being pre-term or SGA:
• If they are the first child
• Their mother is <18 years
• They are born within 18 months of an older sibling

<table>
<thead>
<tr>
<th>Age and birth order</th>
<th>Pre-term SGA RR</th>
<th>Pre-term AGA RR</th>
<th>Term SGA RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 18 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First birth</td>
<td>3.14</td>
<td>1.75</td>
<td>1.52</td>
</tr>
<tr>
<td>Second and third births</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Greater than third birth</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>18 - 34 years old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First birth</td>
<td>1.73</td>
<td>1.75</td>
<td>1.52</td>
</tr>
<tr>
<td>Second and third births</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Greater than third birth</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>35 - 49 years old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First birth</td>
<td>1.52</td>
<td>1.75</td>
<td>1.52</td>
</tr>
<tr>
<td>Second and third births</td>
<td>1</td>
<td>1.33</td>
<td>1</td>
</tr>
<tr>
<td>Greater than third birth</td>
<td>1</td>
<td>1.33</td>
<td>1</td>
</tr>
<tr>
<td>Birth intervals^a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First birth</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>less than 18 months</td>
<td>3.03</td>
<td>1.49</td>
<td>1.41</td>
</tr>
<tr>
<td>18-23 months</td>
<td>1.77</td>
<td>1.1</td>
<td>1.18</td>
</tr>
<tr>
<td>24 months or greater</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Kozuki et al. 2013
How family planning works

- When family planning services are scaled up this decreases the number of projected births
  - Expanded services are restricted by unmet need

- Having fewer births means that the total number of the following will decrease:
  - unfavorable birth outcomes
  - total number of non-stunted children reaching age 5
  - total number of maternal and child deaths

- Family planning also decreases the odds of suboptimal birth spacing \( OR = 0.66 \) of of women without contraception achieving 24 months or greater birth spacing [de Bocanegrea et al. 2014]

- There is a need to be cautious because family planning will radically reduce the number of stunted children (but only has a small and indirect impact on stunting prevalence)
Water, sanitation and hygiene (WASH)

• Five WASH interventions are available in the model:
  1. Improved water source
  2. Piped water
  3. Improved sanitation
  4. Hygienic disposal of stools
  5. Handwashing with soap

• Evidence on the effectiveness of these interventions is mixed and unclear, in particular given some recent large studies
  • WASH Benefits (Bangladesh and Kenya) and SHINE (Zimbabwe)
WASH Benefits and SHINE studies

• **The WASH Benefits study** (Bangladesh\(^a\), N=5551 and Kenya\(^b\), N=8426) compared diarrhoea and stunting between a control group and groups with:
  1. **Chlorinated drinking water**: no effect on diarrhoea or stunting
  2. **Upgraded sanitation**: diarrhoea prevalence ratio 0.61 in Bangladesh, no effect in Kenya; no effect on stunting
  3. **Promotion of handwashing with soap**: diarrhoea prevalence ratio 0.60 in Bangladesh, no effect in Kenya; no effect on stunting

• **The SHINE study** (Zimbabwe\(^c\), N=5280) compared diarrhoea, stunting, anaemia and mortality between a control group and groups with:
  - **WASH** (treated water, latrines, handwashing facilities + promotion, hygienic disposal of stools): no effect on diarrhoea, stunting, anaemia, mortality
  - **IYCF** (breastfeeding promotion, complementary feeding education, provision of Nutributter): reduction in stunting and anaemia, no impact on diarrhoea and mortality

\(^a\)Luby et al. Lancet Glob Health 2018; \(^b\)Null et al. Lancet Glob Health 2018
\(^c\)The Sanitation Hygiene Infant Nutrition Efficacy Trial team. Clinical Inf Dis. 2017
For all five WASH interventions:

• Target population is all children (0-59 months)

• Interventions can be set to reduce diarrhoea incidence

• The current effect size estimates have been set to 1 (no effect);
  • This can be adjusted by users based on local evidence (see exercises).

• **Coverage of WASH interventions are assumed to not decrease**
  (i.e. funding cannot be removed and invested in other interventions)
Other supplement and diarrhoea interventions

**Interventions**
- Calcium supplementation
- Magnesium sulphate
- Oral rehydration solution (ORS)
- ORS + Zinc

**Risk factors**
- Anaemia: women of reproductive age
- SGA / AGA
- Pre-term / term
- Wasting
- Stunting
- Diarrhoea incidence
- Breastfeeding practices
- Past stunting
- Anaemia: children

**Mortality**
- Maternal mortality
- Neonatal mortality
- 1-59 month mortality

**Birth outcomes**
- Stunting
- Wasting
- Pre-term / term
- SGA / AGA

**Risk factors**
- Past stunting
- Anaemia: children
- Wasting
- Stunting
- Pre-term / term
- SGA / AGA
- Anaemia: women of reproductive age

**Interventions**
- ORS + Zinc
- Oral rehydration solution (ORS)
- Magnesium sulphate
- Calcium supplementation
## Other supplement and diarrhoea interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Target population</th>
<th>Effects</th>
<th>Source / effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral rehydration salts (ORS)</td>
<td>Children 0-59 months (different quantity by age)</td>
<td>Reduces diarrhoea mortality</td>
<td>RRR = 0.18 [Munos, et al. 2010, I J Epi; Walker &amp; Black 2010, I J Epi]</td>
</tr>
<tr>
<td>Calcium supplementation</td>
<td>Pregnant women</td>
<td>Reduces maternal mortality (hypertensive disorders)</td>
<td>Mortality RRR = 0.80 [Ronsmans et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces pre-term births</td>
<td>Pre-term RRR = 0.78 [Imdad et al. 2011, BMC Public Health]</td>
</tr>
<tr>
<td>MgSO4 for pre-eclampsia / eclampsia</td>
<td>Pregnant women</td>
<td>Reduces maternal mortality (hypertensive disorders)</td>
<td>RRR = 0.41 [Ronsmans et al. 2011, BMC Public Health]</td>
</tr>
</tbody>
</table>
Exercises

• See worksheet
The data input book: common data sources and model inputs

Day 2 – Session 2
Objectives of session

• The previous sessions have covered how interventions and outcomes are modelled in Optima Nutrition

• This session will cover how data is gathered, stored and used as inputs for a given setting

• At the end of this module and exercises you should:
  • Be familiar with the data inputs workbook. In particular, why each piece of data is relevant and where it is typically available from.
  • Be able to source appropriate data and fill out a workbook for a particular country. This can be challenging as often some of the data needs to be interpreted.
  • Make basic assumptions where data is missing or needs interpretation
Summary of data input tabs

• The model uses an Excel book to store all of the data inputs
• A template can be downloaded from the GUI
• The input book consists of tabs for:
  • Population inputs in a baseline year
  • Demographic projections
  • Mortality by cause
  • Nutritional status (stunting, wasting and anaemia status by age group)
  • Breastfeeding behaviours
  • Fertility risks (age of birth and birth order data)
• These data can be obtained from commonly available sources (largely DHS reports, shown in next slides) and are needed to obtain the baseline characteristics of the setting being modelled.
Population inputs tab

Population inputs include some miscellaneous data, usually obtained from Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), or other population surveys.

- Poverty, school and health facility attendance, unmet need for family planning:
  - Important for defining the target populations and possible coverage of some interventions (e.g. public provision of complementary foods, IYCF delivered through health facilities, and others).

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baseline year data</td>
<td></td>
<td>2017</td>
</tr>
<tr>
<td>2</td>
<td>Projection years</td>
<td>Baseline year (projection start year)</td>
<td>2017</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>End year</td>
<td>2030</td>
</tr>
<tr>
<td>4</td>
<td>Population data</td>
<td>Percentage of population food insecure (default poor)</td>
<td>28%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Percentage of population at risk of malaria</td>
<td>100%</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>School attendance (percentage of 15-19 year women)</td>
<td>23%</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Percentage of pregnant women attending health facility</td>
<td>51%</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Percentage of children attending health facility</td>
<td>37%</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Unmet need for family planning</td>
<td>22%</td>
</tr>
</tbody>
</table>
Population inputs tab

• Food consumption patterns – the percentage of the population consuming a specific type of staples:
  • Important for defining the possible coverage / impact of food fortification interventions
  • **Common source:** FAO food balance sheets, consumption surveys

• Birth age and spacing:
  • Important for the family planning module
  • **Common source:** DHS/MICS reports
Population inputs tab

- Mortality rates, birth outcome distributions, and diarrhoea incidence:
  - Important for calibrating the model to the underlying determinants of malnutrition
  - Common source: DHS/MICS reports
Demographic data tab

- 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).
Causes of death tab

- Fraction of mortality attributable to various causes:
  - 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.
Nutritional status tab

- Stunting, wasting and anaemia status:
  - Important for setting up risk factors, in the absence of any changes to interventions.
  - It is important that these are entered for each age group due to the chronic nature of stunting*. For example, it would be typical for the prevalence of stunting to increase from younger to older age bands.
  - Common source: 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.
Breastfeeding distribution tab

- Breastfeeding distributions:
  - Important for capturing the impact of IYCF interventions
  - **Common source: DHS reports**

- Breastfeeding practice indicators available in DHS by age group (which may need recalculating to fit Optima Nutrition format):
  - Exclusive
  - Breastfeeding + liquids = predominant
  - Breastfeeding + solids = partial
  - None

<table>
<thead>
<tr>
<th>Percentage of children in each category in baseline year (2017) Status</th>
<th>0-1 month</th>
<th>1-5 months</th>
<th>6-11 months</th>
<th>12-23 months</th>
<th>24-59 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breastfeeding</td>
<td>Exclusive</td>
<td>84.0%</td>
<td>44.3%</td>
<td>1.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>Predominant</td>
<td>9.2%</td>
<td>21.7%</td>
<td>3.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>Partial</td>
<td>5.8%</td>
<td>31.6%</td>
<td>93.5%</td>
<td>72.1%</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1.0%</td>
<td>2.4%</td>
<td>1.9%</td>
<td>27.8%</td>
</tr>
</tbody>
</table>
Exercises

• See worksheet
Interpreting the data: costs and cost-coverage relationship

Day 2 – Session 3
Objectives of session

• The previous session covered where population and malnutrition data come from and how they are stored in Optima Nutrition.

• This session will cover the definition of marginal costs and the relationship between intervention cost and coverage in the model, as well as some of the assumptions that are required to calculate these.

• At the end of this module you should be able to make reasonable assumptions to estimate the unit cost of interventions.
How much do things cost?

• Delivering an intervention to someone requires many different types of costs:
  • Commodity costs, logistics and transport costs, staff costs, equipment costs, infrastructure costs, program management costs, other costs

• The unit cost of an intervention is defined as the cost of delivering an intervention to one person

• The marginal cost of an intervention is defined as the cost of delivering an intervention to one additional person

• There are multiple ways to estimate how much things cost:
  • Some of them are simple, some of them are extremely complex.
  • Two major ways to estimate unit costs are the program-experience (“top-down”) method and the ingredients-based (“bottom-up”) method.
Top-down method for estimating costs

- In the program experience/top down method, the unit cost is estimated by dividing the total expenditure for an intervention in a given period by the total number of persons covered.
  - For example, the total expenditure on vitamin A supplementation in the past 6 months divided by the total number of children who received supplementation in that period of time.
  
  \[ \text{Unit cost} = \frac{\text{total expenditure}}{\text{number of persons reached}} \]

- This approach requires accurate data on:
  - Expenditure
  - Number of persons covered

- Best suited for discrete programs (e.g. vitamin A supplementation) delivered on their own.

- It is more difficult to apply to integrated interventions.
Bottom-up method for estimating costs

• In the ingredients-based/bottom-up approach, you:
  • Identify all elements that are needed to deliver the intervention (e.g. inputs, labour, transportation, etc.) – the ingredients
  • Identify the quantities of those ingredients (e.g. 10g of zinc, 2 minutes of a nurse’s labour, etc.)
  • Identify the price of each ingredient
  • Multiply the quantity by price for all ingredients
  • Sum all of those together
    • Unit cost = sum price(i)*quantity(i)
Example: estimating the unit cost of Kangaroo mother care in Tanzania

• We have estimates on:
  • Midwives earn on average US$3,368 per annum.
  • In 2012, Tanzania had 0.428 nurses and midwives per 1000 people.
  • In 2017, Tanzania’s population was 55.57 million people; 2.11 million births.
  • 14% of national births are preterm
  • It costs US$390 to train a midwife (repeated every 5 years).

• Then we can estimate the average cost per preterm birth:
  • On average, delivering one birth requires ~60 minutes of midwife time.
  • This time would cost approximately $3,368 / (45 weeks * 5 days * 8 hours) = $1.87 per birth (i.e. per hour)
  • To incorporate the cost of training, every 5 years there are (5 years * 2.11 million births *14% preterm)/(0.428*0.05557 midwives) = 62 preterm births per midwife.
  • Therefore $390 / 62 preterm = $6.29 training costs per year
  • In total, $1.87 + $6.29 = $8.16 per preterm birth.
The cost of expanding the coverage of interventions may not be linear. It may depend on the existing coverage of the intervention.

- **Constant marginal costs** mean the cost of reaching one more person is always the same.

- **Increasing marginal costs** mean it becomes more expensive to reach an additional person as the intervention expands (e.g. a saturation effect).

- **Decreasing marginal costs** mean it becomes cheaper to reach an additional person as the intervention expands (e.g. an economy of scale effect).

- **U-shaped marginal costs** mean it becomes cheaper to reach an additional person initially, and then more expensive at higher coverage.
Cost-coverage curves

Optima allows users to specify the marginal cost assumption for each intervention.

- This defines a relationship between total spending on an intervention and the intervention coverage (number of people reached)

- Possible options include:
  - Constant marginal costs (red)
  - Increasing marginal costs (blue, current)
  - Decreasing marginal costs (green)
  - U-shaped (purple)

- Default curves are constant marginal costs
Optimization and the objective function

Day 2 – Session 4
Objectives of session

• The previous sessions have covered the model inputs, model structure and model outputs, including running scenario analyses using the graphical user interface.

• This session will cover how the model can be used for optimisation

• We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface

• At the end of this module and exercises you should be able to:
  • Understand how the choice of the objective function can produce different, and sometimes conflicting outcomes
  • Run optimisations with multiple objective functions to identify:
    • Which interventions regularly appear in the mix
    • Which interventions never do
  • Generate policy recommendations based on optimisation results
How the optimisation algorithm works

• When the model is run for a given amount of money spent on each intervention, it produces a collection of outcomes for:
  • Number of deaths
  • Number of stunted children leaving the model (i.e. turning age 5)
  • Stunting, wasting and anaemia prevalence among children at the end of the projection period
  • Anaemia prevalence among pregnant women and women of reproductive age
  • Number of maternal deaths

• When the model is run with a different allocation of funding, it will produce different set of outcomes.
The objective function

• To run an optimisation, we need to define an “**objective function**”

• An objective function takes some or all of the model outcomes and combines them into **a single number**

• For example, an objective function could be the total number of child deaths

• The optimisation can then iteratively shift funding around until it finds the allocation that produces the highest (or lowest) 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
Sample optimisation: minimise child mortality

Optimised spending allocations to minimise child mortality

Priority interventions in example simulation
- Vitamin A supplementation
- IPTp
- IFA supplementation (pregnant women)
- IFA fortification

With increasing budget:
- Treatment of SAM
- Zn + ORS
- Replace IFA supplementation with MMS

With increasing budget:
- Treatment of SAM
- Zn + ORS
- Replace IFA supplementation with MMS

Optimised spending allocation (US$) Millions

Total available budget (as a multiple of US$10M)

Zn + ORS for treatment
Vitamin A supplementation
Treatment of SAM
MMS
IPTp
IFA fortification: maize
IFA fortification: maize

Optima Nutrition
Sample optimisation: minimise anaemia

### Optimised spending allocations to minimise anaemia prevalence

*Among women of reproductive age and children*

<table>
<thead>
<tr>
<th>Optimised spending allocation (US$) Millions</th>
<th>Priority interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100</td>
<td>IFA supplementation (multiple modalities, pregnant / non-pregnant women)</td>
</tr>
<tr>
<td></td>
<td>Double fortification of salt</td>
</tr>
<tr>
<td></td>
<td>IFA fortification</td>
</tr>
<tr>
<td></td>
<td>With increasing budget:</td>
</tr>
<tr>
<td></td>
<td>LLINs</td>
</tr>
<tr>
<td></td>
<td>Micronutrient powders for children</td>
</tr>
<tr>
<td></td>
<td>With high budget:</td>
</tr>
<tr>
<td></td>
<td>Replace IFA supplementation with MMS for pregnant women</td>
</tr>
<tr>
<td></td>
<td>Lipid-based nutrition supplements</td>
</tr>
</tbody>
</table>

With increasing budget:
- LLINs
- Micronutrient powders for children

With high budget:
- Replace IFA supplementation with MMS for pregnant women
- Lipid-based nutrition supplements

---

**Sample optimisation:** minimise anaemia

**Total available budget (as a multiple of US$10M):**

- Iron and iodine fortification of salt
- IFA fortification: maize
- IFAS (pregnant women)
- IFAS (retailer)
- IFAS (school)
- IFAS (health facility)
- IFAS (community)
Sample optimisation: maximise alive and non-stunted children

Priority interventions in example simulation
Initially:
• Vitamin A supplementation
• IPTp (pregnant women)
• IFA supplementation (pregnant women)
Once these are adequately funded:
• IYCF
• Prophylactic zinc supplementation (for the prevention of diarrhoea)
How can Optima Nutrition help with programming choices

• 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, strategic objectives of the national nutrition and health plans and interventions can help define the outcomes that should matter.
  • The national strategic nutrition plan may prioritize stunting reduction over anaemia
How can Optima Nutrition help with programming choices

• Third, an objective can be created using combinations of outcomes:
  • Maximise alive, non-stunted, non-wasted and non-anaemic children
  • Minimise the sum of maternal and child deaths

• Fourth, it is recommended 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”?  

91
Exercises

• See worksheet
Optimization and the objective function (continued)

Day 3 – Session 1
Objectives of session

• In the previous session we covered how to run optimisations in the Optima Nutrition model, and how to interpret the outcomes

• In this session we will cover how to create more complex objective functions

• At the end of this module and the exercises that it includes you should be able to:
  • Understand what an objective function is
  • Define appropriate weightings for objective functions
  • Create weighted objective functions in the graphic user interface
Weighted objective functions

• It is possible to assign weights to particular outcomes
  • “Weights” are numbers that are used to assign a relative importance across each of the model outcomes
  • For example, we might care about stunting more than anaemia, so we could give stunting a larger weight

• In the model it is possible to minimise multiple outcomes. For example for some factors X and Y, minimise:
  \[ X \times \text{number of child deaths} + Y \times \text{number of stunted children} \]
Tanzania example, nutrition action plan

- If completely unsure about what is “best”, national nutrition strategies can provide some guidance.

- For example, Tanzania’s nutrition action plan includes:
  - Reduce stunting prevalence among children under 5 from 34% in 2015 to 28% in 2021
  - Reduce anaemia prevalence among children 6-59 months from 57% in 2015 to 50% in 2021
  - Maintain prevalence of wasting among children under 5 at < 5%

- This can help when choosing weights for outcomes
Tanzania example, nutrition action plan

• To come as close as possible to the targets, we need to be include relative weightings for stunted and anaemic children

• Suggestion:
  • NMNAP targets aim for approximately equal relative reductions in stunting and anaemia
  • In Tanzania, it costs 3.37 times as much to prevent a case of stunting than a case of anaemia (determined by use of the model)
  • Therefore, we want to use weightings so that a stunting case averted counts for 3.37 anaemia cases averted
  • Use an objective that is to maximise:
    \[ 3.37 \times \text{alive and non-stunted children} + \text{alive and non-anaemic children} \]

• BUT, wasting prevalence also has to remain below 5%. So we want to find a budget allocation that maximises:
  \[ 3.37 \times \text{alive and non-stunted children} + \text{alive and non-anaemic children} - 1,000,000,000 \text{ if wasting >5%} \]
Exercise

• See worksheet
Geospatial analysis

Day 3 – Session 2
Objectives of session

• The previous sessions have covered all of the essentials of a country level analysis using Optima Nutrition
• This session will cover how Optima Nutrition can be used for subnational analyses
• At the end of this module you should be able to:
  • Understand the need for geospatial analysis
  • Select an appropriate geographical resolution
  • Understand the different types of geospatial optimisations
  • Be able to perform geospatial and programmatic optimisations in the graphic user interface
Introducing the need for geospatial analysis

• The burden of malnutrition can vary significantly in different parts of a country

• 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 or resources

• Therefore, there is often a need to consider sub-national analyses
Defining the problem

- 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 geospatial analysis, all data that Optima Nutrition needs should be available for the geographies (e.g. all districts, all provinces) you want to consider

- 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? Is it the same for all regions?
For each region, an “investment staircase” can be produced
- This is the impact that can be achieved for a range of different funding

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 $10 million, $25 million, etc.

For each region, a budget-impact curve (right) can be constructed
- X-values are total amount available; Y-values are possible impact
Comparing budget-impact curves across regions

- When the budget-impact curves for each region are compared, we can see where the best value for money is.
- For example, 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.
**Example geospatial analysis**

**AIM 1:** Estimate the impact of programmatically optimising nutrition spending within 22 selected regions of Tanzania

**AIM 2:** Estimate the impact of an additional US$200 million investment in Nutrition in Tanzania (over the period 2019-2025), if optimised geographically across the 22 selected regions and programmatically within each region

The following scenarios were projected for the period 2019-2025:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total budget</th>
<th>Programmatic optimisation</th>
<th>Geographic allocation of additional funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Continued estimated 2017 spending</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1b</td>
<td>Continued estimated 2017 spending</td>
<td>Existing funding</td>
<td>--</td>
</tr>
<tr>
<td>2a</td>
<td>Continued estimated 2017 spending + US$33 million per annum</td>
<td>Only additional funding</td>
<td>Optimised across regions</td>
</tr>
<tr>
<td>2b</td>
<td>Continued estimated 2017 spending + US$33 million per annum</td>
<td>All funding (existing + additional)</td>
<td>Per capita</td>
</tr>
<tr>
<td>2c</td>
<td>Continued estimated 2017 spending + US$33 million per annum</td>
<td>All funding (existing + additional)</td>
<td>Optimised across regions</td>
</tr>
</tbody>
</table>
1a) Estimated 2017 spending

Projections:
2017 spending across the 22 regions was estimated at US$31 million per annum, based on intervention coverages and unit costs.

If continued between 2019-2025, this was estimated to lead to:
- 5,092,000 alive and healthy* children
- 1,064,000 child deaths
- 3,765,000 stunted children (29.6% under-5 prevalence)
- 51% under-5 anaemia prevalence
- 4.68% under-5 wasting prevalence

*Alive and non-stunted, non-wasted and non-anaemic children leaving the model 2019-2025
**Impact** (compared to continued 2017 spending, 2019-2025):

- 231,000 (5%) additional alive and healthy children
- 32,500 (3.1%) fewer child deaths
- 246,000 (6.5%) additional non-stunted children
- 11.1% relative reduction in under-5 stunting prevalence (from 29.6% to 26.3%)
- 3% relative reduction in under-5 anaemia prevalence (from 51% to 49%)
- 0.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.67%)

---

**Estimated 2017 funding allocation (million US$)**

- **Optimised for NMNAP**
2a) An additional US$33M per annum, distributed optimally across regions, only additional money programmatically optimised

**Impact** (compared to continued 2017 spending, 2019-2025):
- 484,000 (10%) additional alive and healthy children
- 67,900 (6.4%) fewer child deaths
- 311,000 (8.3%) additional non-stunted children
- 14.6% relative reduction in under-5 stunting prevalence (from 29.6% to 25.3%)
- 15% relative reduction in under-5 anaemia prevalence (from 51% to 43%)
- 1.1% relative reduction in under-5 wasting prevalence (from 4.68% to 4.63%)
2b) An additional US$33M per annum, distributed on a per capita basis, all money programatically optimised

**Impact (compared to continued 2017 spending, 2019-2025):**
- 657,000 (13%) additional alive and healthy children
- 75,700 (7.1%) fewer child deaths
- 321,000 (8.5%) additional non-stunted children
- 15.2% relative reduction in under-5 stunting prevalence (from 29.6% to 25.1%)
- 27% relative reduction in under-5 anaemia prevalence (from 51% to 37%)
- 1.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.62%)

**Estimated 2017 funding allocation (million US$)**

- Additional funding distributed per capita; all funding programatically optimised for NMNAP
2c) An additional US$33M per annum, distributed optimally across regions, all money programmatically optimised

**Impact** (compared to continued 2017 spending, 2019-2025):
- 663,000 (13%) additional alive and healthy children
- 81,000 (7.6%) fewer child deaths
- 322,000 (8.5%) additional non-stunted children
- 15.2% relative reduction in under-5 stunting prevalence (from 29.6% to 25.1%)
- 27% relative reduction in under-5 anaemia prevalence (from 51% to 37%)
- 1.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.62%)

Estimated 2017 funding allocation (million US$) Additional funding geographically optimised; all funding programmatically optimised for NMNAP
### Projected impact of scenarios (over 22 regions)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1b) Continued estimated 2017 spending</td>
<td>Existing funding</td>
<td>--</td>
<td>231,000 (5%)</td>
<td>246,000 (6.5%)</td>
<td>32,500 (3.1%)</td>
<td>Stunting 11.1% Wasting 0.3% Anemia 3%</td>
</tr>
<tr>
<td>2a) Continued estimated 2017 spending + US$33 million per annum</td>
<td>Only additional funding</td>
<td>Optimised across regions</td>
<td>484,000 (10%)</td>
<td>311,000 (8.3%)</td>
<td>67,900 (6.4%)</td>
<td>Stunting 14.6% Wasting 1.1% Anemia 15%</td>
</tr>
<tr>
<td>2b) Continued estimated 2017 spending + US$33 million per annum</td>
<td>All funding (existing + additional)</td>
<td>Per capita</td>
<td>657,000 (13%)</td>
<td>321,000 (8.5%)</td>
<td>75,700 (7.1%)</td>
<td>Stunting 15.2% Wasting 1.3% Anemia 27%</td>
</tr>
<tr>
<td>2c) Continued estimated 2017 spending + US$33 million per annum</td>
<td>All funding (existing + additional)</td>
<td>Optimised across regions</td>
<td>663,000 (13%)</td>
<td>322,000 (8.5%)</td>
<td>81,000 (7.6%)</td>
<td>Stunting 15.2% Wasting 1.3% Anemia 27%</td>
</tr>
</tbody>
</table>

*Additional alive and non-stunted, non-wasted and non-anaemic children leaving the model 2019-2025, compared to a scenario of continued estimated 2017 spending*
Summary of analysis

- Vitamin A supplementation, IYCF and micronutrient powders were the highest impact interventions for achieving the NMNAP targets

- Relatively large gains may be possible by optimising existing funding
  - For most regions, existing funding volumes were sufficient to scale up the highest impact interventions

- Additional funding should be allocated to ensure that Vitamin A supplementation, IYCF and micronutrient powders interventions have high coverage in all regions

- The optimal distribution of additional funding was similar to the per capita distribution
  - Adequate coverage of the three highest impact interventions in all regions was a greater priority than incremental gains from geographical funding allocations
Geospatial analysis in the GUI
Integration of findings to respective national/provincial policies/strategies/programs

Day 3 – Session 3