

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

Christopher J.L. Murray November 9, 2016

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Outline

1) GBD overview and evolution

- 2) Some key results from GBD 2015
- 3) New analytical directions



Global Burden of Disease today

- 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.
- Goal is to inform decision-makers at every level (local, regional, national and global) with the best evidence on levels, trends and drivers of health so that decisions are ultimately more evidence-based.



Global Burden of Disease today (II)

- Covers 195 countries and territories from 1990 to present. Sub-national assessments for some countries including China, Mexico, UK, US, Brazil, Japan, India, Saudi Arabia, Kenya, South Africa
- 315 diseases and injuries, 2,619 sequelae, 79 risk factors or clusters of risk factors.
- Updated annually; release in September each year.
- Findings published in major medical journals, policy reports, and online data visualizations.



GBD: a global study with a global collaborative network of investigators



1,880 collaborators from 124 countries and 3 non-sovereign territories



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GBD: standardized solution to global health measurement challenges

Challenges:

- 1. Inconsistent coding and case definitions
- 2. No data
- 3. Conflicting data
- 4. Sampling and non-sampling measurement error
- 5. Excluded groups

GBD solutions:

- Quality review of all sources and corrections for garbage coding
- 2. Cross-walking different case definitions, diagnostic technologies, recall periods, etc., using statistical methods
- 3. Statistical methods to deal with missing data, inconsistent data, excluded groups and measurement error

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Multiple metrics for health

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



All data sources in the GBD indexes in on-line catalog with metadata on 60,000+ GBD sources

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GBD as a dynamic scientific enterprise

- 1. Five cycles of GBD estimation: GBD 1990, GBD 1999-2004, GBD 2010, GBD 2013 and GBD 2015.
- 2. Cause list: 109 causes GBD 1990 \rightarrow 315 causes for GBD 2015.
- 3. Risks: 10 risks in GBD 1990 → 79 risks in GBD 2015
- Locations: 8 regions in GBD 1990 →195 countries/territories more than 500 subnational locations in GBD 2015
- 5. Data processing: GBD 1990 redistribution for ill-defined causes of death to statistical cross-walking and detailed garbage code redistribution
- 6. Estimation methods: plausible internally consistent point estimates in GBD 1990 to posterior distributions for each quantity using Bayesian inference.
- 7. Disability weights: GBD 1990 expert panels → population-based surveys in multiple countries for GBD 2010 and beyond.



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Socio-Demographic Index (SDI) quintiles by GBD subnational level 1 geography, 2015. SDI is meant to place locations on the development continuum based on income per capita, average years of schooling and total fertility rate.



Life expectancy at birth and SDI. Black line shows average relationship 1980-2015 and points show the co-evolution of life expectancy and SDI for GBD super-regions



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Expected relationship between age-standardized YLL rates by cause, SDI and sex



Expected relationship between population and SDI



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Expected relationship between all-age YLL rates by cause, SDI and sex



Expected relationship between age-standardized YLD rates by cause, SDI and sex



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Expected relationship between all-age YLD rates by cause, SDI and sex



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Global DALYs by Level 1 GBD causes 1990 to 2015. Panel A: numbers of DALYs; Panel B: all-age DALY rates and Panel C: age-standardized DALY rates



Leading 30 causes of global DALYs for both sexes combined, 1990, 2005, 2015

Leading causes 1990	Leading causes 2005	% change, number of DALYs 1990–2005	% change, all-age DALY rate 1990–2005	% change, ag standardised DALY rate 1990–2005	ge- d	Leading causes 2015	% change, number of DALYs 2005–15	% change, all-age DALY rate 2005–15	% change, age- standardised DALY rate 2005–15
1 Lower respiratory infection	1 Ischaemic heart disease	26.3	2.7	-12.2		1 Ischaemic heart disease	11.0	-1.8	-14-2
2 Neonatal preterm birth	2 Lower respiratory infection	-37.2	-49.0	-37.5	· · · · ·	2 Cerebrovascular disease	0.1	-11.3	-22.2
3 Diarrhoeal diseases	3 Cerebrovascular disease	21.6	-1.0	-13.0		3 Lower respiratory infection	-23.8	-32.6	-31.0
4 Ischaemic heart disease	4 Neonatal preterm birth	-37.9	-49·4	-36·1	···· /	4 Low back and neck pain	18.6	4 ⋅9	-2.1
5 Cerebrovascular disease	5 HIV/AIDS	584.8	445-2	446.8		5 Neonatal preterm birth	-24.4	-33·1	-28.6
6 Neonatal encephalopathy	6 Diarrhoeal diseases	-37.3	-49.0	-39·3		6 Diarrhoeal diseases	-27.2	-35.7	-34.0
7 Malaria	7 Malaria	20.7	-1.4	18·3		7 Sense organ diseases	25.2	9.9	0.6
8 Measles	8 Low back and neck pain	34·5	9.4	-1.8	Y. H	8 Neonatal encephalopathy	-14.6	-24.2	-19·2
9 Congenital anomalies	9 Neonatal encephalopathy	-2.4	-20-4	0.3	1. A.	9 Road injuries	-6.5	-17.1	-17.6
10 COPD	10 Road injuries	11.8	-9.0	-7.9		10 HIV/AIDS	-32.6	-40·4	-40-3
11 Road injuries	11 COPD	-1.1	-19.6	-27.7	-/	11 Diabetes	29.0	14.6	1.6
12 Low back and neck pain	12 Congenital anomalies	-13.1	-28.3	-13-4]/	12 COPD	0.1	-11.5	-22.1
13 Tuberculosis	13 Sense organ diseases	39.4	11.7	2.1	Y 7.	13 Congenital anomalies	1.3	-9.4	-5.5
14 Iron-deficiency anaemia	14 Iron-deficiency anaemia	13.8	-10.0	-1.3	}. / `	14 Malaria	-38.3	-45.0	-43·1
15 Protein-energy malnutrition	15 Tuberculosis	-15.0	-30.5	-35.8].//	15 Depressive disorders	18.2	4 ⋅5	1.0
16 Sense organ diseases	16 Diabetes	65.1	34.4	18·3		16 Iron-deficiency anaemia	-3.3	-17·2	-11-3
17 Drowning	17 Depressive disorders	32.9	8 ⋅1	0.6		17 Skin diseases	12.3	-0.7	0.6
18 Meningitis	18 Skin diseases	22.7	-0.2	1.2	· · ·	18 Tuberculosis	-19.0	-28.2	-32.4
19 Depressive disorders	19 Self-harm	14.8	-6.8	-10.9		19 Lung cancer	14.5	1.1	-11-3
20 Skin diseases	20 Lung cancer	31.7	7.4	-6.1		20 Chronic kidney disease	19.6	4.8	-3.0
21 Self-harm	21 Neonatal sepsis	7.0	-12.9	10.5		21 Self-harm	-4.4	-15.4	-17.0
22 Other neonatal	22 Chronic kidney disease	36.6	10.0	3.5		22 Other musculoskeletal	19.9	6.0	0.8
23 Asthma	23 Migraine	29.7	5.6	-0.3	<u>}`</u> ,∕	23 Migraine	15.3	2.0	0.8
24 Diabetes	24 Meningitis	-23.9	-38.3	-26.8]. / ``	24 Neonatal sepsis	-0.2	-11.7	-5.5
25 Neonatal sepsis	25 Other musculoskeletal	51·5	23.3	13.4	ľ`.	25 Asthma	-2.6	-13.9	-16-9
26 Tetanus	26 Asthma	-12.3	-28.7	-31.2	··. /	26 Falls	9.2	-3.3	-8.7
27 Lung cancer	27 Protein-energy malnutrition	-36·1	-48.0	-36·2		27 Meningitis	-10.6	-21.4	-17.8
28 Falls	28 Measles	-65.1	-71.8	-64.6		28 Anxiety disorders	14.8	1.5	1.0
29 Migraine	29 Drowning	-38.0	-49.6	-42.8	$\mathbb{K} \times //$	29 Alzheimer's disease	32.8	17.4	-3.4
30 Chronic kidney disease	30 Falls	6.0	-13.7	-15.4	Y 🔌 / 🏒	30 Interpersonal violence	-5.9	-16.8	-16.1
31 Interpersonal violence	31 Other neonatal				····	31 Protein-energy malnutrition			
34 Other musculoskeletal	32 Interpersonal violence				1/35	34 Other neonatal			
37 Anxiety disorders	- 33 Anxiety disorders				1/ - N	35 Drowning	l	Communi	capie, maternal,
42 HIV/AIDS	37 Alzheimer's disease				/	81 Measles	I	Non-com	municable
49 Alzheimer's disease	72 Tetanus					100 Tetanus		Injuries	

Observed vs expected age-standardized DALY rates per 100,000 based on SDI alone for both sexes combined, 2015



Leading ten causes of DALYs with the ratio of observed DALYs to DALYs expected on the basis of SDI in 2015, by location

	1	2	3	4	5	6	7	8	9	10
	IHD	Stroke	LRI	Back & neck	NN Preterm	Diarrhoea	Sense	NN Enceph	Road injuries	HIV
Global	(0.92)	(0.93)	(0.65)	(0.96)	(0.72)	(0.76)	(1.00)	(1.17)	(0.80)	(0.66)
	IHD	Back & neck	Sense	Lung C	Stroke	Diabetes	Alzheimer's	Depression	COPD	Skin
High Income	(0.91)	(1.11)	(0.94)	(0.98)	(0.59)	(1.32)	(0.77)	(1.11)	(1.24)	(0.92)
High in some Negath America	IHD	Back & neck	Diabetes	Lung C	Depression	COPD	Alzheimer's	Drugs	Sense	Other MSK
High-Income North America	(1.79)	(1.08)	(2.48)	(1.30)	(1.31)	(2.35)	(0.97)	(3.82)	(0.89)	(1.79)
Canada	Back & neck	IHD	Lung C	Alzheimer's	Sense	Diabetes	Depression	Other MSK	Skin	Stroke
Canada	(1.31)	(1.31)	(1.20)	(0.92)	(0.91)	(1.75)	(0.98)	(1.56)	(1.02)	(0.55)
Creanland	Self-harm	Lung C	IHD	Back & neck	NN Preterm	Stroke	Congenital	COPD	Other MSK	Skin
Greenland	(4.70)	(2.65)	(0.74)	(1.10)	(1.60)	(0.81)	(0.80)	(1.81)	(2.14)	(1.04)
	IHD	Back & neck	Diabetes	Lung C	Depression	COPD	Drugs	Alzheimer's	Sense	Other MSK
USA	(1.84)	(1.05)	(2.57)	(1.31)	(1.34)	(2.49)	(4.01)	(0.98)	(0.89)	(1.81)
A	Back & neck	IHD	Depression	Other MSK	Sense	Diabetes	Lung C	Stroke	Skin	Anxiety
AUSTRIASIA	(1.12)	(1.01)	(1.30)	(1.87)	(0.84)	(1.36)	(0.78)	(0.56)	(0.93)	(1.72)
Australia	Back & neck	IHD	Depression	Other MSK	Sense	Diabetes	Lung C	Stroke	Skin	Drugs
AUSTIAIIA	(1.12)	(1.02)	(1.33)	(1.93)	(0.84)	(1.36)	(0.78)	(0.57)	(0.93)	(2.93)
Now Zealand	Back & neck	IHD	Depression	Diabetes	Sense	Lung C	Stroke	COPD	Skin	Other MSK
New Zealand	(1.15)	(0.96)	(1.14)	(1.40)	(0.85)	(0.79)	(0.53)	(1.38)	(0.93)	(1.52)
	Back & neck	Stroke	IHD	Sense	Alzheimer's	Self-harm	LRI	Lung C	Diabetes	Depression
High-income Asia Pacific	(0.84)	(0.74)	(0.52)	(1.04)	(0.68)	(1.25)	(0.83)	(0.70)	(0.93)	(0.86)
Drunei	Diabetes	IHD	Back & neck	Stroke	Road injuries	Skin	Depression	Congenital	Sense	Iron
bioliei	(4.62)	(2.13)	(0.82)	(1.59)	(2.44)	(0.94)	(0.90)	(1.56)	(1.05)	(1.06)
lanan	IHD	Back & neck	Sense	Stroke	Alzheimer's	LRI	Lung C	Self-harm	Stomach C	Colorect C
јарап	(0.52)	(0.82)	(1.05)	(0.69)	(0.67)	(0.89)	(0.66)	(1.20)	(1.15)	(0.77)
Cinconoro	IHD	LRI	Back & neck	Sense	Stroke	Depression	Skin	Lung C	CKD	Colorect C
Singapore	(0.92)	(1.88)	(0.60)	(1.01)	(0.61)	(0.95)	(0.94)	(0.75)	(1.13)	(0.82)
South Koroo	Back & neck	Stroke	Self-harm	Diabetes	Sense	IHD	Lung C	Liver C	Depression	Skin
South Korea	(0.90)	(0.97)	(1.45)	(1.76)	(1.02)	(0.46)	(0.85)	(2.42)	(0.83)	(0.91)
	0-0-6	53 🔲 0.63-0.79	0.79-0.90	0.90-1.00	1.00-1.09	1.09-1.24	1.24-1.56	1.56-2.49	>2.49	

Global proportion of all-cause DALYs attributable to risk factors, and overlaps by region, both sexes, 2015







Region



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Summary exposure value and SDI for top global risks in terms of attributable DALYs in 2015, with comparisons to expected summary exposure value on basis of SDI



Global decomposition of changes in DALYs attributable to risk factors, 1990-2015 due to population growth and ageing, risk exposure and the risk-deleted DALY rate



Change due to risk-deleted DALY rate

Change due to population growth



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New directions for the GBD and related analytics

Broadly, the goal of the GBD is to help decision-makers make better decisions. We are continuing to expand a number of directions to enhance the interpretability and relevance of the GBD results for different users.

- 1) Healthcare quality and access measured using mortality highly amenable to health care
- 2) Absolute and relative avertable burden
- 3) Forecasts of the GBD 25 years into the future by location
- Finer grained spatial estimation: 2nd administrative level or 5x5 km pixel level.
- 5) Health expenditure by GBD cause/risk

Health system access and quality, 2015

Using the set of causes highly amenable to healthcare e.g. testicular cancer, chronic kidney disease or tuberculosis, to proxy access to high quality healthcare. Rates are risk standardized.



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Potential of healthcare to reduce premature mortality

Estimate the absolute fraction of each cause that could be averted through high quality healthcare and the fraction relative to level of development.

Treemap of global deaths in 2015. Dark color is avertable through healthcare relative to development level, intermediate color is avertable through highest quality healthcare, light shade not avertable through healthcare





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



Historic vs projected annualized rate of change in global risk factors



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Super-region life expectancy decomposition, females



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Super-region life expectancy decomposition, males



Using high resolution maps to target interventions: malaria in sub-Saharan Africa

High mortality and low treatment coverage, 2015



High mortality and low bed-net coverage, 2015



Complete estimation of age, sex, cause, county mortality 1980-2014



Age-standardized mortality rate (deaths per 100,000 population):

<pre><0.4 0.7 1 1.3 >1.6</pre>	I				
<0.4 0.7 1 1.3 >1.6					
	<0.4	0.7	1	1.3	>1.6

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