

Measuring global disease burden: challenges, perspectives, limitations

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**World Health
Organization**

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Overview

- GBD principles and objectives; brief GBD history
- Recent results: GBD 2004, CRA, projections
- GBD 2005 study – an overview
- Summary measures of population health – DALYs in particular
- Challenges and limitations
- Conclusions

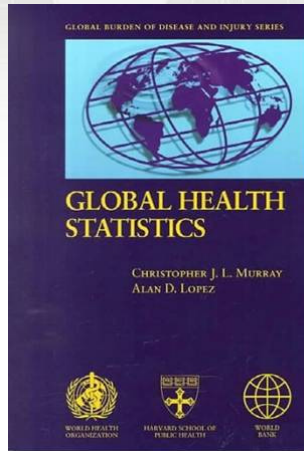
Global Burden of Disease (GBD) Goals

- Measure loss of health due to **comprehensive** set of disease, injury, and risk factor causes in a **comparable** way
- Measure population health for the world, and for a set of regions
- Decouple epidemiological assessment and advocacy
- Inject **non-fatal health outcomes** into health policy debate
- Use a **common metric** for BOD assessment and intervention analysis that combines mortality and non-fatal outcomes

GBD Principles

- Quantities of interest are total events or states at the population level
- Best available data used to make estimates
- Corrections for major known biases to improve cross-population comparability
- Comprehensive set of disease and injury causes – nothing is left out in principle
- No blanks in the tables, only wider uncertainty intervals
- Internal consistency used as a tool to improve validity

Abbreviated GBD history (1)

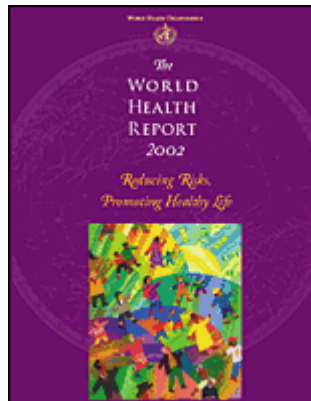


1991-96 Global Burden of Disease 1990 Study

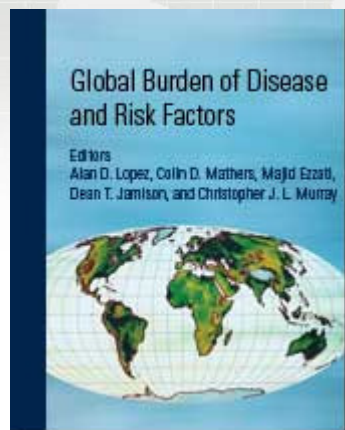
- World Bank 1993; Murray & Lopez 1996

2005-08 WHO updates for years 2000-2002

- Mortality estimates – 192 Member States
- Regional revisions - epidemiology
- Comparative Risk Assessment - 26 RFs
- WHO-CHOICE: generalized CEA
- Healthy LE (HALE) – 192 Member States



Abbreviated GBD history (2)

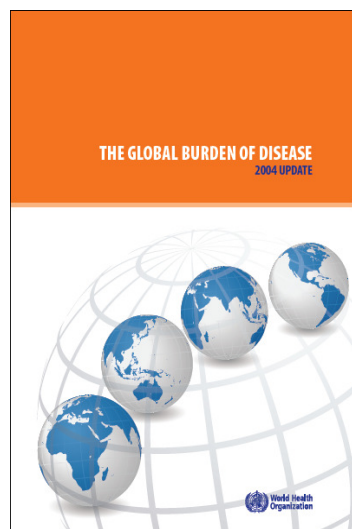


2004-06 Disease Control Priorities Project

- Lopez, Mathers et al 2006

2005-08 WHO updates: projections and GBD 2004

- Projections to 2030
- GBD 2004 (release Oct 08)
- CRA 2004 - 28 RFs (by end 08)
- Country level estimates (by end 08)



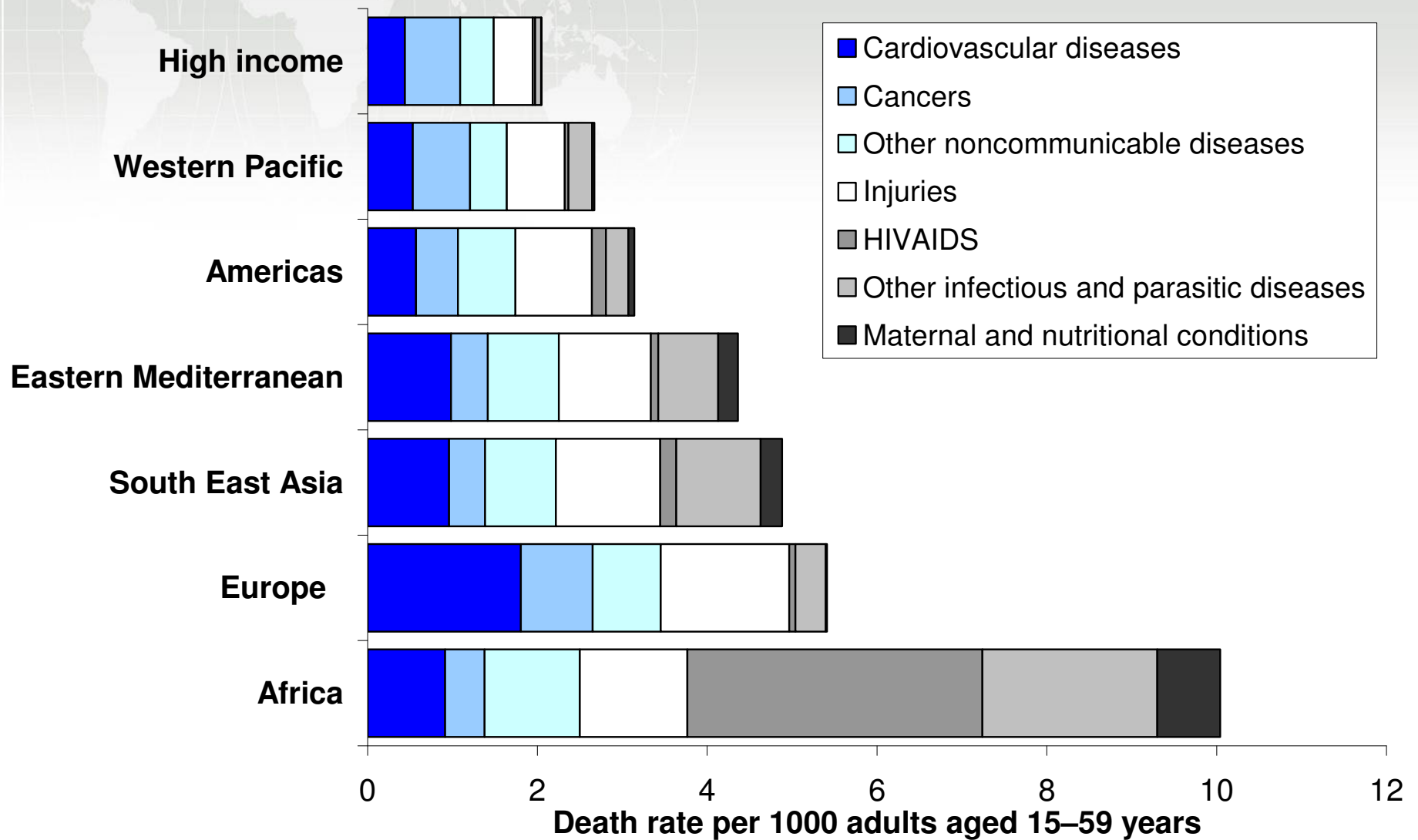
2007-10 GBD 2005 complete update (IHME, WHO..)

Burden of Disease (BOD)

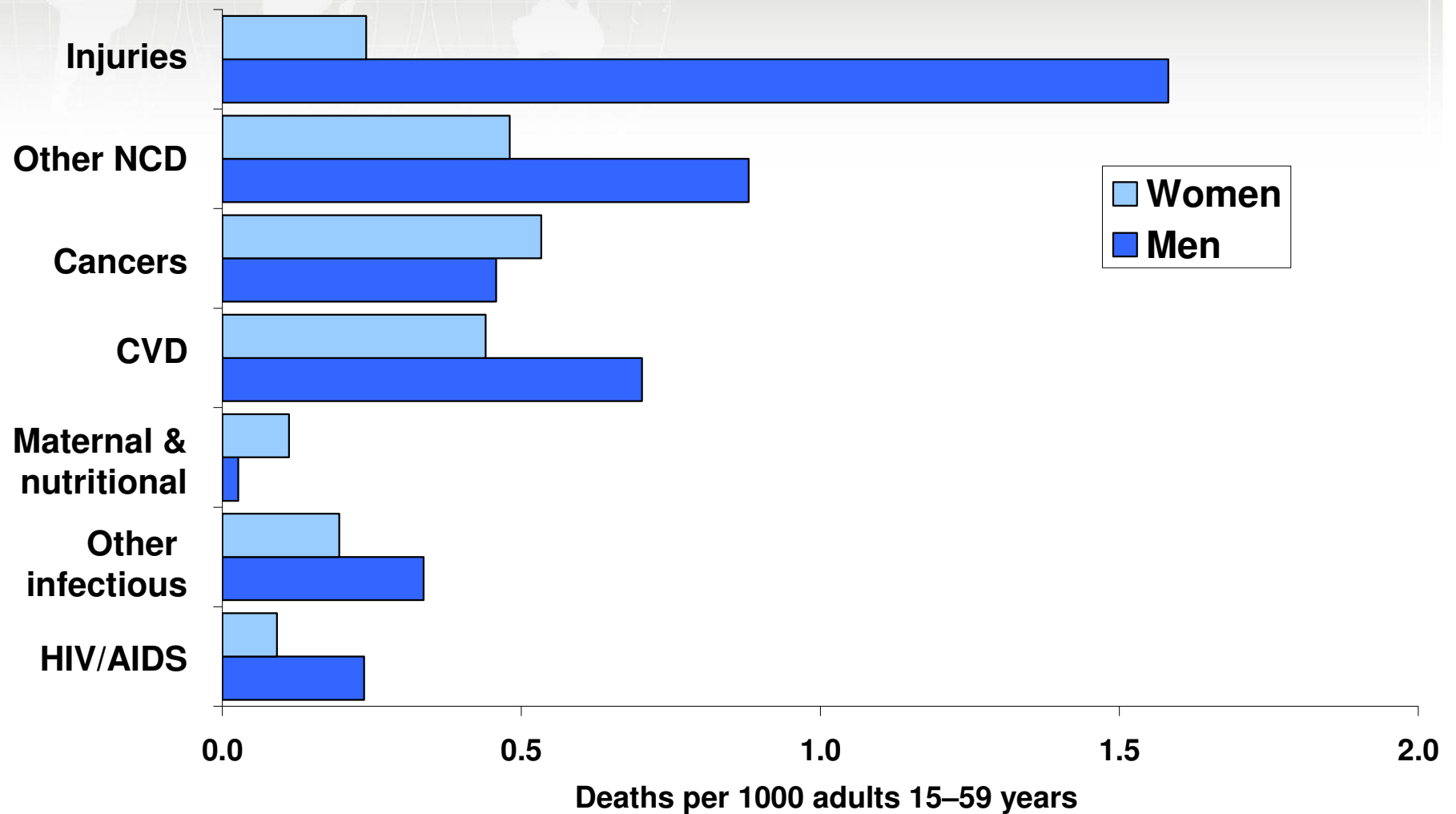
A standardized framework for integrating all available information on mortality, causes of death, individual health status, and condition-specific epidemiology to provide an overview of the levels of population health and the causes of loss of health

- Consistent, comprehensive descriptive epidemiology
- Common metric or summary measure

Adult mortality rates by major cause group and region, 2004



Adult mortality rates by sex and cause, ages 15-59 years, Latin America and Caribbean, 2004



Leading Causes of Mortality and Burden of Disease Latin America and Caribbean, 2004

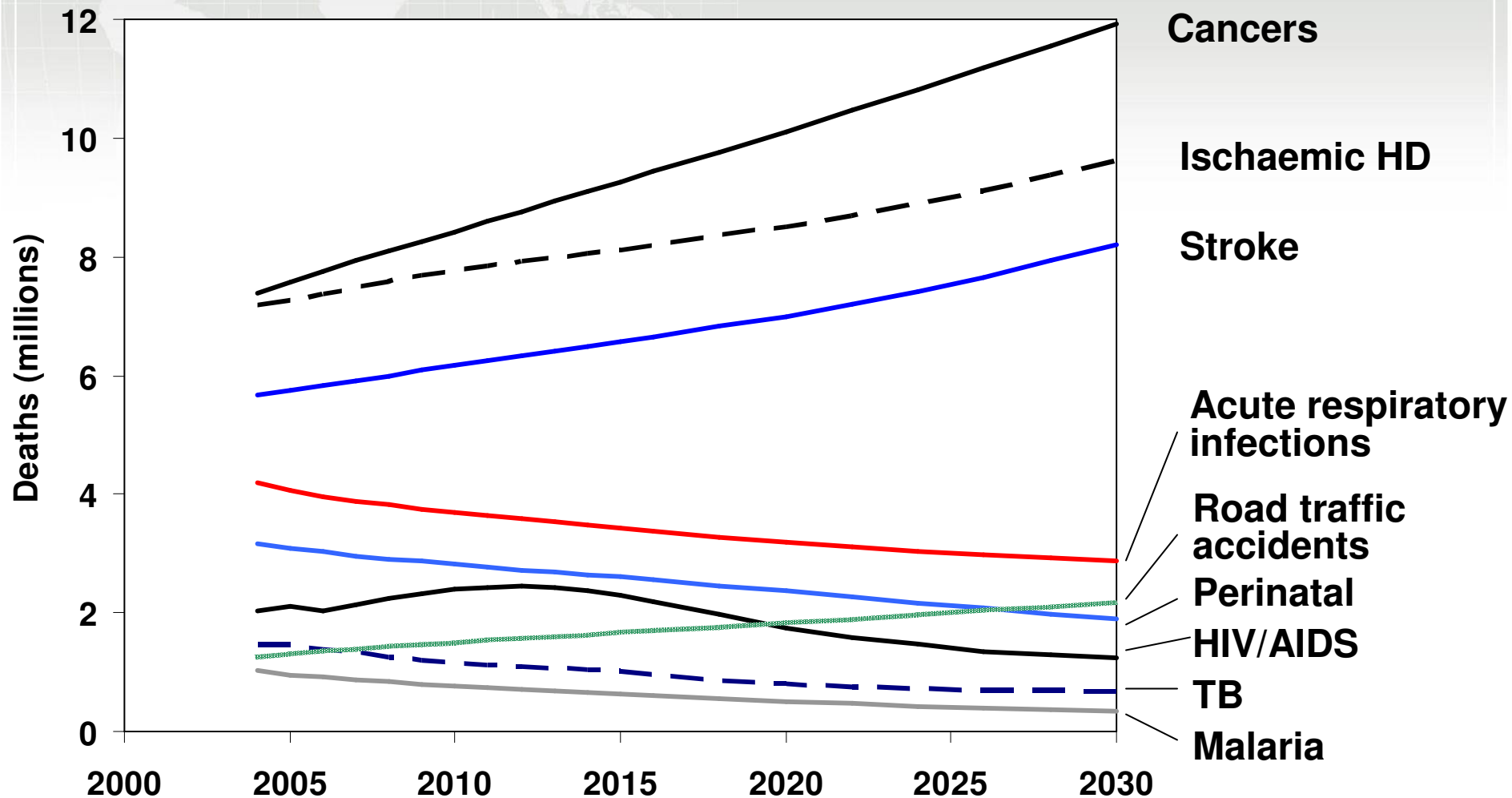
Mortality

	%
1. Ischaemic heart disease	11.4
2. Cerebrovascular disease	8.2
3. Lower respiratory infections	5.5
4. Diabetes mellitus	5.0
5. Violence	3.9
6. COPD	3.1
7. Road traffic accidents	3.0
8. Hypertensive heart disease	2.4
9. Cirrhosis of the liver	1.9
10. Nephritis and nephrosis	1.9

DALYs

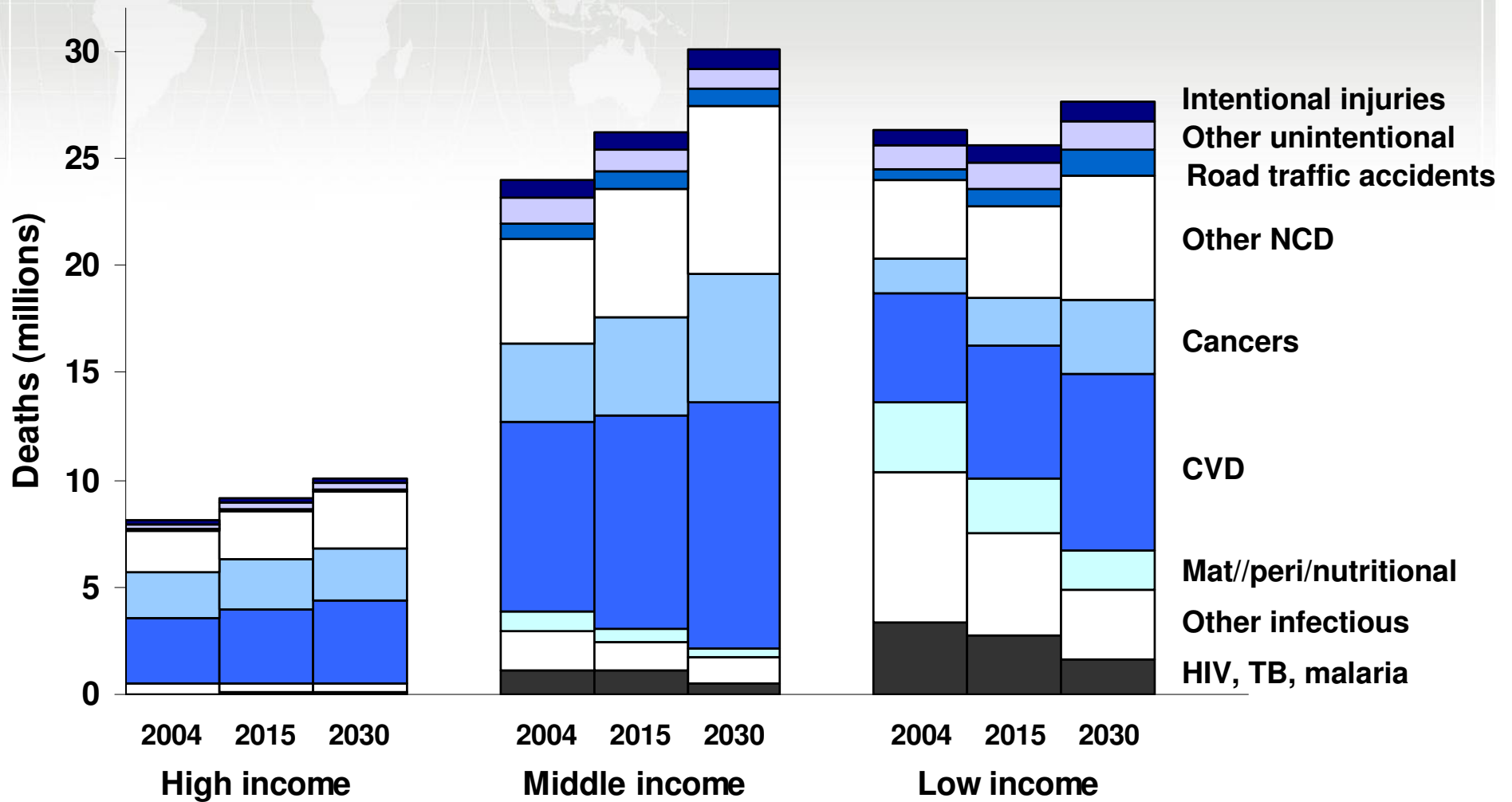
	%
1. Depression	6.3
2. Violence	6.0
3. Ischaemic heart disease	3.5
4. Lower respiratory infections	3.4
5. Road traffic accidents	3.3
6. Alcohol use disorders	3.0
7. Cerebrovascular disease	2.7
8. Diabetes mellitus	2.7
9. Diarrhoeal diseases	2.5
10. Congenital anomalies	2.3

Global projections for selected causes, 2004 to 2030

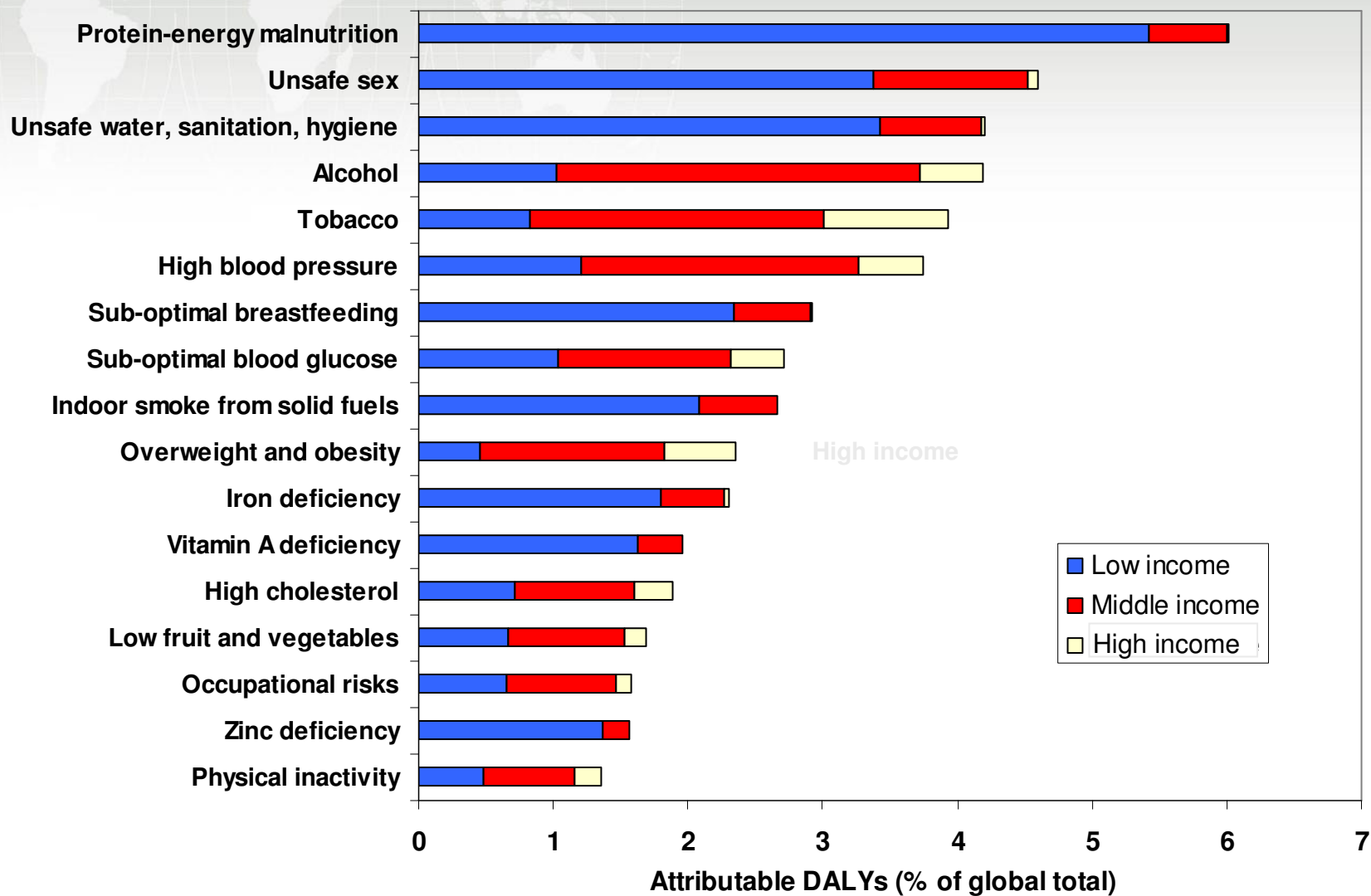


Updated from Mathers and Loncar, PLoS Medicine, 2006

Projected deaths by cause and income, 2004 to 2030



Global burden of disease attributable to leading selected risk factors, preliminary results, 2004



A complete new assessment

GBD 2005

- \$11m grant from Gates Foundation
- Led by Institute for Health Metrics and Evaluation (Seattle)
- + WHO, Harvard University, Univ. of Queensland, Johns Hopkins
- Complete revision of GBD – all causes, risk factors, disability weights
- Started in 2007, aim to complete by end 2010

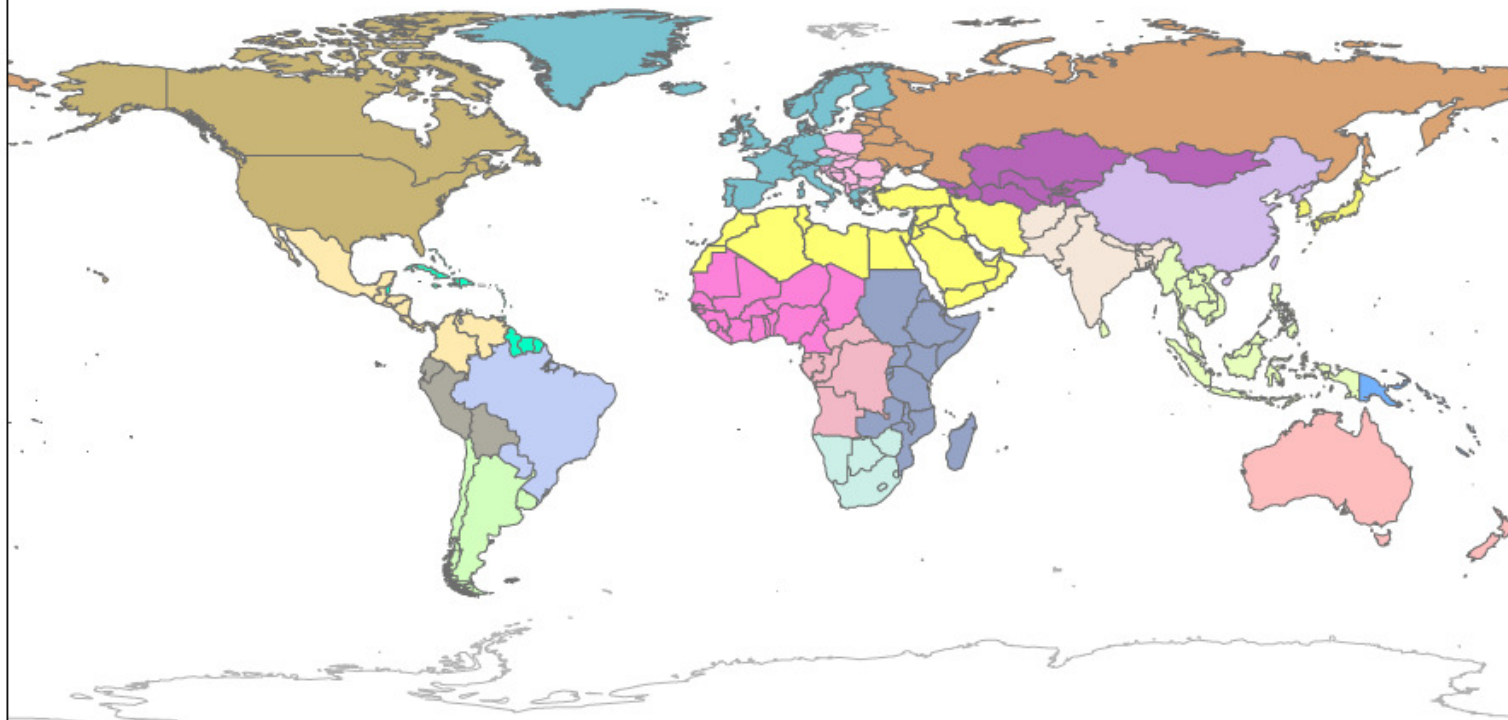
Objectives

- New disease, injury, risk factor estimates for 1990 and 2005
- For 21 regions spanning the global population
- Create simplified analytical tools and training for BOD studies

GBD 2005 – regions

The 21 regions are defined based upon broad geographic regions or continents, are no fewer than two countries, and are based on child and adult mortality levels.

**Global Burden of Diseases, Injuries, and Risk Factors
Regions**



- | | | | |
|---------------------------|------------------------|-----------------------------|------------------------------|
| Asia Pacific, High Income | Caribbean | Latin America, Southern | Sub-Saharan Africa, East |
| Asia, Central | Europe, Central | Latin America, Tropical | Sub-Saharan Africa, Southern |
| Asia, East | Europe, Eastern | North Africa / Middle East | Sub-Saharan Africa, West |
| Asia, South | Europe, Western | North America, High Income | Oceania |
| Asia, Southeast | Latin America, Andean | Sub-Saharan Africa, Central | |
| Australasia | Latin America, Central | | |

GBD 2005 – expanded cause lists

Diseases and injuries

- Diarrhoea, LRI, meningitis categorized by pathogen
- Additional infectious diseases: mumps, rubella, yellow fever, rabies, cysticercosis, etc
- Additional cancer sites
- Haemolytic and other anaemias
- Childhood mental disorders, more specific drug use disorders
- Expanded CVD, digestive etc
- Additional external causes: surgical/medical, machinery, animals, disasters

Risk factors

- Additional dietary factors:
 - Excess caloric intake
 - Transfat
 - Sub-optimal blood glucose
 - Salt intake
- Infective risks: HPV and H.Pylori
- Injury risks: intimate partner violence and osteoporosis
- Genetic factors, consanguinity
- Perinatal/early childhood and social determinants?

Organizational structure

- Core team (collaborating Institutions)
- External advisory board
- Central subteams: mortality, COD, YLD, DW, CRA
- Expert groups for diseases and risk factors, organized into 5 clusters with cluster coordinators (from core team)
- Approx 40 expert groups, involving 350-1000 experts

For more information: www.globalburden.org

Overview

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- Recent results: GBD 2004, CRA, projections
- GBD 2005 study – an overview
- ➔ • Summary measures of population health – DALYs in particular
- Challenges in measuring DALYs
 - Limitations in mortality and COD data
 - Limitations in epidemiological data: bias and missingness
 - What should the DALY measure?
 - Causal attribution issues and comorbidity
 - Health states and health state valuations
 - Social values: age weights and discounting
 - Quantifying risk factors and health determinants
- Conclusions

Summary Measures of Population Health (SMPH)

- Measures/metrics that combine information on mortality and non-fatal health outcomes to represent the health of a particular population as a single number
- Health expectancies (DFLE, ALE, HALE etc) summarize mortality and morbidity/disability from all causes for the population in terms of expected healthy years (1971+)
- DALYs provide cause-specific estimates of health loss

Disability Adjusted Life Years

$$DALY = YLL + YLD$$

*Time is used as the common metric
for mortality and health states*

YLL Years of **life lost** due to mortality

YLD Equivalent **years (of healthy life) lost** due to **disability**

How many life years lost for each death?

Loss associated with death at age x =

- Difference between x and a specified limit to life (PYLL) } Same target LE across ages
- Period life expectancy at age x (PEYLL) } Age-specific target LE
- Cohort life expectancy at age x (CEYLL)
- Standard life expectancy at age x (SEYLL)

Loss depends on local setting

Loss is standardized across settings

Years Lived With disability

$$YLD = I \times L \times DW$$

YLD = Years of life lived with disability

I = Number of incident cases in the population

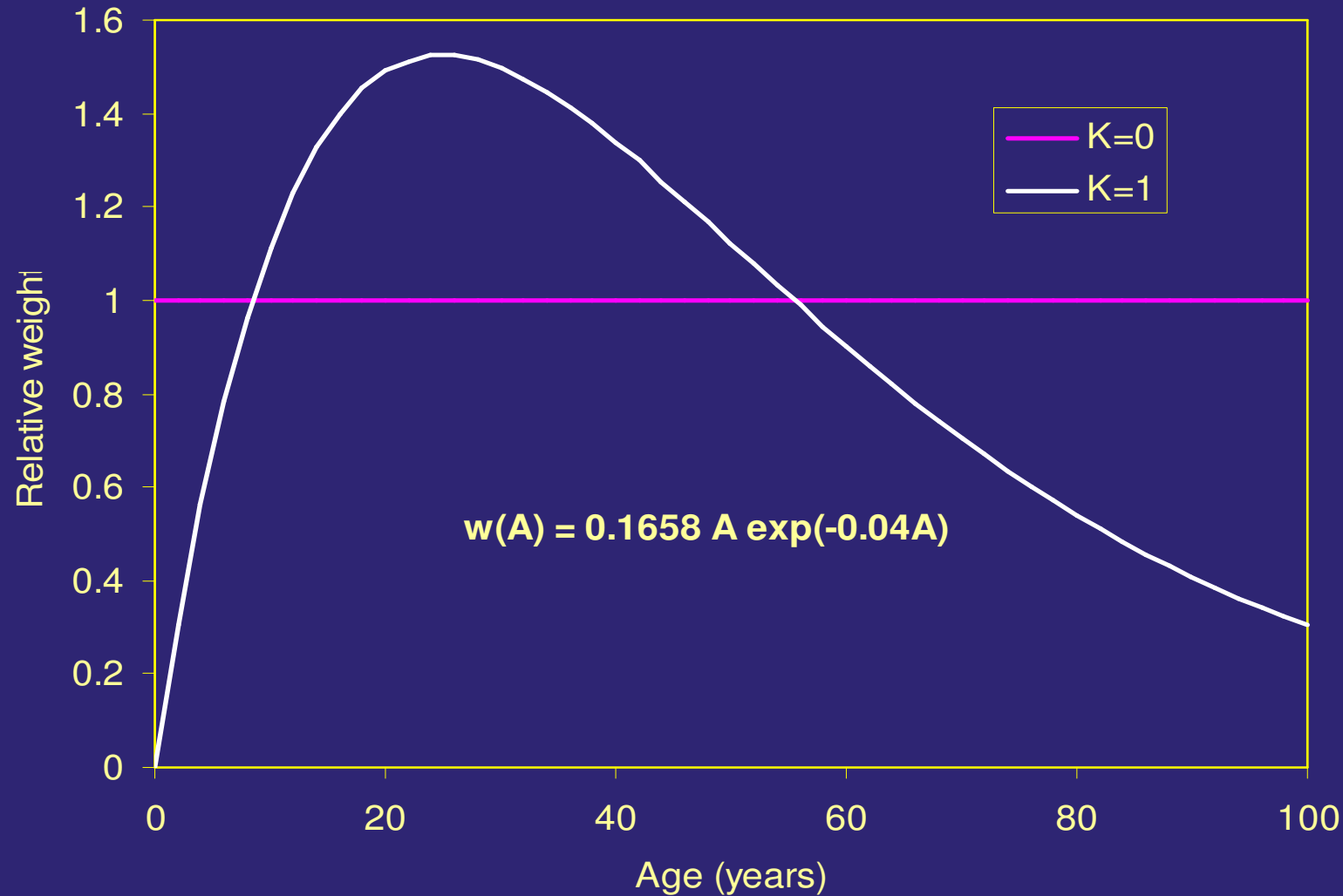
DW = Disability weight

L = Duration of disability [years]

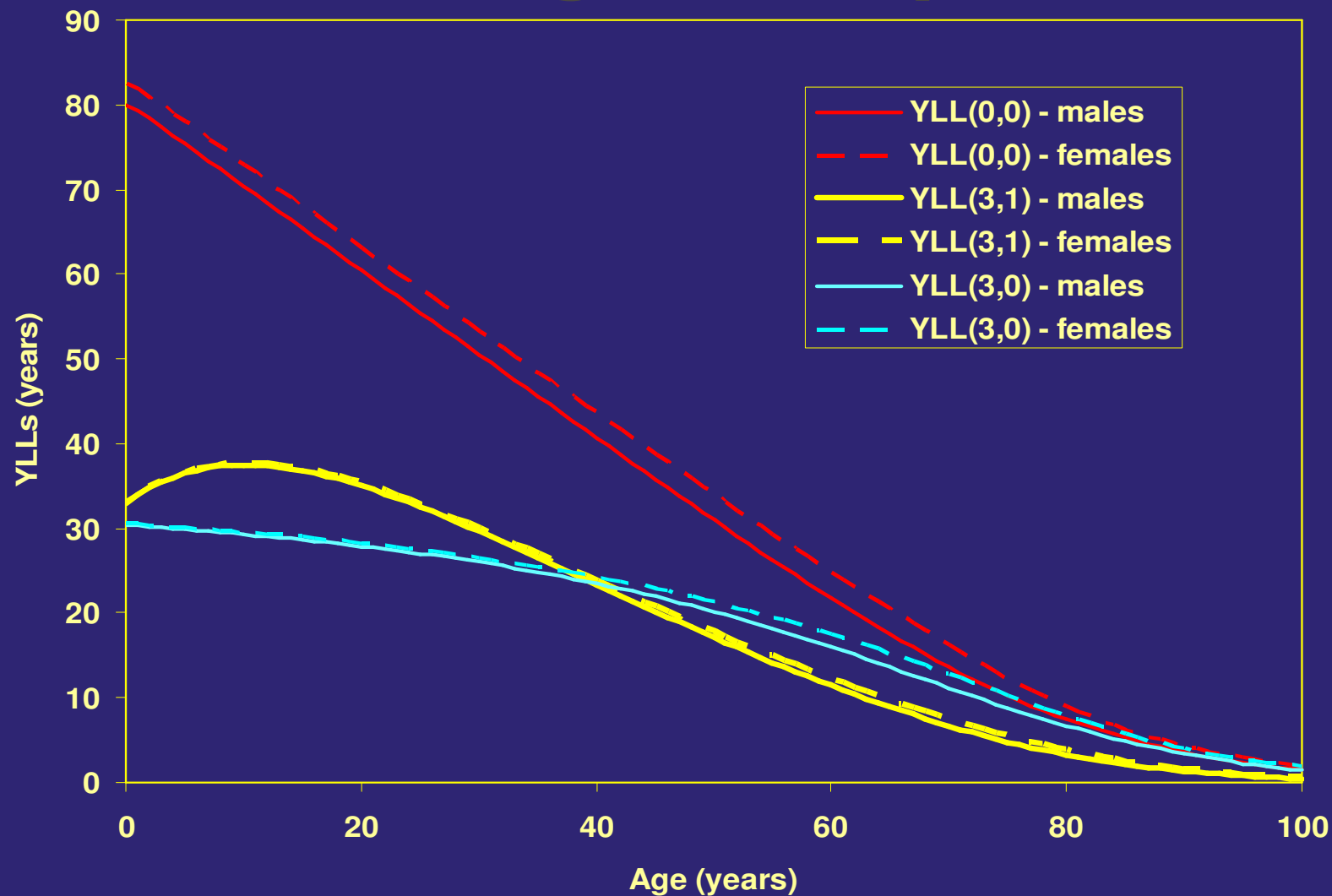
4 cases of mild mental retardation (DW=0.36) due to lead exposure in early childhood :

$$4 \times 0.36 \times 77.8 \text{ years} = 112 \text{ YLD}$$

Age weights in the standard DALY



Effect of age weights and 3% discounting on YLL per death



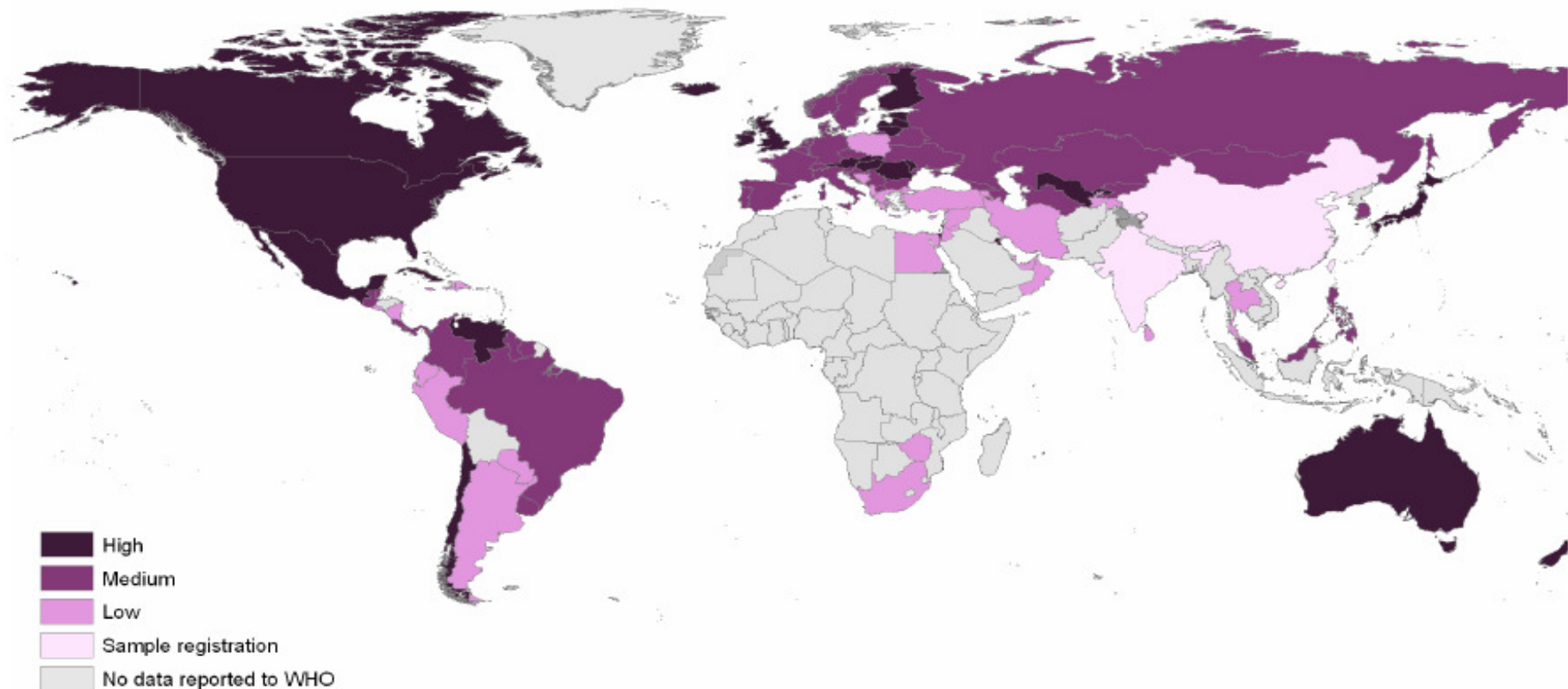
Criticisms and controversies

- Estimates should not be made where gaps in knowledge and information are too great (Cooper and others)
- DALYs discriminate against people with disabilities, global weights do not represent local experiences, disabilities do not represent loss of health (Mont)
- Criticisms of health state valuation methods (PTO), age weights and discounting (Nord, Anand, Barendregt etc)
- Should DALYs be used for setting health priorities, should they even be calculated at all? (Williams, Mooney)

Challenges to measuring mortality

- Lack of complete death registration in many developing countries; some have no death registration data at all
- Quality of certification and coding of underlying cause of death
- Garbage codes – general and specific
- Is verbal autopsy data useable?
- Survey and census reporting of deaths: birth history, deaths in household, sibling survival...

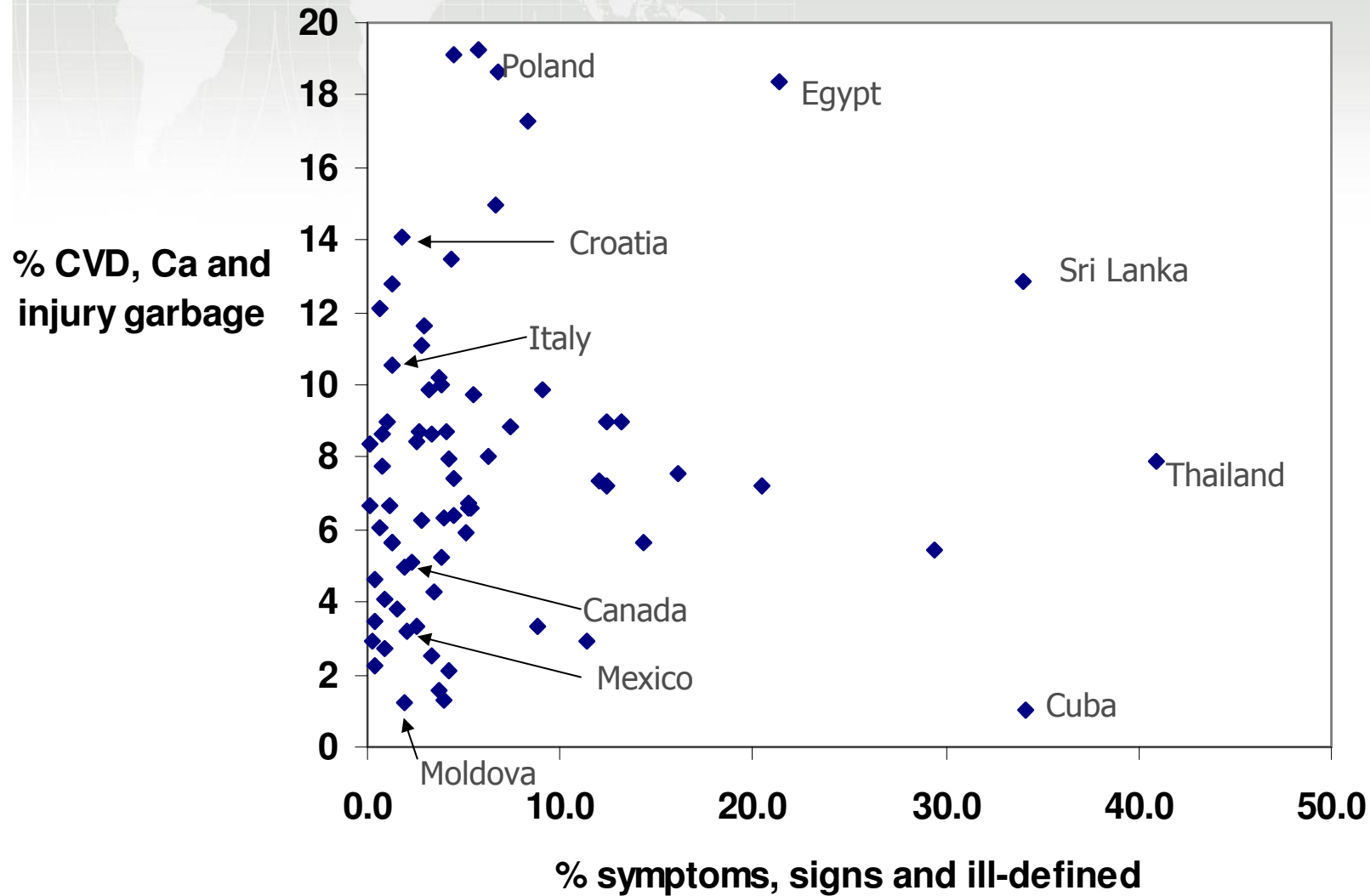
Quality of cause-of-death information from national civil registration systems, based on latest data received from WHO Member States, circa 2003



Underlying cause of death and “garbage coding”

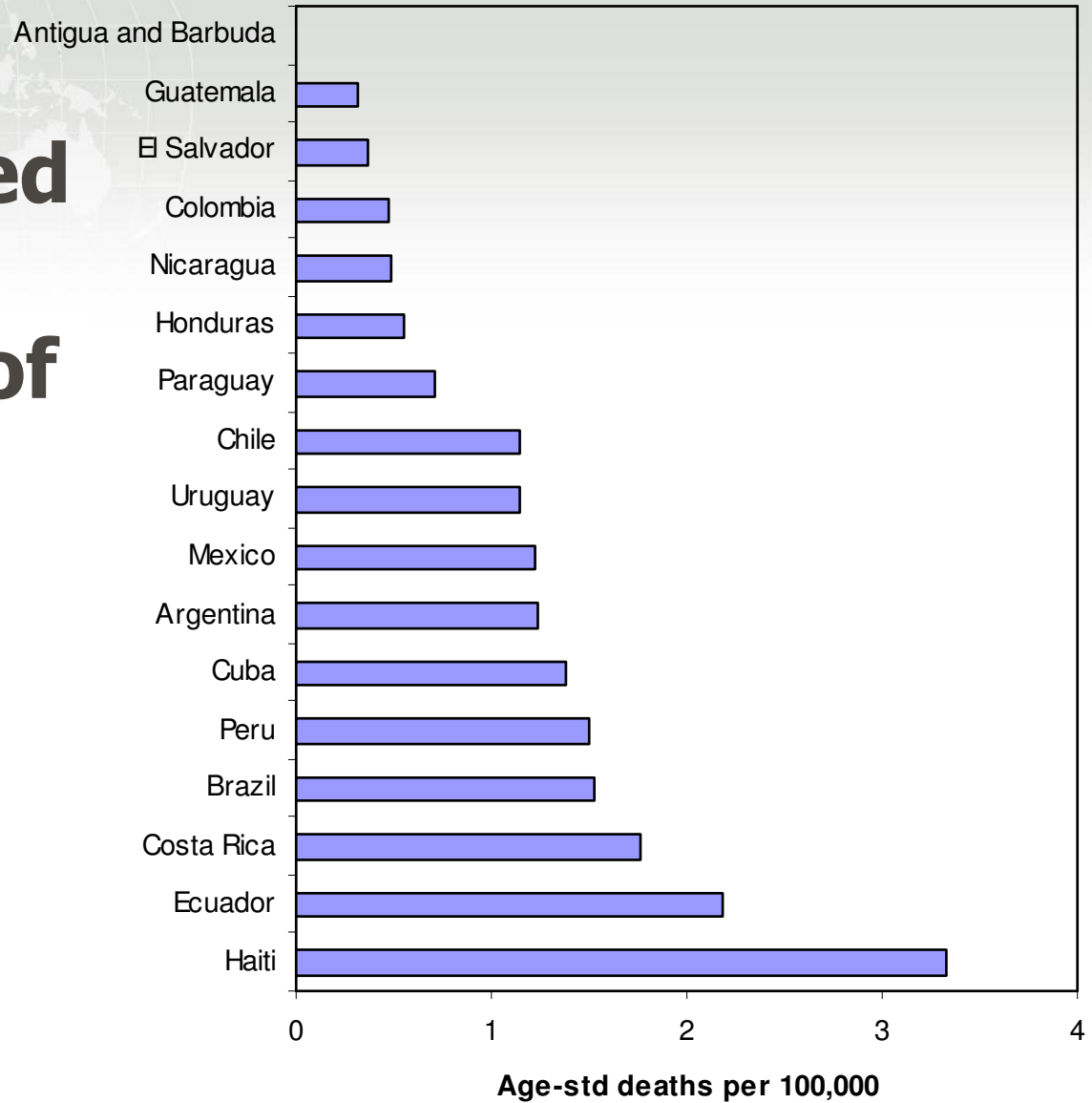
- The ICD defines the underlying cause of death as “ the disease or injury, which initiated the train of morbid events leading directly to death, or the circumstance of the accident or violence which produced the fatal injuries”
- When more than one cause of death is recorded, selection should be made following ICD rules based on the concept of underlying cause of death.
- From ICD 6 on, ICD has grown into a coding scheme for all disease, including fatal and non-fatal health conditions, signs and symptoms, some risk factors, other reasons for health system encounters
- *Garbage codes in mortality data are those codes which do not signify an underlying cause of death, including ill-defined causes, signs and symptoms, intermediate, immediate, and unlikely or ambiguous causes of death.*
- In mortality data submitted to WHO by Member States, garbage codes represent from 0 to 50% of deaths, with a median of 12%

Ill-defined and garbage codes



Many untouched problems in comparability of death registration data.....

Parkinson disease mortality in Latin America



What about countries without useable death registration data?

- Hospital deaths data
 - Figure out how to correct for admission selection bias?
- Disease registries (completeness, coverage, bias in diagnosis)
- Surveys
 - Ask mothers to report on survival of children
 - Ask respondents to report on survival of siblings, parents, spouses
 - Correct for biases introduced by using survey methods (selection bias and recall bias)
- Verbal autopsy data (demographic surveillance, surveys)
 - Big problems with validation and replicability
 - Inherent difficulties in diagnosis of causes with nonspecific symptoms
 - Bayesian probabilistic diagnosis methods show promise (Murray et al)
- Models
 - If child mortality measured, can use models to predict death rates at other ages (model life tables)
 - Death distribution models (following on from Preston)
- Data quality and bias are issues with all data sources

Challenges: adjusting for bias in epidemiological data

- Quantities of interest are ALWAYS events/cases in the total population (21 regions for GBD 2005)
- Epidemiological data must relate to a standard GBD case definition (or be translatable to it)
- Crude data that relate to notifications, health service contacts, or diagnoses through specific sectors of health system (eg publicly funded clinics) will provide biased estimates
- In some cases (not enough!!) this may be correctable (eg. if the completeness of notifications/coverage can be estimated with adequate precision)

Measurement instrument bias

- Self-report bias (eg. height and weight)
- "Unassigned cause" categories cause bias and must be redistributed
- sensitivity and specificity of instrument – low prevalence conditions may be overestimated
- Regression dilution bias
- Self-report instruments – cross-population DIF
AKA cutpoint shift
 - a particular problem for symptom and functioning questions with unanchored response categories

Unrepresentativeness bias

- OFTEN THE MOST DIFFICULT ISSUE TO ADDRESS
- Studies conducted in subpopulations
 - Geographic subpopulations
 - Restricted age or sex range (eg. 25-64 age group)
 - higher-risk or at-risk subpopulations
 - Unrepresentative SES distribution
 - Dealing with unexplainable outliers
- Can also be thought of as "missing data" problem
- If the variation of QOI with relevant covariates can be quantified, then adjusted statistics can be derived for the whole population (eg. known age distribution, known urban/rural prevalence ratio)
- Seasonality may be an issue also

What should the DALY measure?

Lost years of equivalent full health

But does the disability weight quantify:

- Health (more healthy, less healthy)
- Goodness of health (value of lost health to society)
- "health-related quality of life"
- Quality-of-life, wellbeing (includes dimensions that most people agree are outside "health")
- Utility (beloved of economists)

The DALY quantifies "health"

- The DALY is now conceptualized as quantifying "health" not the goodness of health (the original conceptualization) or wellbeing/QoL
- Health conceptualized in terms of human functioning capacities in a set of domains/dimensions of health
- Disability is seen as synonymous with loss of health
- Decrements in health are decrements in functioning capacity in one or more health domains
- Above a certain threshold in a domain, improvements may be seen as "talent" rather than increasing "health"
- Does health end at the skin? What about aids?
- GBD considers some aids close to the skin as improvements in health (contacts, glasses, hearing aids, basic mobility aids)

Two important distinctions:

- ***Health vs. determinants of health***

Exposures to risks (like pollution) can have consequences in terms of future health, but pollution is not part of your health.

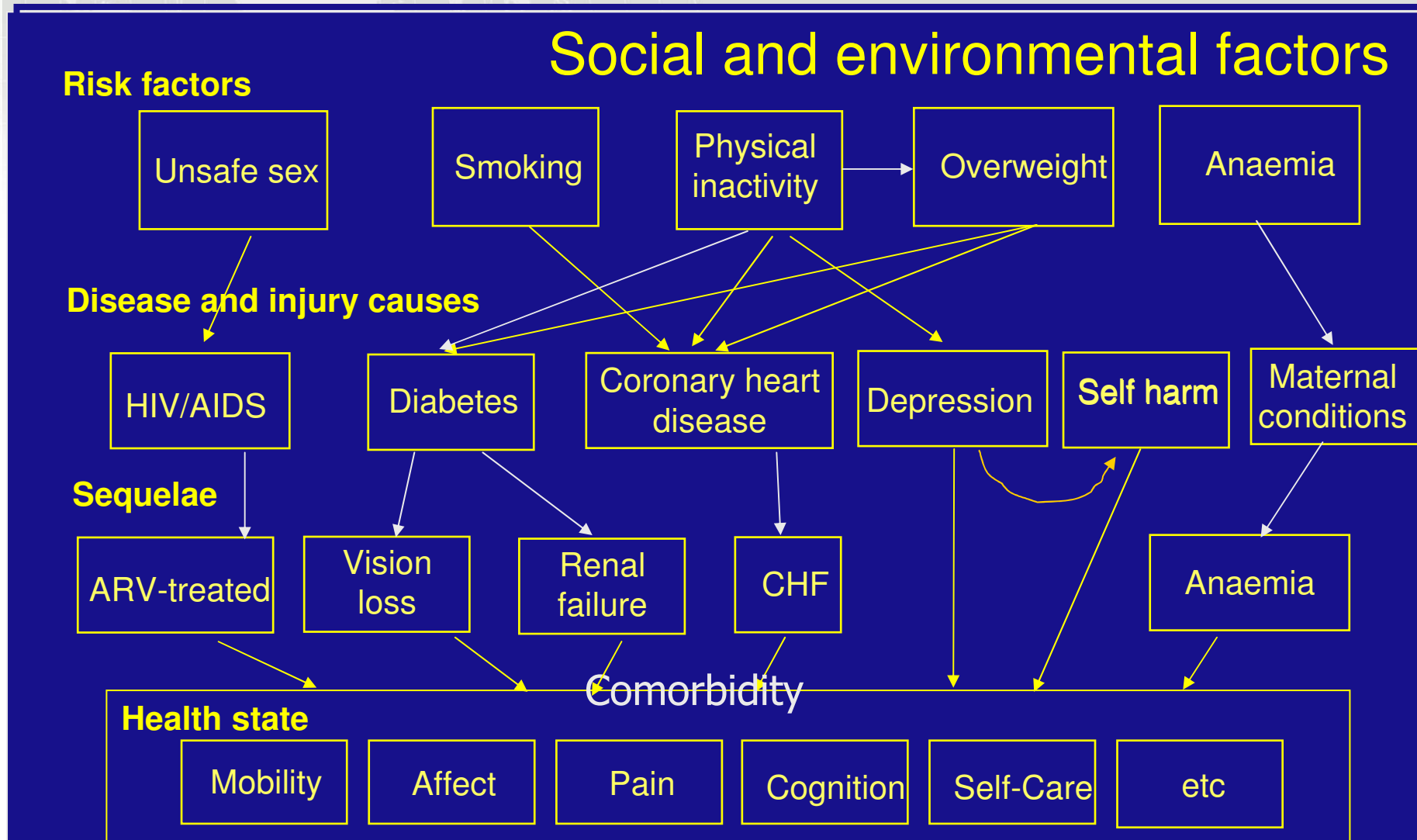
Same applies to alcohol, tobacco, social class, etc. [+ poverty, education, etc.]

- ***"Health state" vs. "disease state"***

A *disease state*, defined for example, by a diagnosis of diabetes, can produce very different consequences for different individuals

A *health state* is defined in terms of levels on different domains of health. For example, a person with diabetes may have reduced vision or blindness due to leakage from blood vessels in the retina

Causal attribution issues



Health state valuations (disability weights)

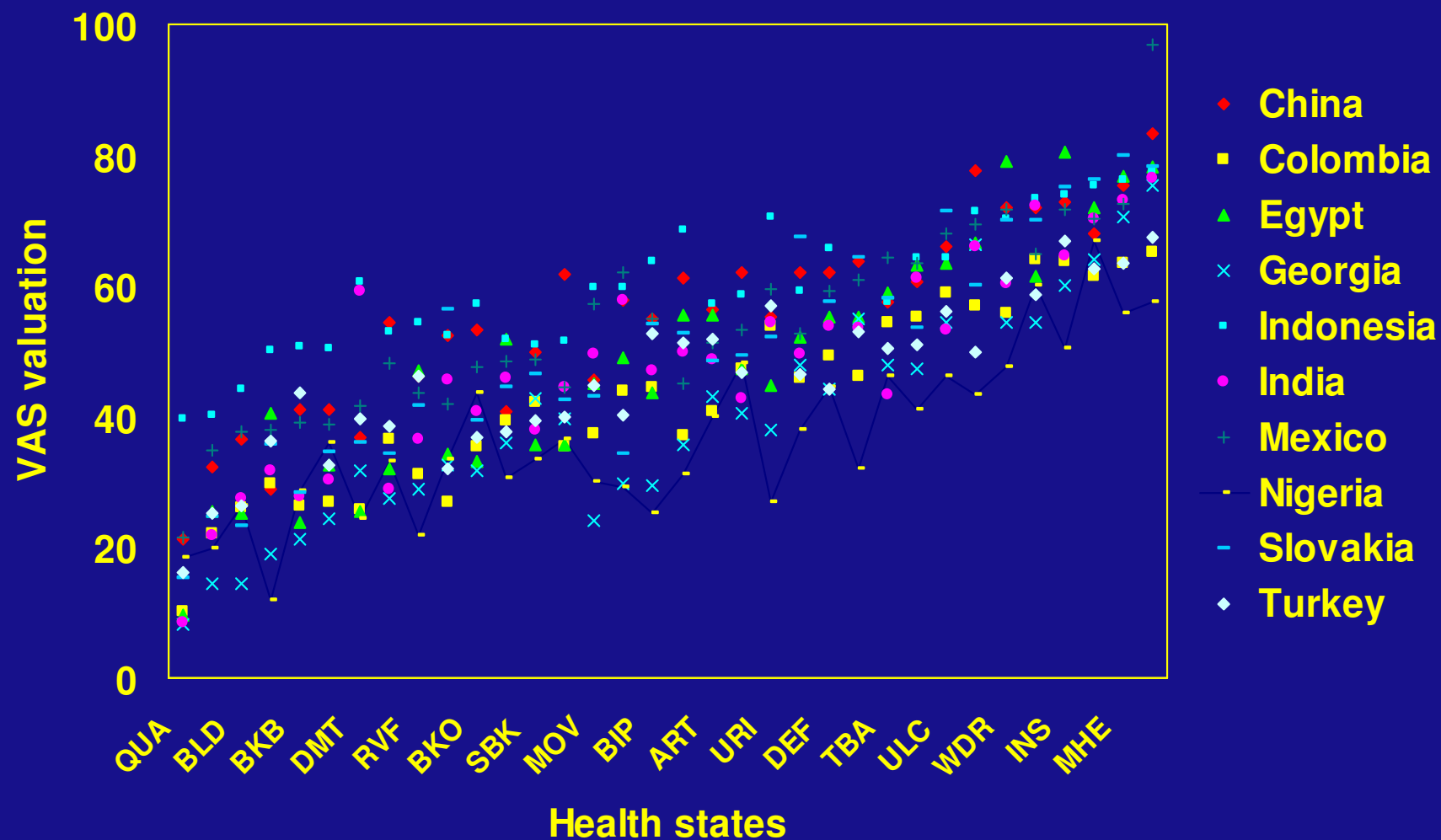
- Quantify preferences for health states in terms of a single number on an interval level scale
- 0 = full health
- 1 = health state equivalent to death
- DW quantify "health", not quality of life, utility or the "value" of a person
(bigger weight -> more lost health)

Should global disability weights be used?

- *No, because...*
 - Health is culturally constructed
 - Everything is relative
 - Social context affects health levels
 - Participation levels may be quite different for the same impairment in different environments
- *Yes, because...*
 - There is a broad common understanding of health
 - Empirical results suggest cultural variation may be smaller than imagined
 - Standardization assigns the same value to the same health state

Average visual analogue scale values

WHO Multi-Country Survey Study 2001-2002



GBD 2005 strategy for revising the disability weights

- Measurement in community samples in diverse settings (e.g. Tanzania, Mexico, India, Philippines)
- Sequelae presented with brief word descriptions capturing most salient aspects of functioning and symptoms for the average case
- Main response task based on paired comparisons
- TTO for a number of moderate severity conditions
- Internet survey for remaining sequelae
- Modified PTO for mild conditions
- Explicit analysis of cross-population variability

Social values: age weights & discounting

- GBD 2005 conceptualizes the DALY as quantifying loss of health in populations, not the "value of health"
- Implication: for basic reporting DALYs should not include age weights of discounting
- Discounting may still be applied for applications of DALY such as for measuring outcomes in cost effectiveness analyses
- Chris Murray: although DALYs are not intended to be used directly for priority setting, they cast a normative shadow – which needs to be kept in mind

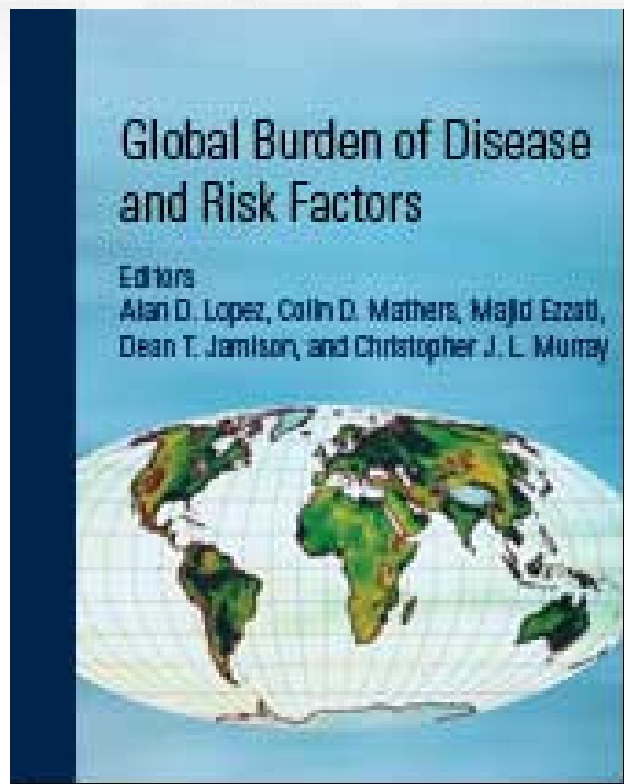
Issues in quantifying risks

- Choosing risks: not too broad, not too specific
- Evidence thresholds: causality, effect size, etc
- What is a risk and what is a lack of an intervention?
- Generalizability of RRs across populations
- Comparability of counterfactuals across risks
- Dealing with the causal chain and joint effects
- Attributable or avoidable burden?

Conclusions: challenges and limitations

- Mortality data issues:
 - New methods (survey and census, VA, hospital data)
 - Longer term improvements in death registration
- Increased standardization, transparency and replicability in dealing with bias and missingness: but difficult issues remain
- Disability critique: DALY quantify loss of health using global standard values for specific health states
- Improved health state valuation methods: but the grand goal of unified cause-specific and population health state measurement and valuation remains distant
- GBD measures the average health of populations. It is one of many inputs in health priority setting and resource allocation

For more information



<http://www.who.int/evidence/bod>

<http://www.dcp2.org/pubs/GBD>

<http://www.globalburden.org>

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