Evidence-based technology management in global health

Lessons from the global, national, and sub-national analyses of risk factors

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Presentation outline

• Comparative Risk Assessment study
• Integrated analysis of the poverty, nutrition, environment, and child survival MDGs
• Application of risk assessment to household energy and health interventions in Africa

Risk factors in the CRA project

<table>
<thead>
<tr>
<th>Child &amp; maternal undernutrition</th>
<th>Sexual and reproductive health risks</th>
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<tbody>
<tr>
<td>Child and maternal underweight</td>
<td>Unsafe sex</td>
</tr>
<tr>
<td>Iron deficiency anaemia</td>
<td>Non-use and ineffective use of contraception</td>
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<tr>
<td>Zinc deficiency</td>
<td>(unwanted pregnancy)</td>
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<td>Suboptimal breastfeeding *</td>
<td>Environmental risks</td>
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<tr>
<td>Term IUGR *</td>
<td>Unsafe water, sanitation, and hygiene</td>
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<tr>
<td>Metabolic, nutritional and lifestyle risks for chronic diseases</td>
<td>Urban air pollution</td>
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<tr>
<td>High blood pressure</td>
<td>Indoor smoke from household solid fuel use</td>
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<tr>
<td>High cholesterol</td>
<td>Lead exposure</td>
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<tr>
<td>High blood glucose *</td>
<td>Global climate change</td>
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<tr>
<td>Overweight and obesity</td>
<td>Occupational risks</td>
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<tr>
<td>Inadequate fruit and vegetable intake</td>
<td>Risk factors for injury</td>
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<tr>
<td>Physical inactivity</td>
<td>Carcinogens</td>
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<tr>
<td>Addictive substances</td>
<td>Airborne particulates</td>
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<tr>
<td>Smoking and oral tobacco use</td>
<td>Ergonomic stressors</td>
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<tr>
<td>Alcohol use</td>
<td>Noise</td>
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<tr>
<td>Nicot drug use</td>
<td>Other selected risks to health</td>
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<tr>
<td>* Subsequent analysis</td>
<td>Contaminated health care injections</td>
</tr>
<tr>
<td></td>
<td>Child sexual abuse</td>
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</tbody>
</table>

Mortality attributable to leading risk factors in the year 2000

- High blood pressure
- Tobacco
- High cholesterol
- Underweight
- Unsafe sex
- Non-use and ineffective use of contraception
- Indoor smoke from household solid fuel use
- Lead exposure
- Global climate change
- Occupational risks
- Risk factors for injury
- Carcinogens
- Airborne particulates
- Ergonomic stressors
- Noise
- Other selected risks to health
- Contaminated health care injections
- Child sexual abuse

Ezzati et al, Lancet 2002
Burden of disease from leading risk factors in the year 2000

- Underweight
- Unsafe sex
- High blood pressure
- Tobacco
- Alcohol
- Unsafe water, sanitation, and hygiene
- High cholesterol
- Indoor smoke from solid fuels
- Iron deficiency
- Overweight and obesity
- Zinc deficiency
- Low fruit and vegetable intake
- Vitamin A deficiency
- Physical inactivity
- Lead exposure
- Illicit drugs
- Occupational risk factors for injury
- Contaminated health care injections
- Lack of contraception
- Childhood sexual abuse

DALYs (% of global DALYs - Total 1.46 billion)

Reanalysis of child and maternal undernutrition risks

Leading risk factors in high-mortality developing regions

- Underweight
- Unsafe sex
- Unsafe water, sanitation, and hygiene
- Indoor smoke from solid fuels
- Zinc deficiency
- Iron deficiency
- Vitamin A deficiency
- High blood pressure
- Tobacco
- High cholesterol

Leading risk factors in demographically developed regions

- Tobacco
- High blood pressure
- Alcohol
- High cholesterol
- Overweight and obesity
- Inadequate fruit and vegetable intake
- Physical inactivity
- Illicit drugs
- Unsafe sex
- Iron deficiency

Leading risk factors in lower-mortality developing regions

- Alcohol
- High blood pressure
- Tobacco
- Underweight
- Overweight and obesity
- High cholesterol
- Inadequate fruit and vegetable intake
- Indoor smoke from solid fuels
- Iron deficiency
- Unsafe water, sanitation, and hygiene

Diseases and multiple risk factors

- Mortality and morbidity can be attributed to
  - disease or injury outcomes
  - risk factors

- Underweight 52%
- Zinc deficiency 20%
- Poverty, low education, etc.
- Indoor air pollution 46%
- 2 million child pneumonia deaths
Summary findings from the CRA study

- Substantial disease burden from risk factors like undernutrition, poor water and sanitation, and indoor air pollution remains in the poorest developing countries
- Simultaneously risks from a number of factors such as adult chronic diseases are present globally
- Effects quantified by region, age, and gender for individual as well as clusters of risk factors
- Initial (cross-sectional) step in decoupling of the epidemiological and nutritional transitions based on multiple risk factors

BMI in relation to national income

Metabolic risks in relation to national income

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Poverty, nutrition, environment, and child survival MDGs

- Proportion of population below $1 (PPP) per day
- Poverty gap ratio [incidence x depth of poverty]
- Share of poorest quintile in national consumption

Burden of disease from leading risk factors

- Underweight
- Unsafe sex
- High blood pressure
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- Alcohol
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Research questions for MDG-related interventions

- How much would interventions related to the nutritional and environmental MDGs help achieve the child mortality MDG?
- How do these benefits vary based on the poverty status of the recipients?
- What are the effects on disparities in child mortality?

Data sources

- Demographic and Health surveys for 42 countries in three regions
  - Latin America and the Caribbean, LAC (59% of regional population)
  - South Asia, SA (96%)
  - sub-Saharan Africa, SSA (83%)
- Comparable measurement of household economic status
- Risk factor exposure by economic status
- Association of child mortality with economic status
- WHO and CHERG child mortality databases used for total and disease-specific child deaths by country
  - Vital statistics
  - Sample registration
  - Population- and community-level demographic and epidemiological studies and models
- Systematic reviews and meta-analyses of epidemiological studies from the CRA project for risk factor effect sizes
Risk factor exposure by quintiles of economic status (sub-Saharan Africa)

- Underweight
- Water and sanitation (risk of fecal oral transmission)
- Fuel use

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very high</th>
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<tbody>
<tr>
<td>SD</td>
<td>0%</td>
<td>20%</td>
<td>40%</td>
<td>60%</td>
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Poorest Q2 Q3 Q4 Wealthiest

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Risk factor intervention scenarios

- Equal implementation
  - Complete coverage of interventions for nutritional and environmental risks (Equal-100)
  - 50% coverage of interventions for nutritional and environmental risks in every wealth quintile (Equal-50)
- Differential implementation
  - 50% coverage of interventions for nutritional and environmental risks, first reaching the poor (Pro-poor)
  - 50% intervention on nutritional and environmental risks, first reaching the better-off (Pro-wealthy)
- Estimate the reduction in child mortality (by economic status, country, and disease) using the CRA analytics
  - Account for multi-causality and mediated effects

Child mortality before and after intervention by wealth quintile (sub-Saharan Africa)

- Current mortality
- Equal-100
- Equal-50

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Summary and conclusions

- Complete coverage of interventions for environment and nutrition MDGs would save an estimated 49,700 (14% of all child deaths) child deaths in LAC, 0.80 million (24%) in SA, and 1.47 million (31%) in SSA.
- These figures are equivalent to 30-48% of the current regional gaps towards the MDG target on reducing child mortality.
- 50% coverage of interventions would reduce 30-75% more child deaths if they target the poor than if they reached better-off households who nonetheless are in need of interventions.
- MDG policies, monitoring and evaluation should be based on packages of interventions, and explicitly address the poverty status of the recipient households / communities.

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Household solid fuel use by country

Multiple purposes of household solid fuel use: cooking, heating, food drying, etc.

Solid fuels and indoor air pollution
Burden of disease from leading risk factors

Mortality effects of indoor air pollution by age, gender, and (established) disease

Household economic status and fuel use

Policy interest in indoor air pollution

Africa integrated assessment of energy, the environment, and health research overview

Attributable and avoidable disease burden
Key drivers of avoidable burden

- “Business-as-usual” trajectory of exposure
- Business-as-usual trends for disease outcomes (WHO projections)
  - Demographic change
  - “Secular” changes in disease epidemiology
- Reversibility of proportional risk over time after exposure is removed (instantaneous or gradual)

Future fuel use in Africa (business-as-usual)

Future fuel use in Africa (energy transitions)

Mortality impacts of business-as-usual fuel use

Mortality impacts of fuel use scenarios
Summary and policy implications of findings

- Petroleum fuels provide larger health benefits than charcoal
- “Early action” on fuel shift will have health benefits above and beyond the number of households receiving clean fuels
- However, scaling-up petroleum rapidly not a feasible option in sub-Saharan Africa (economics and infrastructure)
- Sustainable biomass management (tree replacement and high-efficiency charcoal production) can have significant health benefits in near future, with limited additional greenhouse gas emissions
- Need to consider other biofuels and local feasibility

Evidence-based technology management in global health

- The need, and the opportunity, for analytical and empirical research, and for policy translation
- “Meta-analyses” of vast existing data
- Field data collection and basic research on risk factor exposure, effects, and interventions
- Intervention design, testing, and population level effect modeling
- Theoretical and empirical social science on scaling up known or new interventions, and evaluation of community effectiveness

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- Comparative risk assessment project: S Vander Hoorn, A Lopez, A Rodgers, C Murray, and CRA collaborating group
- Reanalysis of child and maternal undernutrition risks: R Black, L Allen, Z Bhutta, L Caulfield, M de Onis, C Mathers, J Rivera, and Maternal and Child Undernutrition Study Group
- Integrated analysis of the poverty, environment, nutrition, and child survival MDGs: E Gakidou, S Oza, C Vidal Fuertes, A Li, D K Lee, A Sousa, M Hogan, and S Vander Hoorn
- Integrated analysis of energy and health in Africa: R Bailis and D Kammen