Ecosystem services to alleviate iodine, selenium and zinc malnutrition in sub-Saharan Africa

Health economic analyses

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Structure
- Ecosystem services
- Nutritional deficiencies
- Health outcomes
- Comparison of outcomes
- Global dimensions
- Socio-economic impacts
- Impact of interventions
- Cost-effectiveness of interventions

Ecosystem services and valuations
- Soil formation (incl. release of minerals from rock)
- Nutrient cycling (incl. trace elements)
- Provision of renewable resources (incl. food)
- Valuation according to market values
- Valuation based on indirect market values (e.g. replacement cost, travel cost, hedonic pricing)
- Contingent valuation (e.g. hypothetical questions, willingness to pay)

Mineral deficiencies

Number of people affected (billion)

- Hunger
- Iodine deficiency
- Zinc deficiency
- Iron deficiency
- Selenium deficiency

Difference in estimates

> + vitamin deficiencies = multiple deficiencies
Health outcomes
- Maternal mortality, cognitive impairment, fatigue,
  child mortality, pneumonia, diarrhoea, stunting,
  goitre, cretinism, heart diseases, etc.
- Health outcomes of mineral deficiencies not uniform
- They affect different target groups
- They impose different levels of suffering
- Magnitudes of some outcomes are intuitive,
  but impact of others difficult to grasp

Burden of disease
- The deficiency that affects most people (incidence)
  is not necessarily the one representing the biggest
  overall health loss
- How to measure loss of health consistently?
- World Bank and WHO introduced
  “disability-adjusted life years” (DALYs)
- Single index taking into account the duration
  and severity of each health outcome

Burden of disease
- Severity is captured through a “disability-weight”
  ranging from 0% (no health loss) to 100% (death)
- No measurement of the intrinsic value of life but
  measurement of loss of functioning
- Loss is expressed in the number of DALYs
- Adding up DALYs gives the “burden of disease”
  - Premature death is counted in “Years of Life Lost” (YLL)
  - Morbidity in “Years Lived with Disability” (YLD)

Burden of disease
- Burden = $\text{DALYs}_{\text{lost}} = \text{YLL} + \text{YLD}_{\text{weighted}}$
- More formally:
  \[
  \text{DALYs}_{\text{lost}} = \sum_j T_j M_j \left( \frac{1 - e^{-r L_j}}{r} \right) + \sum_j \sum_i T_j I_j D_i \left( \frac{1 - e^{-r d_i}}{r} \right)
  \]
  \[
  T_j = \text{total number of people in target group } j
  M_j = \text{mortality rate associated with the condition in target group } j
  L_j = \text{average remaining life expectancy for target group } j
  I_j = \text{incidence rate of condition } i \text{ in target group } j
  D_i = \text{disability weight for condition } i \text{ in target group } j
  d_i = \text{duration of the condition } i \text{ in target group } j
  r = \text{discount rate for future life years}
Burden of disease

- Ranking of major health risks (WHO 2002)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>DALYs Lost %</th>
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<tbody>
<tr>
<td>Underweight</td>
<td>10%</td>
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<tr>
<td>Unsafe sex</td>
<td>6%</td>
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<tr>
<td>Blood pressure</td>
<td></td>
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<tr>
<td>Tobacco</td>
<td></td>
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<tr>
<td>Alcohol</td>
<td></td>
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<tr>
<td>Lack of sanitation</td>
<td></td>
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<tr>
<td>Cholesterol</td>
<td></td>
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<tr>
<td>Indoor smoke</td>
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<tr>
<td>Iron deficiency</td>
<td></td>
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<tr>
<td>Overweight</td>
<td></td>
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<tr>
<td>Zinc deficiency</td>
<td></td>
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<tr>
<td>Little fruit &amp; veggies</td>
<td></td>
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<tr>
<td>Vitamin A deficiency</td>
<td></td>
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<tr>
<td>Physical inactivity</td>
<td></td>
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<tr>
<td>Risks for injury</td>
<td></td>
</tr>
</tbody>
</table>

Socio-economic impacts

- Malnutrition imposes economic costs by hampering individual productivity and overall economic growth
- There is a purely economic rationale for fighting it
- The malnutrition-poverty trap:
- Similar relationship at the national level...

Impact of interventions

- Different micronutrient interventions are available
- Calculating their impact in the DALYs framework:

\[
DALYs_{intervention} = \sum_j T M_j \left( 1 - \frac{e^{-\lambda_j}}{r} \right) + \sum_j \sum_i T I_j D_i \left( 1 - \frac{e^{-\lambda_i}}{r} \right)
\]
Impact of interventions

Impact of fertilisation = DALYs lost in status quo minus DALYs lost in a “with fertilisation” scenario

Impact can be expressed in indicators like
- percent reduction of the burden of mineral deficiencies
- number of DALYs saved per 1m population

The direct benefit of fertilisation consists in the averted health loss (i.e. the DALYs saved)

Cost-effectiveness of interventions

- Impact alone is a bad guide for policy making!
- Alternatives may use resources more efficiently
- If they save more DALYs with given funds they give “more bang for the buck”
- Or they may save as many DALYs but use less funds, thus leaving resources for other interventions
- Implementing the most cost-effective interventions first ensures the biggest overall public health gain
Cost-effectiveness of interventions

- Total costs and DALYs saved can be juxtaposed
- The result is a metric for cost-effectiveness: “Dollars per DALY”
- The more it costs to save a DALY, the less favourable the intervention from an economic point of view
- This metric allows to compare and rank different interventions in the field of public health and beyond

Biofortification (BF) of rice and wheat in India

- Fe = 20-60% lower burden (1-2m DALYs saved), 50¢ to $5.40 per DALY saved
- Zn = 20-50% lower burden (0.5-1.5m DALYs saved), 70¢ to $7.30 per DALY saved

World Bank threshold for cost-effectiveness: $200 per DALY saved
Others use a country’s per capita income or proxies like $1,000 per DALY saved

Questions

- Coverage and targeting of fertiliser?
- Consumption of fertilised crops by target group?
- Link between mineral fertilisation, crop mineral content and human mineral intake?
- Cost of the fertiliser? Timeframe?
- All data and statistics available for calculation?

Thank you very much for your attention!

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