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

Health economic analyses

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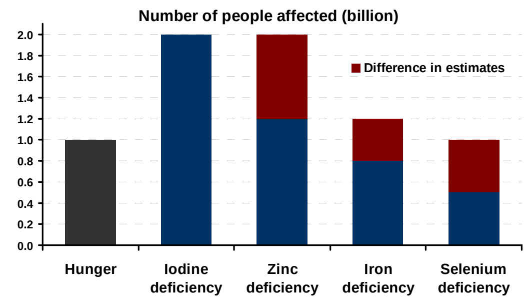
Structure

- 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



- + 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

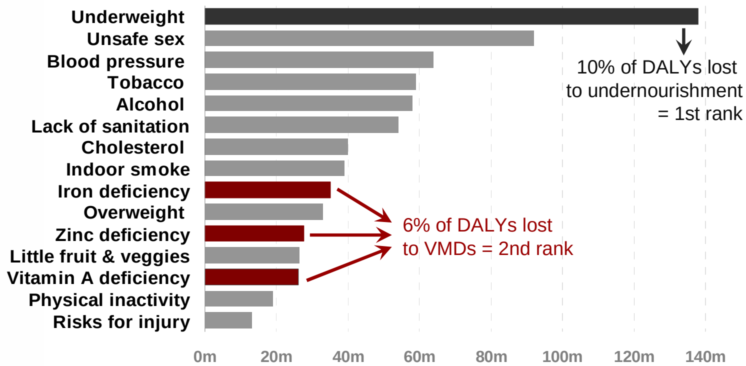
- Burden = $DALYs_{\mathbf{lost}}$ = YLL + $YLD_{\mathbf{weighted}}$
- More formally:

$$DALYs_{lost} = \sum_j T_j M_{ij}\left(\frac{1-e^{-rL_j}}{r}\right) + \sum_i \sum_j T_j I_{ij} D_{ij}\left(\frac{1-e^{-rd_{ij}}}{r}\right)$$

T_j = total number of people in target group *j*
M_j = mortality rate associated with the condition in target group *j*
L_j = average remaining life expectancy for target group *j*
I_{ij} = incidence rate of condition *i* in target group *j*
D_{ij} = disability weight for condition *i* in target group *j*
d_{ij} = duration of the condition *i* in target group *j*
r = discount rate for future life years

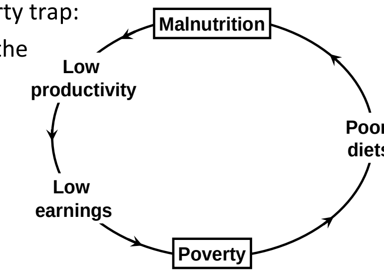
Burden of disease

- Ranking of major health risks (WHO 2002)



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…



Socio-economic impacts

- Mineral deficiencies also affect cognitive abilities, hence they even reduce *future* productivity
- Babies of malnourished mothers are more sickly later on in life, which again affects future productivity
- Fogel (2004): 30% of UK's per capita income growth over the last 200 years due to better nutrition
- Other estimates indicate annual losses of 2-5% of GDP due to micronutrient deficiencies
- Farther reaching effects (MDGs: education, gender, …)

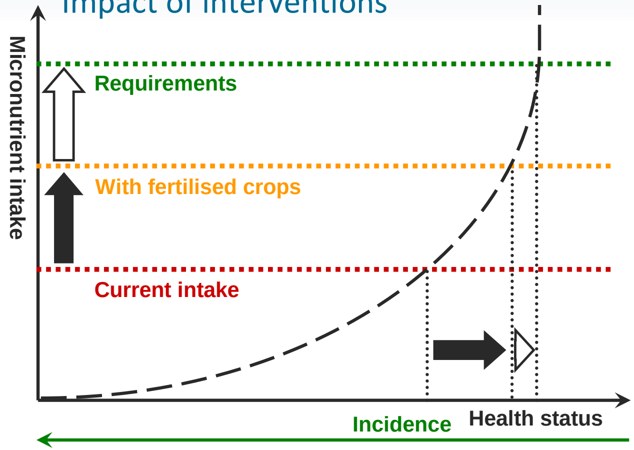
Impact of interventions

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

$$DALYs_{lost} = \sum_j T_j M_{ij} \left(\frac{1-e^{-rL_j}}{r} \right) + \sum_i \sum_j T_j I_{ij} D_{ij} \left(\frac{1-e^{-rd_{ij}}}{r} \right)$$

- How to get from fertilisers to incidence rates?

Impact of interventions



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

- Impact (effectiveness) can be quantified with DALYs
- For the costs all the resources used to achieve the impact have to be expressed in monetary terms
  - start-up costs (new formula and production process)
  - share of inputs (incl. labour and depreciation)
  - overheads, monitoring, marketing, etc.
  - subsidies or price premiums
  - etc.

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

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Cost-effectiveness of interventions

- 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

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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?

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Thank you very much

for your attention!

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