Global burden of disease study: Past, present, and future

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May 1, 2016
Outline

1) Study goals
2) GBD study overview
3) Key results from GBD 2013
4) Some debates
5) GBD 2015 main innovations
6) New analytical directions
Global Burden of Disease Study Goals

1. Provide valid, reliable, timely and local assessments of the state of health and trends of all populations in the world at national or subnational level.

2. Communicate effectively these results to the scientific community, health decision-makers, the media, and the public.
Global Burden of Disease Study Goals

To achieve these goals, we need to

1. Identify, access and analyze the world’s data on health
2. Use the best methods and where needed innovate the methods used to synthesize and analyze health data
3. Create a vibrant global collaboration to tap into expertise relevant to the GBD around the world.
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Global Burden of Disease

1. A **systematic, scientific** effort to quantify the **comparative** magnitude of **health loss** from all major diseases, injuries, and risk factors by age, sex, and population and over time.

2. 195 countries and territories from 1990 to present. Sub-national assessments for some countries (e.g. **China, Mexico, UK, US, Brazil, Japan, India, Saudi Arabia, Kenya, South Africa**)

3. 306 diseases and injuries, 2,337 sequelae, 79 risk factors or clusters of risk factors.

4. Updated annually; release planned for September each year.

A global study with a global network of investigators: 1,656 investigators, 119 countries
Multiple metrics for health

1. **Traditional metrics**: Disease and injury prevalence and incidence, death numbers and rates.

2. **Years of life lost** due to premature mortality (YLLs) – count the number of years lost at each age compared to a reference life expectancy of 86 at birth.

3. **Years lived with disability** (YLDs) for a cause in an age-sex group equals the prevalence of the condition times the disability weight for that condition.

4. **Disability-adjusted life years (DALYs)** are the sum of YLLs and YLDs and are an overall metric of the burden of disease.

5. **Healthy life expectancy (HALE)** is a positive summary measure counting the expected years of life in full health.
Some core GBD methods

1. Cause of death garbage code analysis – redistribution of causes that cannot be underlying cause of death.

2. Cause of death ensemble modeling (CODEm)


4. Comorbidity microsimulation to estimate co-occurrence of multiple sequelae.

5. Joint risk factor analysis
## Risk hierarchy

<table>
<thead>
<tr>
<th>Behavioral</th>
<th>Environmental/Occupational</th>
<th>Metabolic</th>
</tr>
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<tbody>
<tr>
<td>Child and maternal malnutrition</td>
<td>Unsafe water, sanitation and handwashing</td>
<td>High fasting plasma glucose</td>
</tr>
<tr>
<td>Suboptimal breastfeeding</td>
<td>Unsafe water source</td>
<td>High total cholesterol</td>
</tr>
<tr>
<td>Childhood undernutrition</td>
<td>Unsafe sanitation</td>
<td>High blood pressure</td>
</tr>
<tr>
<td>Iron deficiency</td>
<td>No handwashing with soap</td>
<td>High body-mass index</td>
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<tr>
<td>Vitamin A deficiency</td>
<td>Air pollution</td>
<td>Low bone-mineral density</td>
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<tr>
<td>Zinc deficiency</td>
<td>Ambient particulate matter pollution</td>
<td>Low glomerular filtration rate</td>
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<tr>
<td><strong>Tobacco smoke</strong></td>
<td>Household air pollution from solid fuels</td>
<td></td>
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<tr>
<td>Smoking</td>
<td>Ambient ozone pollution</td>
<td></td>
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<tr>
<td>Second-hand smoke</td>
<td>Other environmental risks</td>
<td></td>
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<tr>
<td><strong>Alcohol and drug use</strong></td>
<td>Residential radon</td>
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<tr>
<td>Alcohol use</td>
<td>Lead exposure</td>
<td></td>
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<tr>
<td>Drug use</td>
<td><strong>Occupational risks</strong></td>
<td></td>
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<tr>
<td><strong>Dietary risks</strong></td>
<td>Occupational carcinogens</td>
<td></td>
</tr>
<tr>
<td>Diet low in fruits</td>
<td>Occupational asthmagens</td>
<td></td>
</tr>
<tr>
<td>Diet low in vegetables</td>
<td>Occupational particulate matter, gases, and fumes</td>
<td></td>
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<tr>
<td>Diet low in whole grains</td>
<td>Occupational noise</td>
<td></td>
</tr>
<tr>
<td>Diet low in nuts and seeds</td>
<td>Occupational injuries</td>
<td></td>
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<tr>
<td>Diet low in milk</td>
<td>Occupational ergonomic factors</td>
<td></td>
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<tr>
<td>Diet high in red meat</td>
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<td></td>
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<tr>
<td>Diet high in processed meat</td>
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<tr>
<td>Diet high in sugar-sweetened beverages</td>
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<tr>
<td>Diet low in fiber</td>
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<tr>
<td>Diet suboptimal in calcium</td>
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<tr>
<td>Diet low in seafood omega-3 fatty acids</td>
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<tr>
<td>Diet low in polyunsaturated fatty acids</td>
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<tr>
<td>Diet high in trans fatty acids</td>
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<td></td>
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<tr>
<td>Diet high in sodium</td>
<td></td>
<td></td>
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<tr>
<td>Low physical activity</td>
<td></td>
<td></td>
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<tr>
<td>Sexual abuse and violence</td>
<td></td>
<td></td>
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<tr>
<td>Childhood sexual abuse</td>
<td></td>
<td></td>
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<tr>
<td>Intimate partner violence</td>
<td></td>
<td></td>
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<tr>
<td>Unsafe sex</td>
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On-line catalog with metadata on 50,000+ GBD sources
Some GBD 2013 publications

Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013

Global Burden of Disease Study 2013 Collaborators*

Summary
Background with disabling Disease States 188 countries
Methods: Ex with some it to reviews, one severity split cause and it

Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013

Global Burden of Disease Study 2013 Collaborators*

Summary
Methods: The GBD 2013 Mortality and Causes of Death Collaborators


GBD 2013 DALYs and HALE Collaborators*

Summary
Background: The Global Burden of Disease Study 2013 (GBD 2013) aims to bring together all available epidemiologic data using a coherent measurement framework, standardized estimation methods, and transparent data sources to enable comparisons of health loss over time and across causes, age-sex groups, and countries. The GBD can be used to generate summary measures such as disability-adjusted life-years (DALYs) and healthy life expectancy (HALE) that make possible comparative assessments of broad epidemiologic patterns across countries and time. These summary measures can also be used to quantify the component of variation in epidemiology that is related to sociodemographic development.

Methods: We used the published GBD 2013 data for age-specific mortality, years of life lost due to premature mortality (YLLs), and years lived with disabilities (YLDs) to calculate DALYs and HALE for 1990, 1995, 2000, 2005, 2010, and 2013 for 188 countries. We calculated HALE using the Sullivan method: 95% uncertainty intervals (UIs) represent uncertainty in age-sex-specific death rates and YLDs per person for each country, age, sex, and year. We estimated DALYs for 386 causes for each country as the sum of YLLs and YLDs. 95% UIs represent uncertainty in YLL and YLD rates. We quantified patterns of the epidemiologic transition with a composite indicator of sociodemographic status, which we constructed from income per person, average years of schooling after age 15 years, and the total fertility rate and mean age of the population. We applied hierarchical regressions to DALY rates by cause across countries to decompose variance related to the sociodemographic status variable, country, and time.
Benchmarking using the GBD: example of United Kingdom

1) Based on demand from Jeremy Hunt, Secretary of State for Health, GBD 2010 used to benchmark the UK with western Europe.

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Total DALYs, crude DALY rates, and age-standardised DALY rates from 1990 to 2013
Data viz

www.healthdata.org
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Are diet effects over-estimated?

1) Diet components and joint effects based on meta-analyses of cohort studies and randomized trials (mortality and intermediate outcomes).

2) Huge potential health gains through diet modification but substantial controversy about magnitude of the effects in the clinical community.

3) More systematic capture of all cohort studies and internal validation of combined diet effects on mortality should be undertaken.
Integrated exposure response curve (IER)

1) Relative risk curve as a function of PM2.5 constructed from pooling data from ambient air pollution, indoor air pollution, second-hand smoke and tobacco studies for CVD and chronic respiratory outcomes.

2) Ambient air pollution studies show excess risk at low levels PM 2.5 leading to a concave risk curve.

3) Policy implication is that health gains from reducing high levels of PM2.5 to moderate is quite small but gains from moderate to low are large.
Systolic blood pressure

1) GBD 2013 relative risks based on meta-analysis of pooled cohort and trial data show excess risk for SBP>110-115 mm Hg.

2) JNC8 argued that benefits unclear below SBP 150.

3) SPRINT results confirm magnitude of SBP results quantified in the GBD.

4) HOPE-3 questions benefits in those without disease and SBP below 130
Salt and mortality: implications of PURE

1) GBD 2013 considerable debate within collaboration on the theoretical minimum risk level (TMREL) for salt – level below which there is no further benefit.

2) IOM review and then PURE findings led to widening uncertainty interval for TMREL from 1gm Na/day to 5gm Na/day.
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GBD 2015

1. **New subnational analyses**: India, South Africa, United States, Sweden, Saudi Arabia, Brazil, Japan, Kenya.

2. Added selected territories with high quality data: American Samoa, Puerto Rico, Marshall Islands, Bermuda, Greenland

3. **Enhanced analysis of epidemiological transition**: major emphasis in the analysis of estimating the average pattern of age, sex, and cause-specific burden as a function of socio-demographic status.

4. HIV estimation and all-cause mortality estimation linked at the draw level – ensemble model to estimate HIV using both demographic data sources and EPP-Spectrum natural history model
GBD 2015

5) New causes including Ebola, division of leukemias into ALL, CLL, AML, CML, motor neuron disease

6) GATHER guidelines compliance

7) DisMod-MR 2.1 added estimation for subnational units in analytical cascade

8) Explicit risk-outcome evidence matrix

9) Summary exposure estimation – risk weighted prevalence for each risk factor on a 0 to 1 scale

10) Improvements to GBD Compare
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Major extensions to the GBD

1) Next annual update to 2016 to be released in September 2017.

2) Mapping the burden of disease at the pixel level – beginning with malaria, HIV, tuberculosis, diarrhea and lower respiratory infections will estimate burden at the 5 X 5 km square level.

3) Forecasting platform – creating a burden of disease forecasting platform to create short, medium and long-range forecasts for the GBD. Platform will also allow for exploration of alternative scenarios.

4) Extending risk factors to social determinants and intervention coverage
Fine-grained mapping of disease outcomes and impact of interventions: Malaria Atlas Project
Two distinct goals for health futures platform

1) Generate and regularly update past trends and relationships scenario (PTRS) for mortality, morbidity and population from now to 25 years in the future by age, sex, cause and GBD geographies (over 500 now)

2) Create a comprehensive framework to assess alternative scenarios of interest to relevant stakeholders with different trajectories for independent drivers
Scenarios framework

- Risk factors
- Independent drivers
- Fertility & migration
- Populations
- Mortality
- Morbidity
- Interventions
Distal risks and interventions

1) Expansion of GBD Comparative Risk Assessment to encompass distal risks such as income per capita, poverty, education, electrification….

2) Expansion to include the absence of certain well characterized interventions e.g. rotavirus vaccine.