IPI-OUAT-IPNI
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Global impacts of *human* mineral malnutrition

Alexander J. Stein, *University of Hohenheim, Stuttgart, Germany*

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This presentation was made at the IPI-OUAT-IPNI International Symposium, 5-7 November 2009, OUAT, Bhubaneswar, Orissa, India. The Role and Benefits of Potassium in Improving Nutrient Management for Food Production, Quality and Reduced Environmental Damage.

The difference between a manager and an office boy is iodine

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Structure

- Introduction
- Impacts of mineral malnutrition
  - Health consequences
  - Burden of disease
  - Socio-economic impacts
- Causes and determinants of malnutrition
- Interventions against mineral malnutrition
- Conclusions

Introduction

- FAO (2009): 1,020,000,000 are hungry

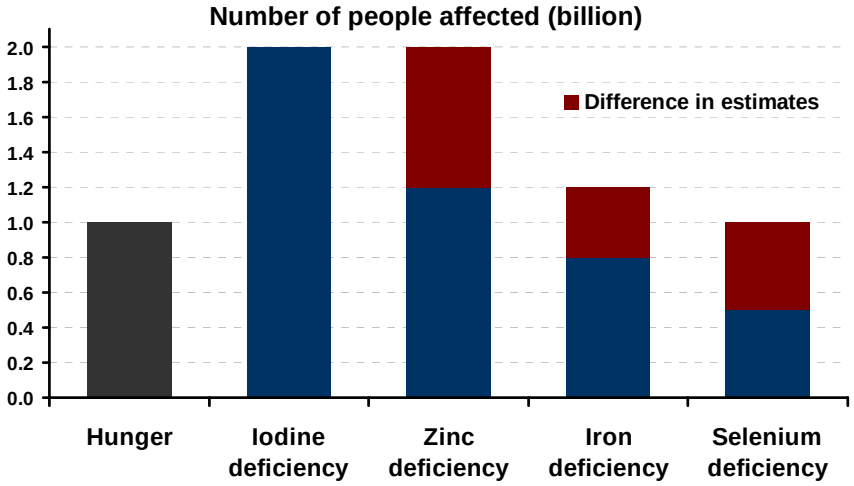
Introduction

- Increasingly also “hidden hunger” falls under the definition of malnutrition
- Chronic lack of vitamins & minerals
- “Hidden" because people feel not hungry; often no immediately visible signs of it
- Global **impacts of mineral deficiencies in humans** are subject of this presentation

Impacts of mineral malnutrition

- 20+ dietary minerals & trace elements essential for proper functioning of body
- Most are abundant in food or are only needed in very small amounts
- But for some minerals deficiencies occur:
  - globally: iron (*Fe*), zinc (*Zn*) and iodine (*I*)
  - regionally: calcium (*Ca*) and selenium (*Se*)
  - less: magnesium (*Mg*) and copper (*Cu*)

Impacts of mineral malnutrition



+ vitamin deficiencies = multiple deficiencies

Health consequences

- Iron deficiency leads to anaemia and
  - higher maternal mortality
  - lower mental development in children
  - impaired physical activity and fatigue
- Zinc def. in infants & children contributes to
  - under-five mortality
  - pneumonia & diarrhoea
  - stunting

Health consequences

- Iodine deficiency causes goiter and mental retardation & cretinism
- Calcium deficiency causes bone problems (especially rickets in children) and may aggravate certain chronic diseases
- Selenium deficiency is associated with a heart disease that is often fatal (Keshan) and it increases a number of other health risks

Health consequences

➔ Impact of mineral deficiencies **not uniform**:

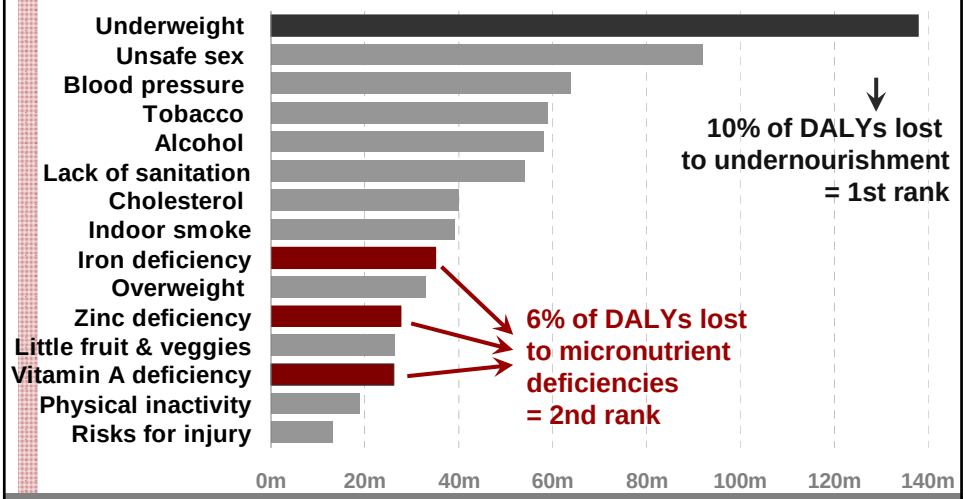
- They affect different functional outcomes, hit different target groups and impose different levels of suffering
- Magnitude of some health consequences intuitive, but impact of others difficult to grasp
- The deficiency that affects most people is not necessarily the one representing the biggest overall health loss

Burden of disease

- How to **measure "health loss"** consistently?
- World Bank and WHO introduced "disability-adjusted life years" (DALYs)
- Single index taking into account the duration and severity of each health outcome
- Severity captured through a disability-weight ranging from 0 (no health loss) to 1 (death)
- Adding up DALYs gives "burden" of disease

Burden of disease

- Ranking of major health risks (WHO 2002)



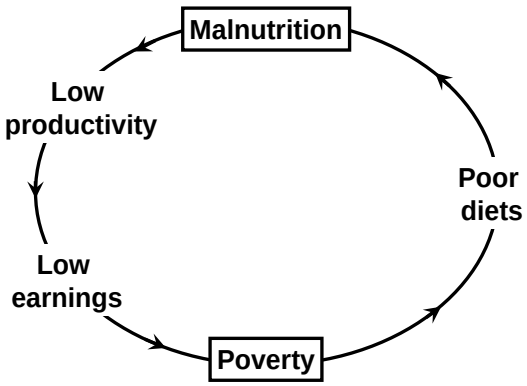
Socio-economic impact

- Mineral deficiencies affect billions of people, cause ill health and suffering, and contribute to the global burden of disease
- They also impose tangible economic costs by hampering both individual productivity and overall economic growth

➔ Apart from a moral obligation, there is a purely **economic rationale** for fighting them

Socio-economic impact

- Controlling malnutrition (incl. mineral def.) helps break the malnutrition-poverty trap



Socio-economic impact

- In the aggregate the mechanism is similar:
  - Malnutrition reduces overall productivity, economic growth and national income
  - This keeps labor demand down, suppresses wages and thus perpetuates poverty...
  - ... and it limits public resources that can be used for nutrition and health interventions

Socio-economic impact

- Mineral deficiencies affect cognitive abilities, hence they even reduce *future* productivity by lowering the success of schooling
- Malnourished mothers have smaller babies that are more sickly later on in life, thus again reducing future productivity

➔ Mineral malnutrition not only affects health but also economic outcomes in many ways

Socio-economic impact

- Fogel (2004): **30%** of growth in British per capita income **over the last 200 years** due to better nutrition (incl. vitamins & minerals)
- World Bank (1994): deficiencies of vitamin A (VA), iodine & iron can cost up to **5%** of GDP
- Horton & Ross (2003): iron deficiency costs developing countries **4%** of GDP
- MI/UNICEF (2004): Fe, I, VA & folate deficiency can cost over **2%** of GDP

Socio-economic impact

- However, economic growth and a higher GDP are no ends in themselves
- Ultimate goal is human happiness & development (Millennium Development Goals)

➔ Less hunger, less poverty, more education, more gender equality, less mortality, more health, more environmental sustainability, more participation – **minerals help!**

Causes of malnutrition

- No **availability** of (mineral-rich) food: disasters, shortages, seasonality
- Lack of **access** to food & health care:
  - poverty trap = low food intakes
  - intra-household distribution (individual level)
  - poverty = monotonous, mineral-poor diets

Causes of malnutrition

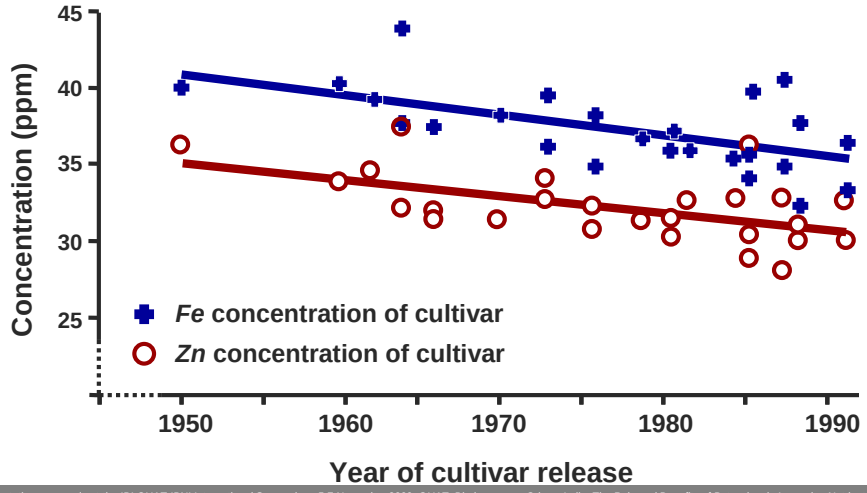
- Poor **utilisation** of available food:
  - low bioavailability of minerals (monotonous, cereal-based diets)
  - mineral content irrelevant for people's food preferences (even if affordable)
  - poor food choices result of lack of nutrition knowledge
- **Loss** of nutrients due to disease, e.g. diarrhoea or bleeding

Causes of malnutrition

- Low **mineral content** in staple crops:
  - cultivation on mineral deficient soils
  - depletion of soils through higher crop production per unit area
  - increased yields in cultivars associated with reduced mineral concentrations in crops

Causes of malnutrition

Wheat cultivars released by CIMMYT from 1950 to 1992 (Monasterio & Graham 2000)



Micronutrient interventions

- Various control interventions:
  1. supplementation (e.g. iron pills)
  2. fortification (more in the following)
  3. dietary diversification (production & promotion of mineral-rich crops)

  + complementary interventions (infant feeding, nutrition education, public health, WASH, poverty reduction)

Micronutrient interventions

- Toolbox of interventions with different strengths and weaknesses:
  - time horizon
  - dose adjustment
  - infrastructure needs
  - resource use
  - cooperation of beneficiaries
  - long-term sustainability, etc.

Micronutrient interventions

- What is the role of agriculture?
- Provision of (wholesome) food is the key function of agriculture
- So far food was fortified industrially, i.e. during food processing (e.g. salt with iodine, flour with iron, juices with vitamins, etc.)
- Since a few years interest in agricultural approaches (breeding for higher micronutrient content or fertilisation)

Micronutrient interventions

- **Biofortification** (breeding)
  - target populations eat plenty of staple crops, i.e. biofortification is self-targeting
  - poor & rural populations difficult to reach otherwise (eat little processed food)
  - economies of scale: once developed, germ-plasm can be shared & seeds can be saved
  - mineral biofortification my be synergetic by improving plant vigour in parallel

Micronutrient interventions

- Feeding trials & sensory analyses promising
- Ex-ante analyses support potential impact:
  - *Fe* biofortified rice & wheat could reduce **20-60%** of the Indian burden of iron def. and save **1-2m DALYs** (Stein et al. 2008)
  - *Zn* biofortified rice & wheat could reduce **20-50%** of the Indian burden of zinc def. and save **0.5-1.5m DALYs** (Stein et al. 2007)

Micronutrient interventions

- The analyses also show cost-effectiveness:
  - *Fe* biofortification of rice & wheat in India may cost **50¢ to $5.40 per DALY** saved
  - *Zn* biofortification of rice & wheat in India may cost **70¢ to $7.30 per DALY** saved
  - A threshold for cost-effective interventions used by the World Bank is $200 per DALY
  - Others use a country's per capita income or proxies like $1,000 per DALY

Micronutrient interventions

- **Mineral fertilisation** (agronomic biofort.):
  - + targeting of staple crops also possible
  - - access for poor farmers & in remote areas? (fertiliser subsidies & infrastructure develop't)
  - - no economies of scale as fertiliser needs to be applied regularly
  - + synergetic by improving plant nutrition
  - + where infrastructure quick impact possible
  - - no impact or cost-effectiveness studies yet

Micronutrient interventions

- Biofortification projects:
  HarvestPlus, Golden Rice, BioCassava Plus, African Biofortified Sorghum, BAGELS, HarvestZinc, INSTAPA, smaller projects
- Target crops:
  rice, wheat, maize, millet, sorghum, cassava, sweet potato, beans, bananas, vegetables

Target minerals:
iron, zinc, selenium, calcium, magnesium

Micronutrient interventions

- Adoption by farmers?
  - Agronomic properties (yield, drought, pests ...)
  - Locally adapted varieties, planting material
  - Income generation (market acceptance, price)
- Acceptance by consumers?
  - No price premium
  - Similar taste, consistency, storability, ...

➔ Collaboration, participation, education, etc.

Conclusions

- Mineral malnutrition has big negative impact
- One direct cause are insufficient intakes
- Currently minerals are **added** to food and in the form of medicine
- Wholesome food should already **contain** them – this is a challenge for agriculture

➔ Agricultural approaches to combat mineral malnutrition are very promising

Good health should come from the farm, not the pharmacy or the factory

Thank you very much for your attention!

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