Institute for
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Global Health Informatics

A Big Data Revolution in Disease Burden Measurement

April 30, 2013

Abraham D. Flaxman

Assistant Professor

UNIVERSITY of WASHINGTON

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Global Burden of Disease Study 2010

Published Dec 13, 2012

Executive summary

The Global Burden of Disease Study 2010 (GBD 2010) is the largest ever systematic effort to describe the global distribution and causes of a wide array of major diseases, injuries, and health risk factors. The results [illegible] infectious diseases, maternal and child illness, and malnutrition [illegible] fewer deaths and less illness [illegible] twenty years. As a result, fewer children are dying every year, more young and middle-aged adults are living and suffering from disease and injury, as non-communicable diseases such as cancer and heart disease become the dominant cause of death and disability worldwide. Since 1970, men and women worldwide gained slightly more than ten years of life expectancy overall, but they spend more years living with injury and illness.

GBD 2010 consists of seven Articles, each containing a wealth of data on different aspects of the study (including data for different countries and world regions, men and women, and different age groups), while accompanying Comments include reactions to the study's publication from WHO Director-General Margaret Chan and World Bank President Jim Yong Kim. The study is described by *Lancet* Editor-in-Chief Dr Richard Horton as "a critical contribution to our understanding of present and future health priorities for countries and the global community."

Comments

Audio

MP3 Audio (1):

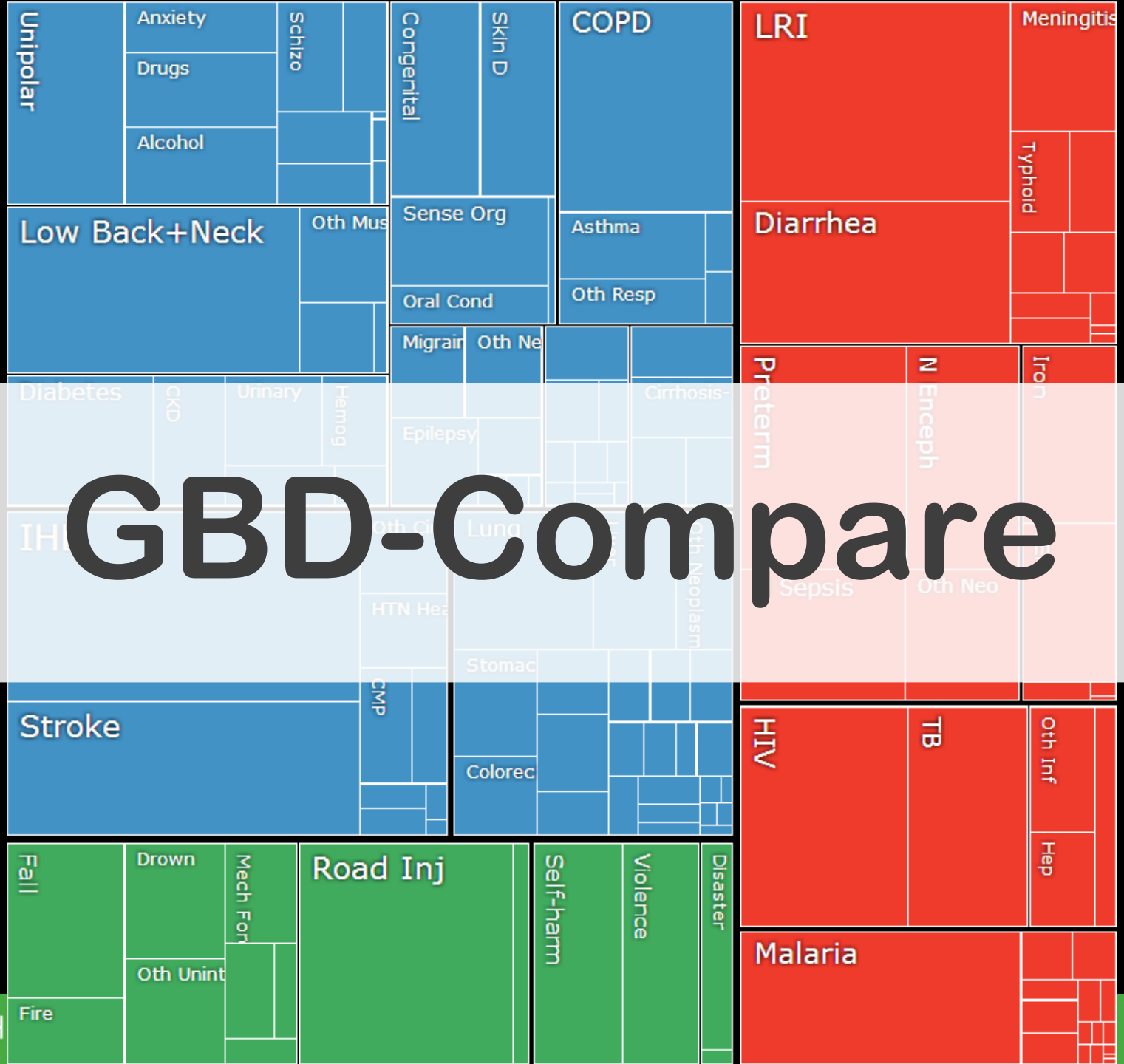
00:00/00:00

Global Burden of Diseases
Richard Horton with a background and overview of GBD 2010.
Download this audio (8.10Mb)

Interactive graphs and figures interpret the GBD 2010 data

Click on the image below to view the interactive graphs and

DALYs = YLL + YLD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Anxiety
Drugs
Alcohol
Schizo
Congenital
Skin D
COPD
Asthma
Oth Resp
Sense Org
Oral Cond
Low Back+Neck
Oth Mus
Migrain
Oth Ne
Diabetes
CKD
Urinary
Hemog
Epilepsy
Cirrhosis-
IH
Oth Ci
Lung
Oth Neoplasm
HTN Hea
Stomac
CMP
Stroke
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Meningitis
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Oth Neo
HIV
TB
Oth Inf
Hep
Malaria
Fall
Fire
Drown
Oth Unint
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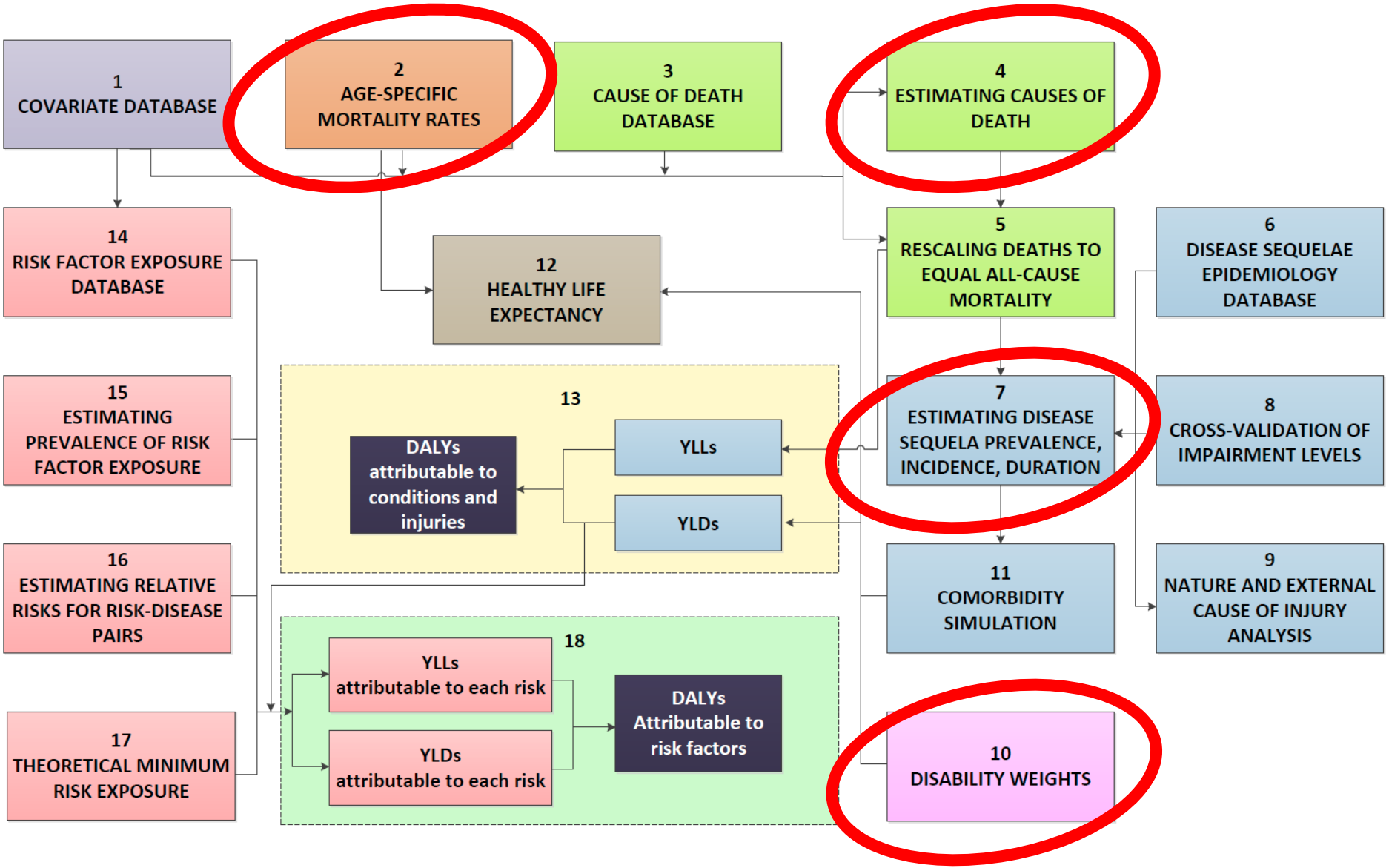
Road Inj
Self-harm
Violence
Disaster

GBD-Compare

Figure 7. GBD 2010 Data and Model Flow Chart



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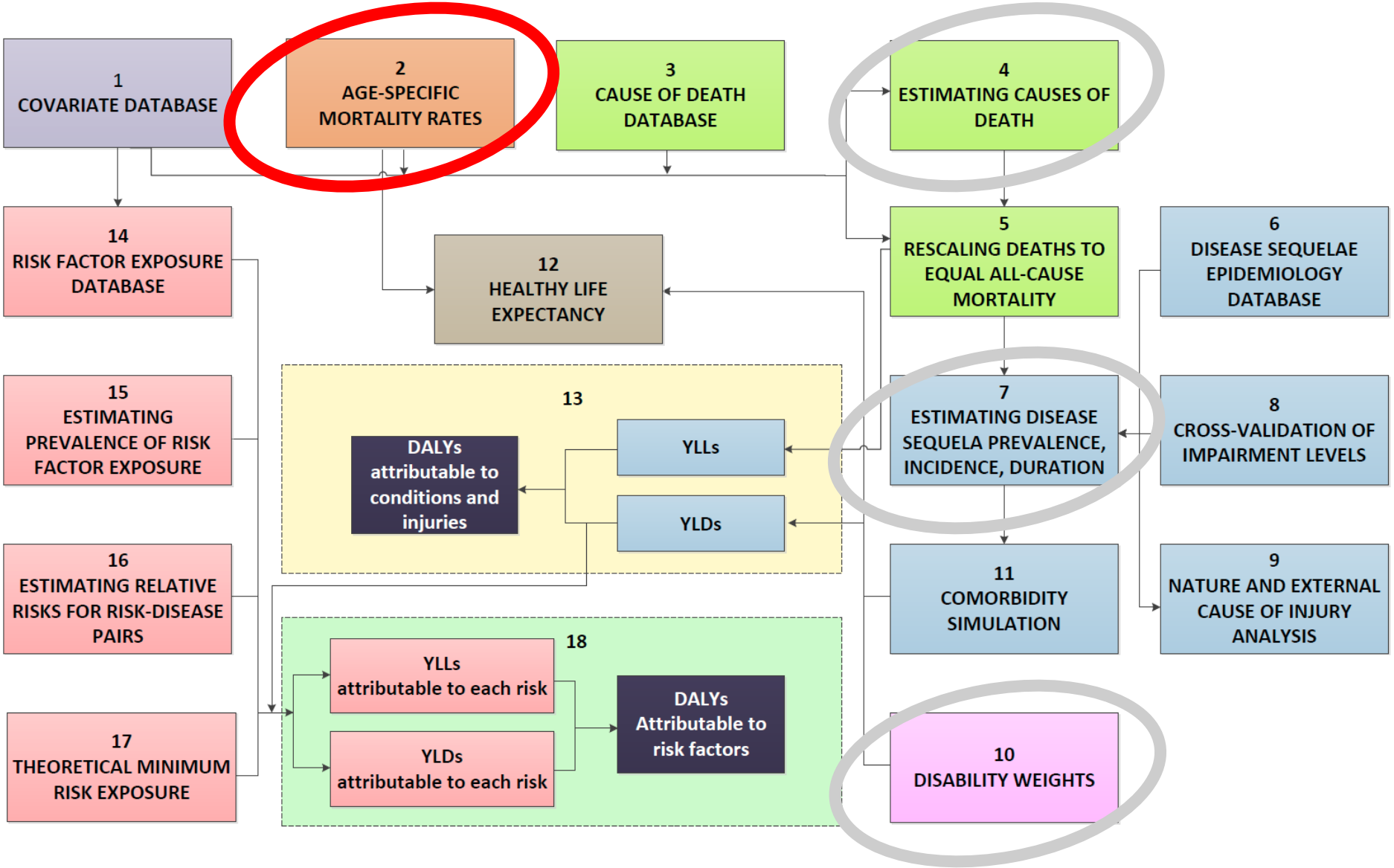

The Lancet, Volume 380, Issue 9859, Pages 2071 - 2094, 15 December 2012
doi:10.1016/S0140-6736(12)61719-X Cite or Link Using DOI
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Age-specific and sex-specific mortality in 187 countries, 1970–2010: a systematic analysis for the Global Burden of Disease Study 2010

Haidong Wang PhD [a], Laura Dwyer-Lindgren MPH [a], Katherine T Lofgren BA [a], Julie Knoll Rajaratnam PhD [a], Jacob R Marcus MPH [a], Alison Levin-Rector MPH [a], Carly E Levitz BA [a], Prof Alan D Lopez PhD [b], Prof Christopher JL Murray MD [a]

Summary

Background

Estimation of the number and rate of deaths by age and sex is a key first stage for calculation of the burden of disease in order to constrain estimates of cause-specific mortality and to measure premature mortality in populations. We aimed to estimate life tables and annual numbers of deaths for 187 countries from 1970 to 2010.

Methods

We estimated trends in under-5 mortality rate (children aged 0–4 years) and probability of adult death (15–59 years) for each country with all available data. Death registration data were available for more than 100 countries and we corrected for undercount with improved death distribution methods. We applied refined methods to survey data on sibling survival that correct for survivor, zero-sibling, and recall bias. We separately estimated mortality from natural disasters and wars. We generated final estimates of under-5 mortality and adult mortality from the data with Gaussian process regression. We used these results as input parameters in a relational model life table system. We developed a model to extrapolate mortality to 110 years of age. All death rates and numbers have been estimated with 95% uncertainty intervals (95% UIs).

Findings

From 1970 to 2010, global male life expectancy at birth increased from 56·4 years (95% UI 55·5–57·2) to 67·5 years (66·9–68·1) and global female life expectancy at birth increased from 61·2 years (60·2–62·0) to 73·3 years (72·8–73·8). Life expectancy at birth rose by 3–4 years every decade from 1970, apart from during the 1990s (increase in male life expectancy of 1·4 years and in female life expectancy of 1·6 years). Substantial reductions in mortality occurred in eastern and southern sub-Saharan Africa since 2004, coinciding with increased coverage of antiretroviral therapy and preventive measures against malaria. Sex-specific changes in life expectancy from 1970 to 2010 ranged from gains of 23–29 years in the Maldives and Bhutan to declines of 1–7 years in Belarus, Lesotho, Ukraine, and Zimbabwe. Globally, 52·8 million (95% UI 51·6–54·1 million) deaths occurred in 2010, which is about 13·5% more than occurred in 1990 (46·5 million [45·7–47·4 million]), and 21·9% more than occurred in 1970 (43·3

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Worldwide mortality in men and women aged 15—59 years from 1970 to 2010: a systematic analysis

Julie Knoll Rajaratnam PhD [a], Jake R Marcus BA [a], Alison Levin-Rector BSPH [a], Andrew N Chalupka [b], Haidong Wang PhD [a], Laura Dwyer BA [a], Megan Costa BA [a], Prof Alan D Lopez PhD [c], Prof Christopher JL Murray MD [a]

Summary

Background

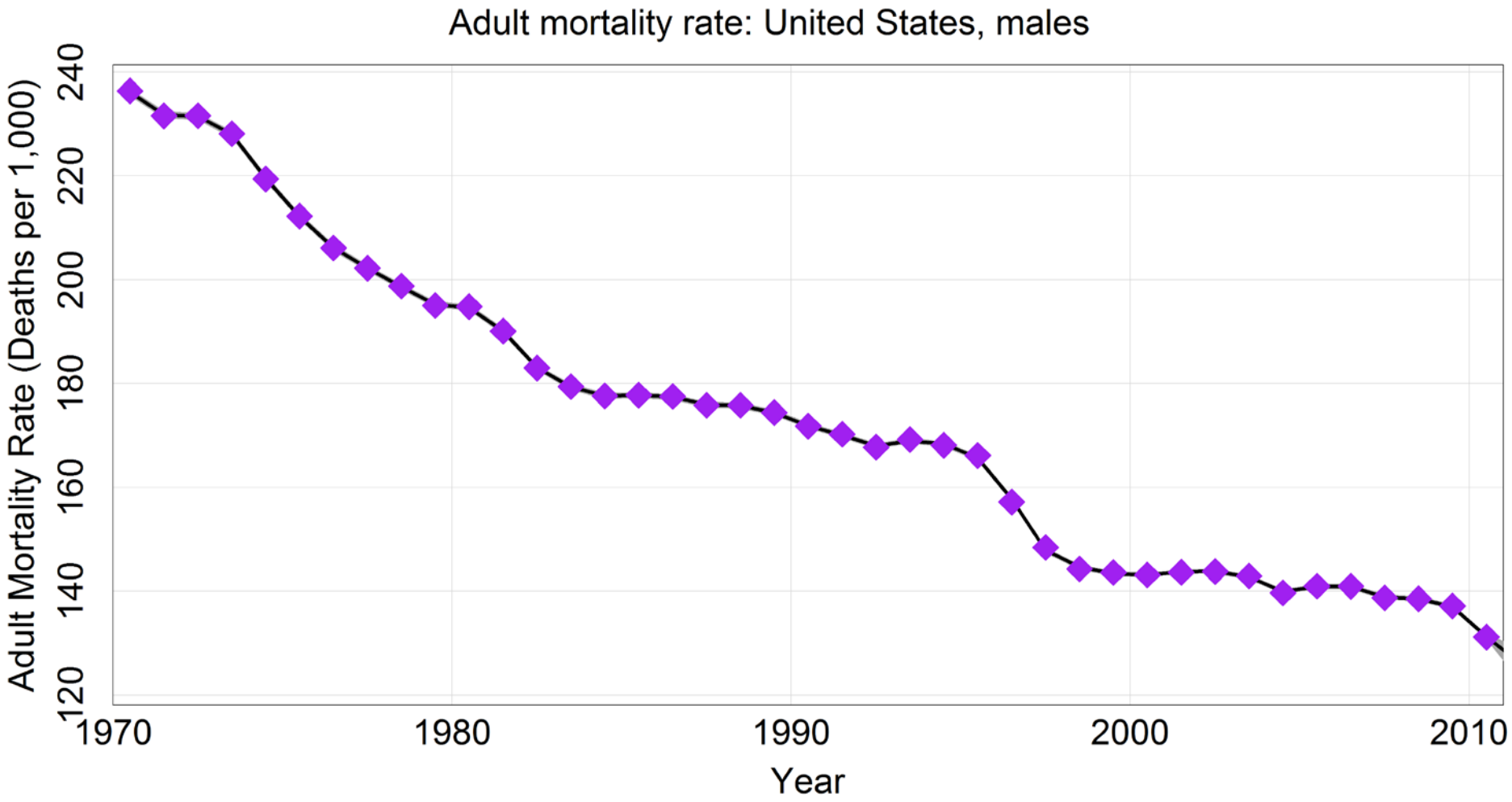
Adult deaths are a crucial priority for global health. Causes of adult death are important components of Millennium Development Goals 5 and 6. However, adult mortality has received little policy attention, resources, or monitoring efforts. This study aimed to estimate worldwide mortality in men and women aged 15—59 years.

Methods

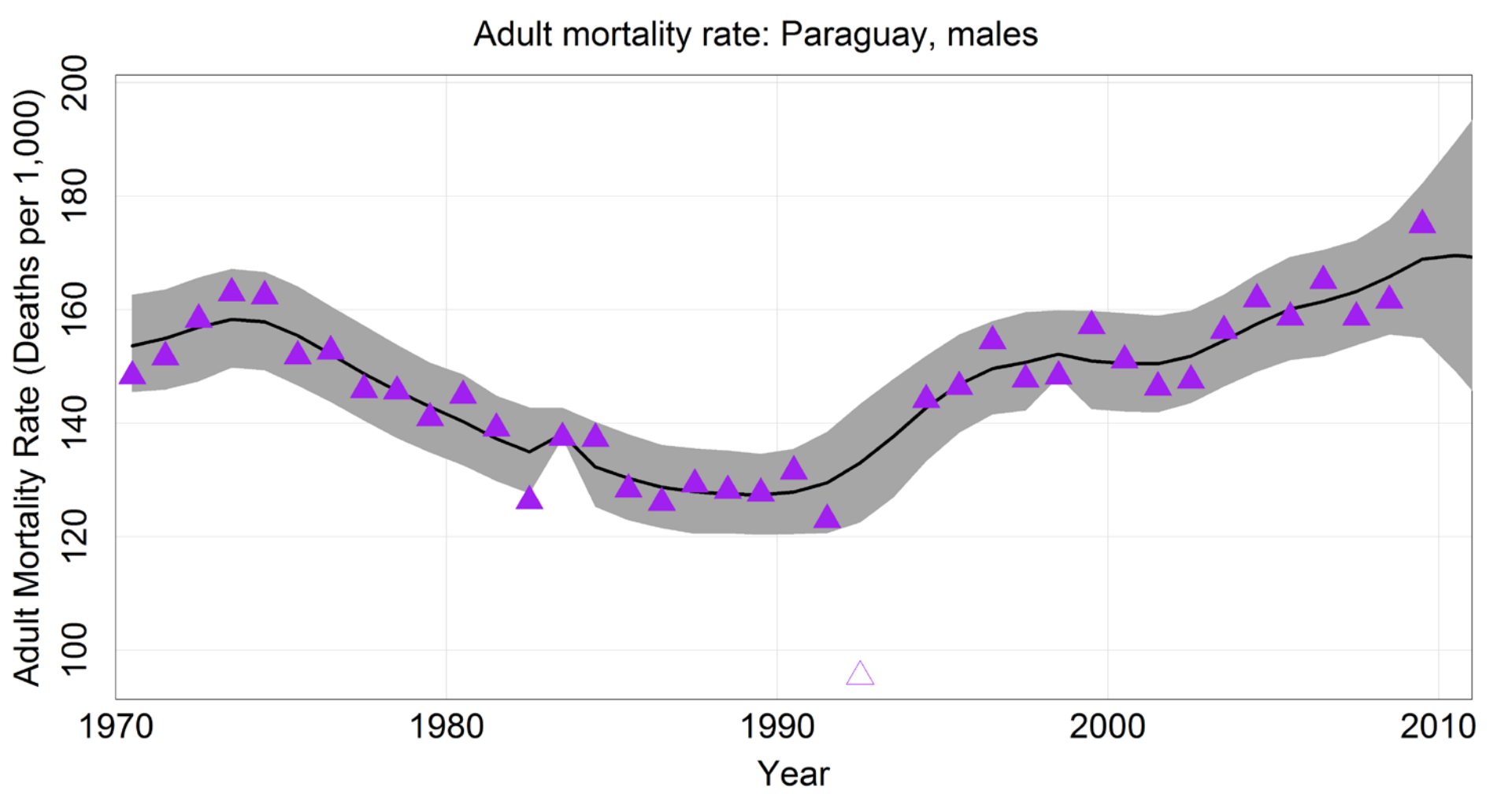
We compiled a database of 3889 measurements of adult mortality for 187 countries from 1970 to 2010 using vital registration data and census and survey data for deaths in the household corrected for completeness, and sibling history data from surveys corrected for survival bias. We used Gaussian process regression to generate yearly estimates of the probability of death between the ages of 15 years and 60 years (45q15) for men and women for every country with uncertainty intervals that indicate sampling and non-sampling error. We showed that these analytical methods have good predictive validity for countries with missing data.

Findings

Adult mortality varied substantially across countries and over time. In 2010, the countries with the lowest risk of mortality for men and women are Iceland and Cyprus, respectively. In Iceland, male 45q15 is 65 (uncertainty interval 61—69) per 1000; in Cyprus, female 45q15 is 38 (36—41) per 1000. Highest risk of mortality in 2010 is seen in Swaziland for men (45q15 of 765 [692—845] per 1000) and Zambia for women (606 [518—708] per 1000). Between 1970 and 2010, substantial increases in adult mortality occurred in sub-Saharan Africa because of the HIV epidemic and in countries in or related to the former Soviet Union. Other

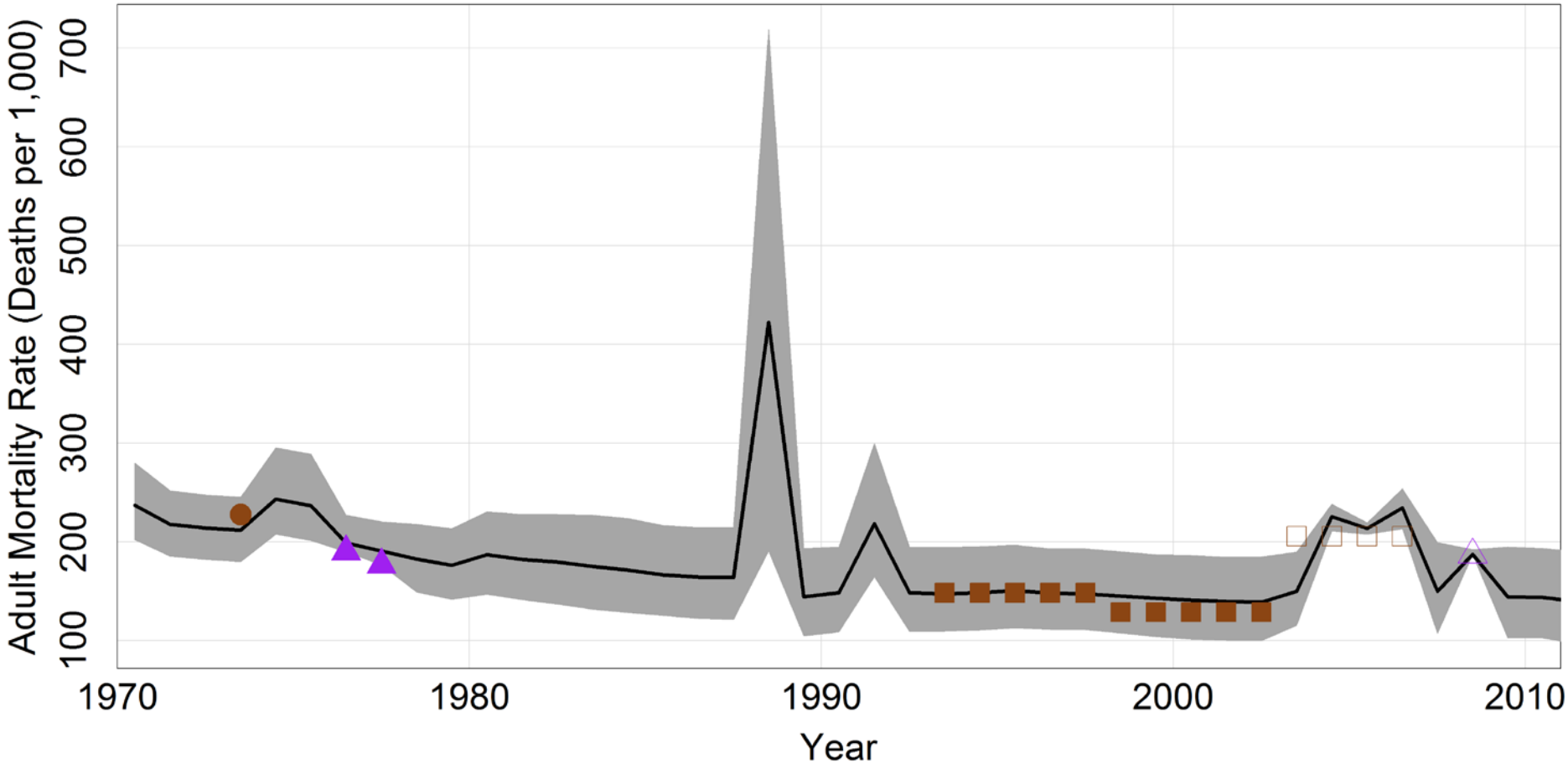


*Hollow points indicate data excluded from the analysis



*Hollow points indicate data excluded from the analysis

Adult mortality rate: Iraq, males

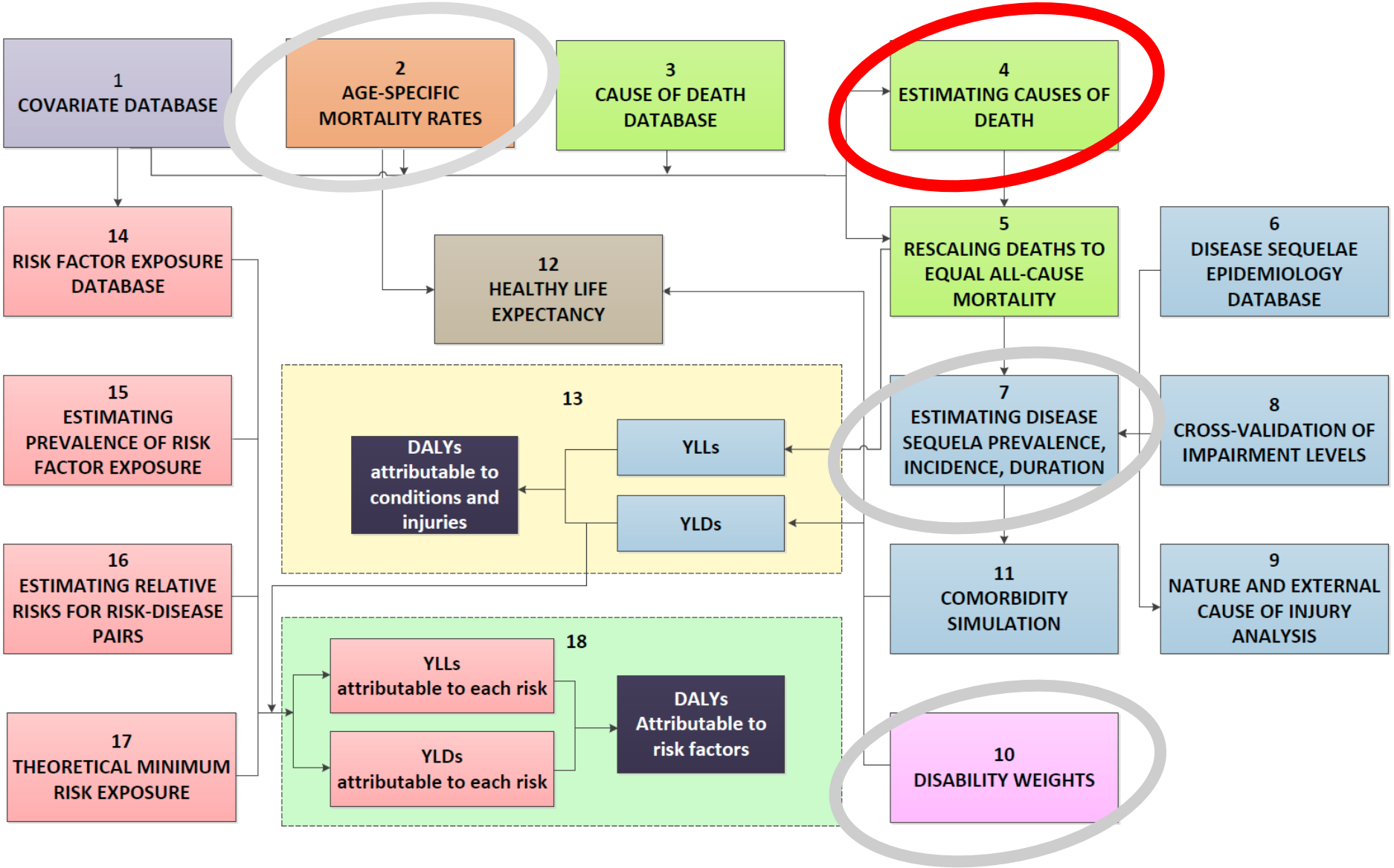


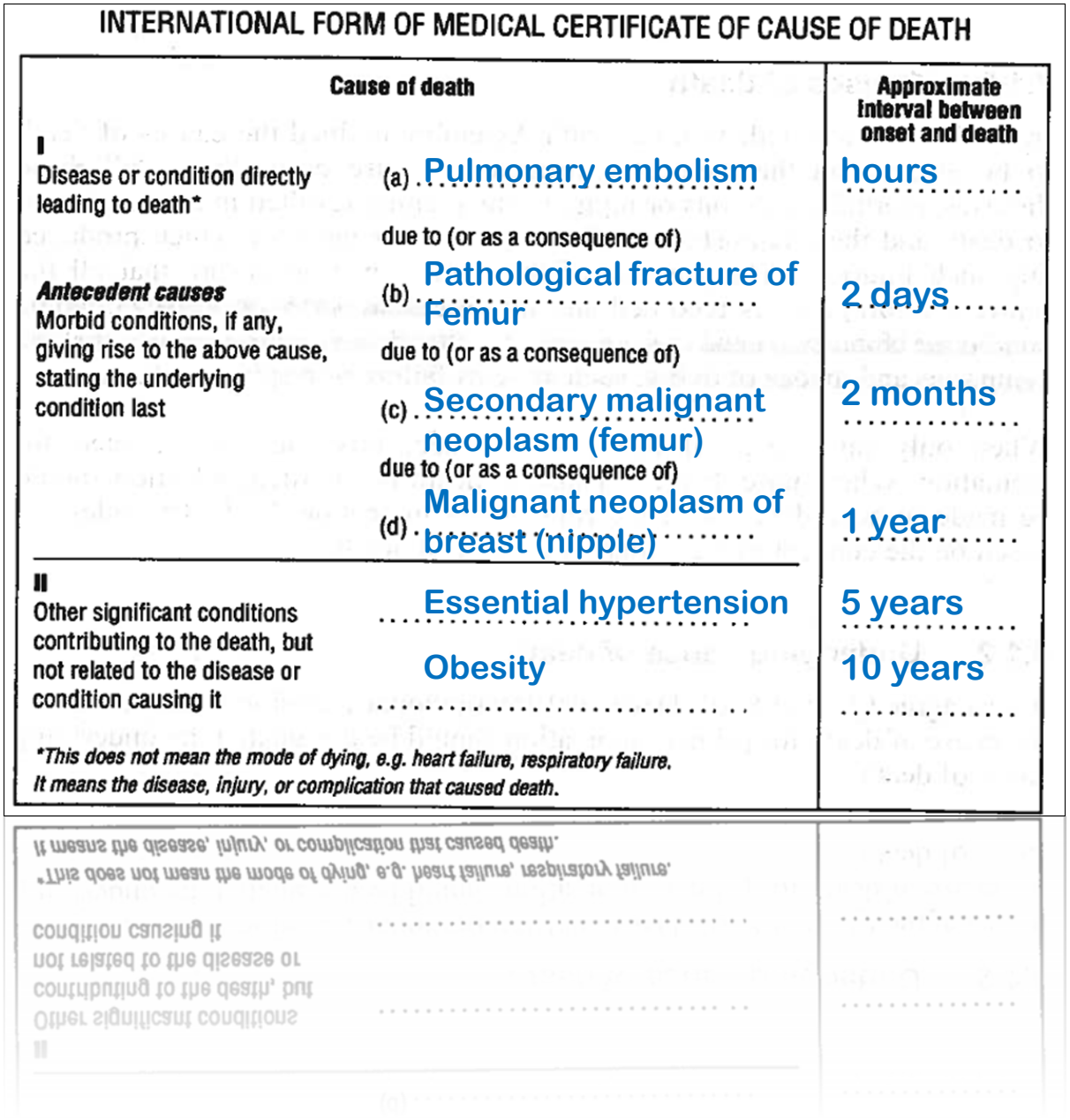
Data Source and Type:

- Gaussian Process Regression with Uncertainty
- Vital Registration - DDM Adjusted
- Iraq Family Health Survey - Sibling History
- Demographic Sample Survey - Unadjusted

*Hollow points indicate data excluded from the analysis

Figure 7. GBD 2010 Data and Model Flow Chart

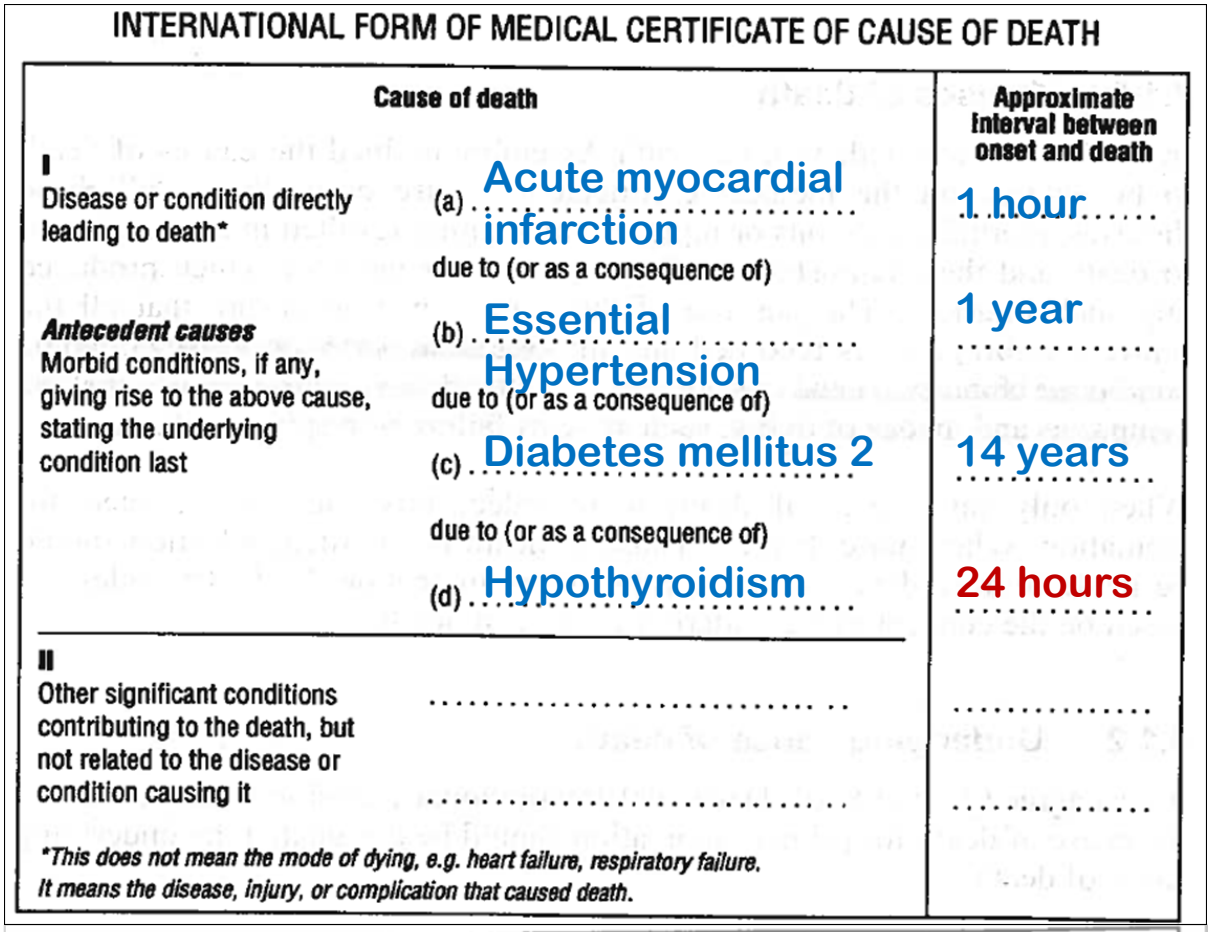




INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

Cause of death		Approximate interval between onset and death
I Disease or condition directly leading to death*	(a) Pulmonary embolism	hours
	due to (or as a consequence of)	
Antecedent causes Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last	(b) Pathological fracture of Femur	2 days
	due to (or as a consequence of)	
	(c) Secondary malignant neoplasm (femur)	2 months
	due to (or as a consequence of)	
	(d) Malignant neoplasm of breast (nipple)	1 year
II Other significant conditions contributing to the death, but not related to the disease or condition causing it	Essential hypertension	5 years
	Obesity	10 years

**This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury, or complication that caused death.*

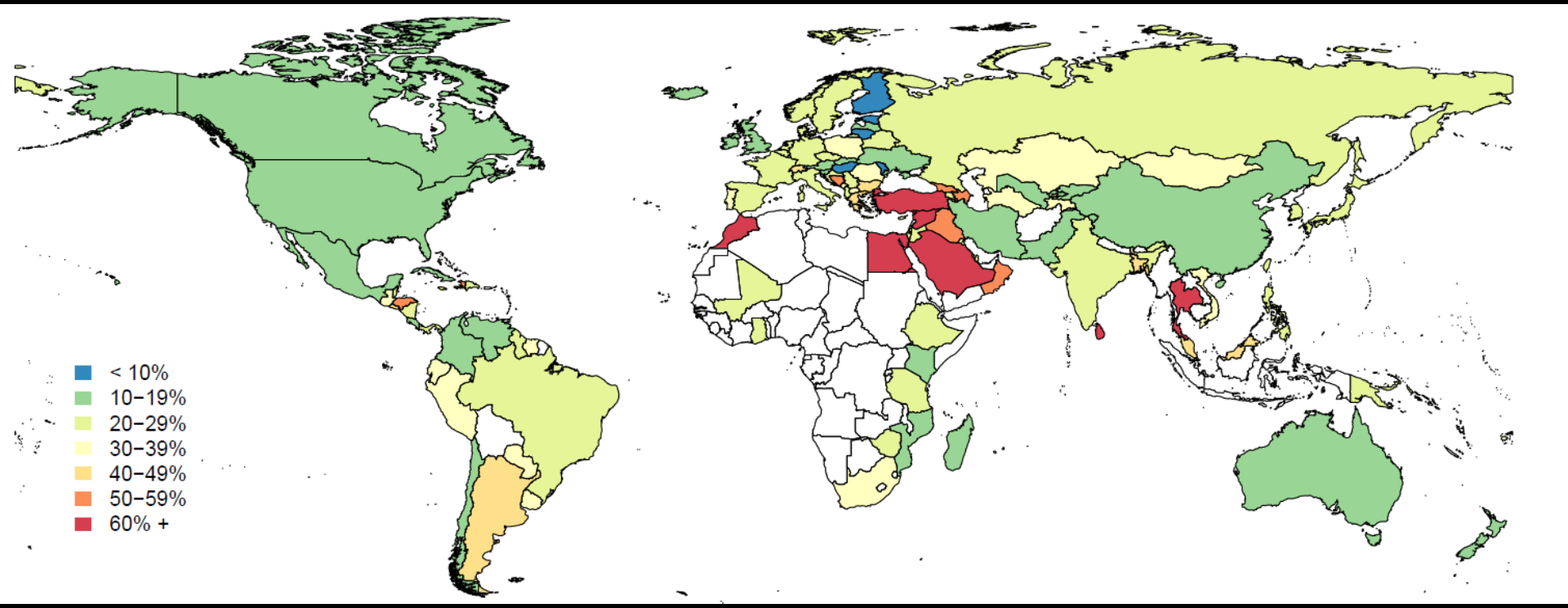


INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

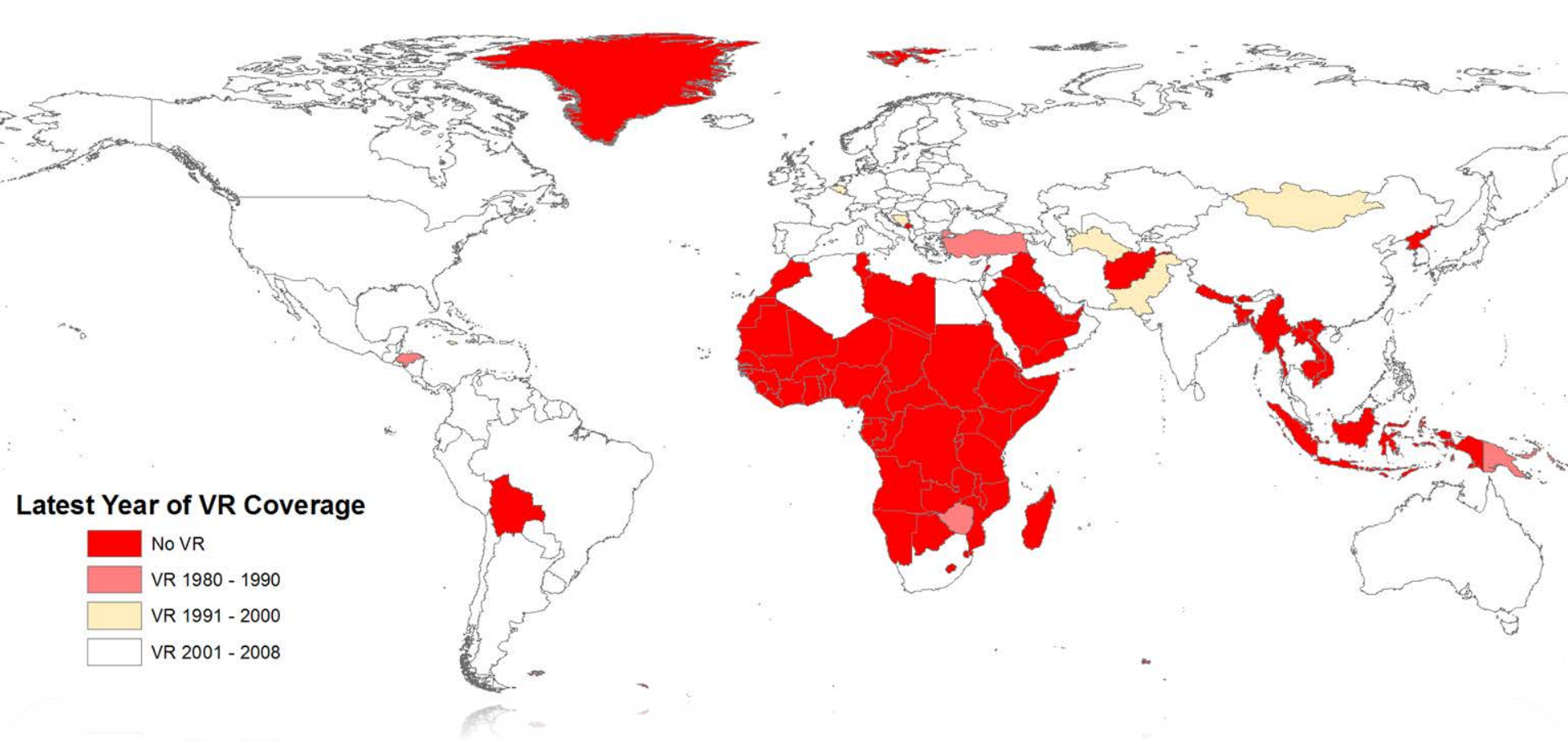
Cause of death		Approximate interval between onset and death
I Disease or condition directly leading to death*	(a) Acute myocardial infarction	1 hour
	due to (or as a consequence of)	
Antecedent causes Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last	(b) Essential Hypertension	1 year
	due to (or as a consequence of)	
	(c) Diabetes mellitus 2	14 years
	due to (or as a consequence of)	
	(d) Hypothyroidism	24 hours
II Other significant conditions contributing to the death, but not related to the disease or condition causing it		

**This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury, or complication that caused death.*

Percent of “Garbage” Death Certificates



Death Registration Coverage



Verbal Autopsy

SECTION 4. DESCRIPTIVE REPORT OF ILLNESS AND EVENTS THAT LED TO THE DEATH

401. Explain to the respondent that we would like to hear the details about everything that happened during the last illness before _____ death starting from the beginning of the ilness and also about what happened during the final hours of the woman's death.

Verbatim:

	Symptoms	Duration	Severity
501	1.		VERY SEVERE ..... 1 MODERATE ..... 2 MILD 3
501A	2.		VERY SEVERE ..... 1 MODERATE ..... 2 MILD 3
	3.		VERY SEVERE ..... 1 MODERATE ..... 2 MILD 3
501B	4.		VERY SEVERE ..... 1 MODERATE ..... 2 MILD 3
501C	5.		

ERY 1 - 2 DAYS 2

AT NIGHT ONLY 3

OTHER 7

DATE

YEAR

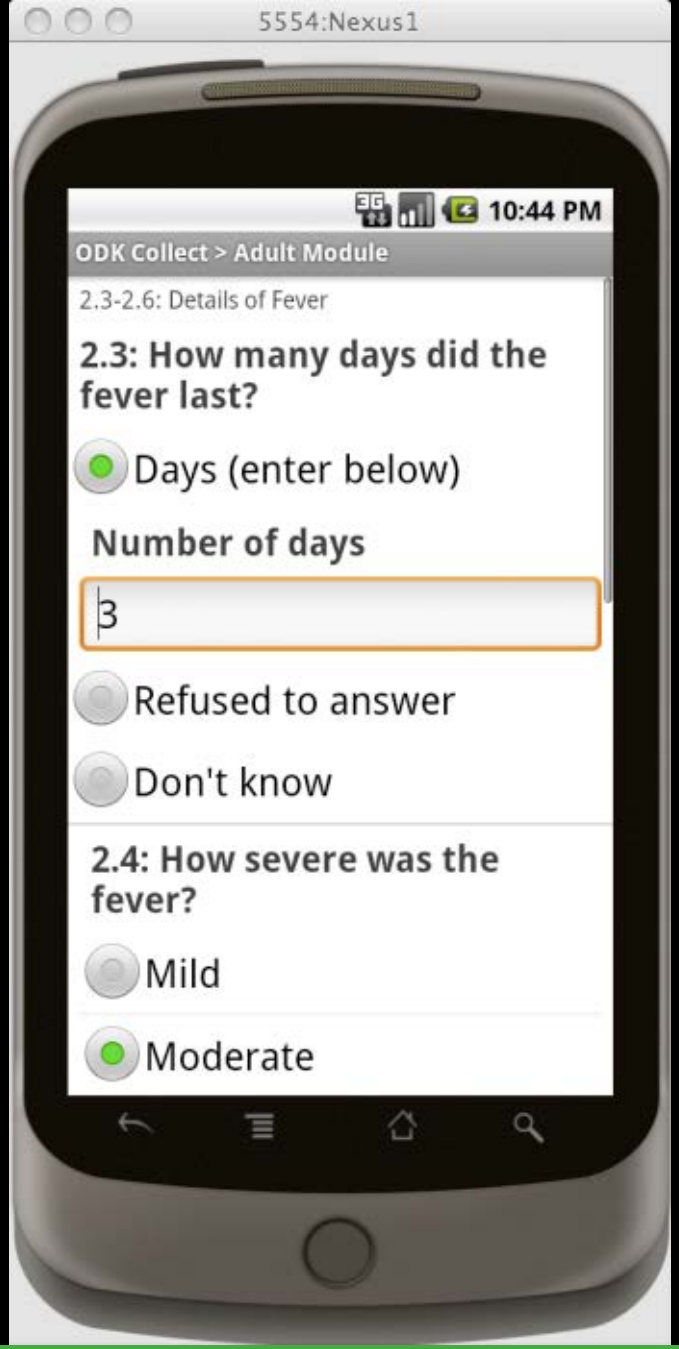
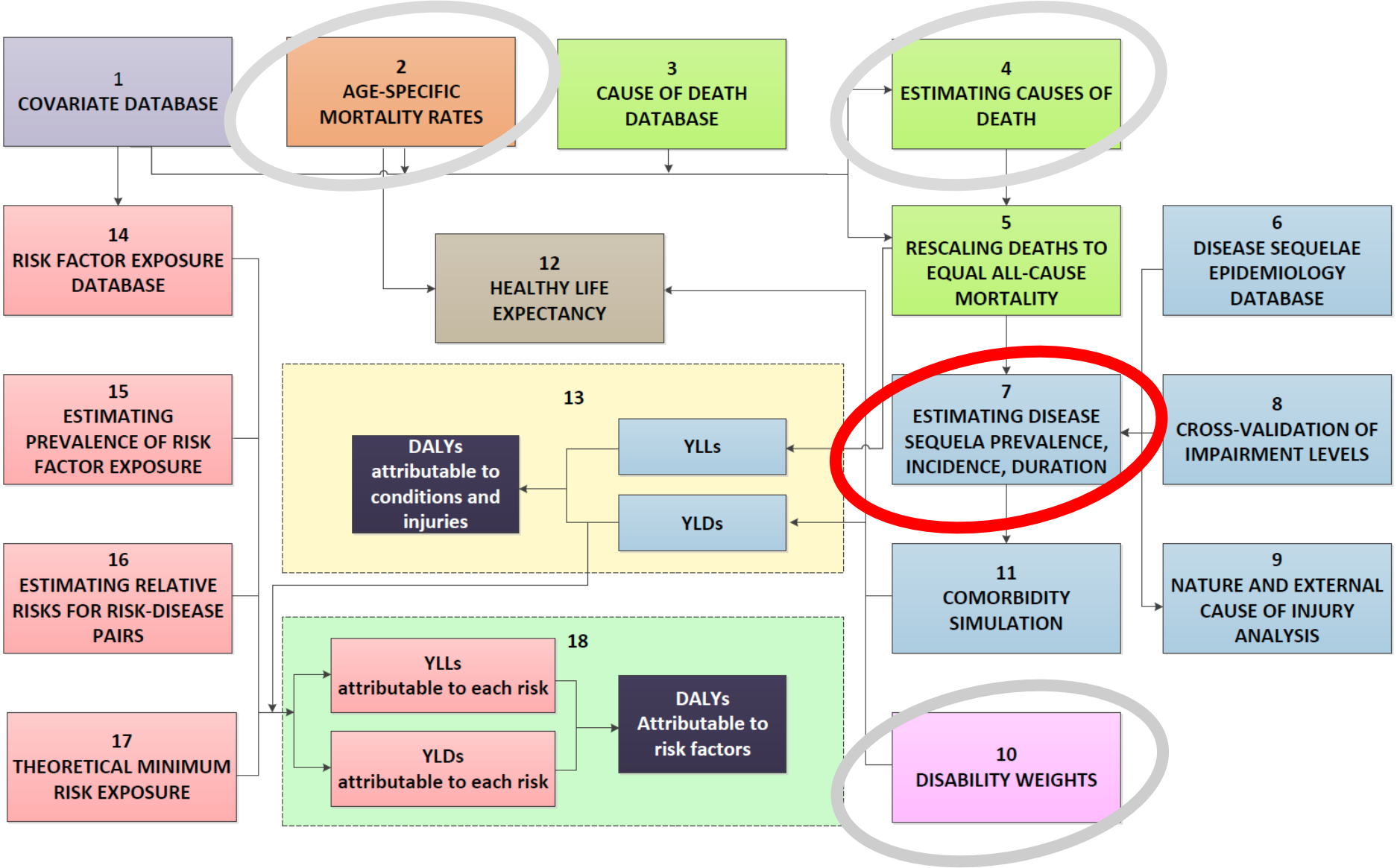
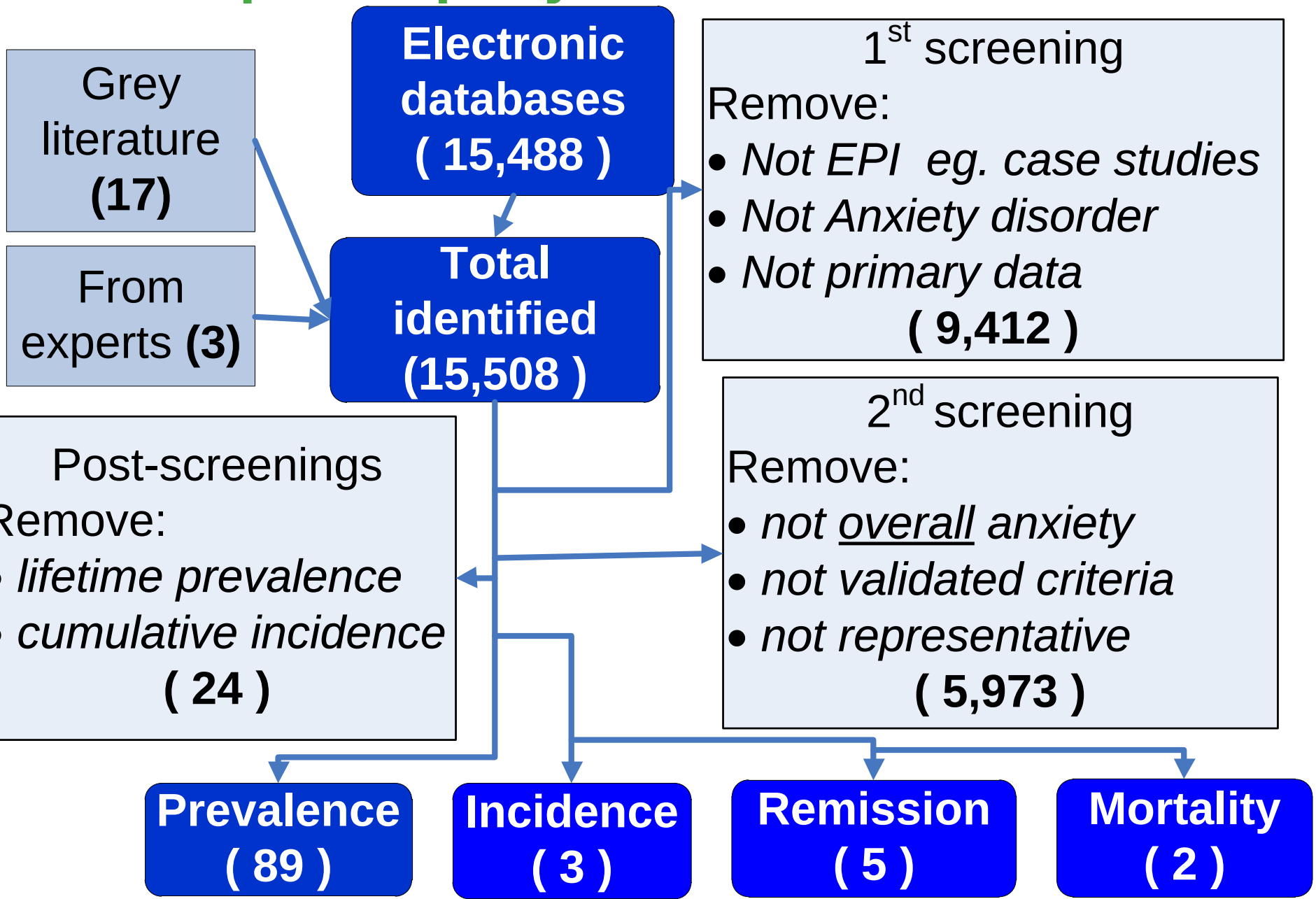
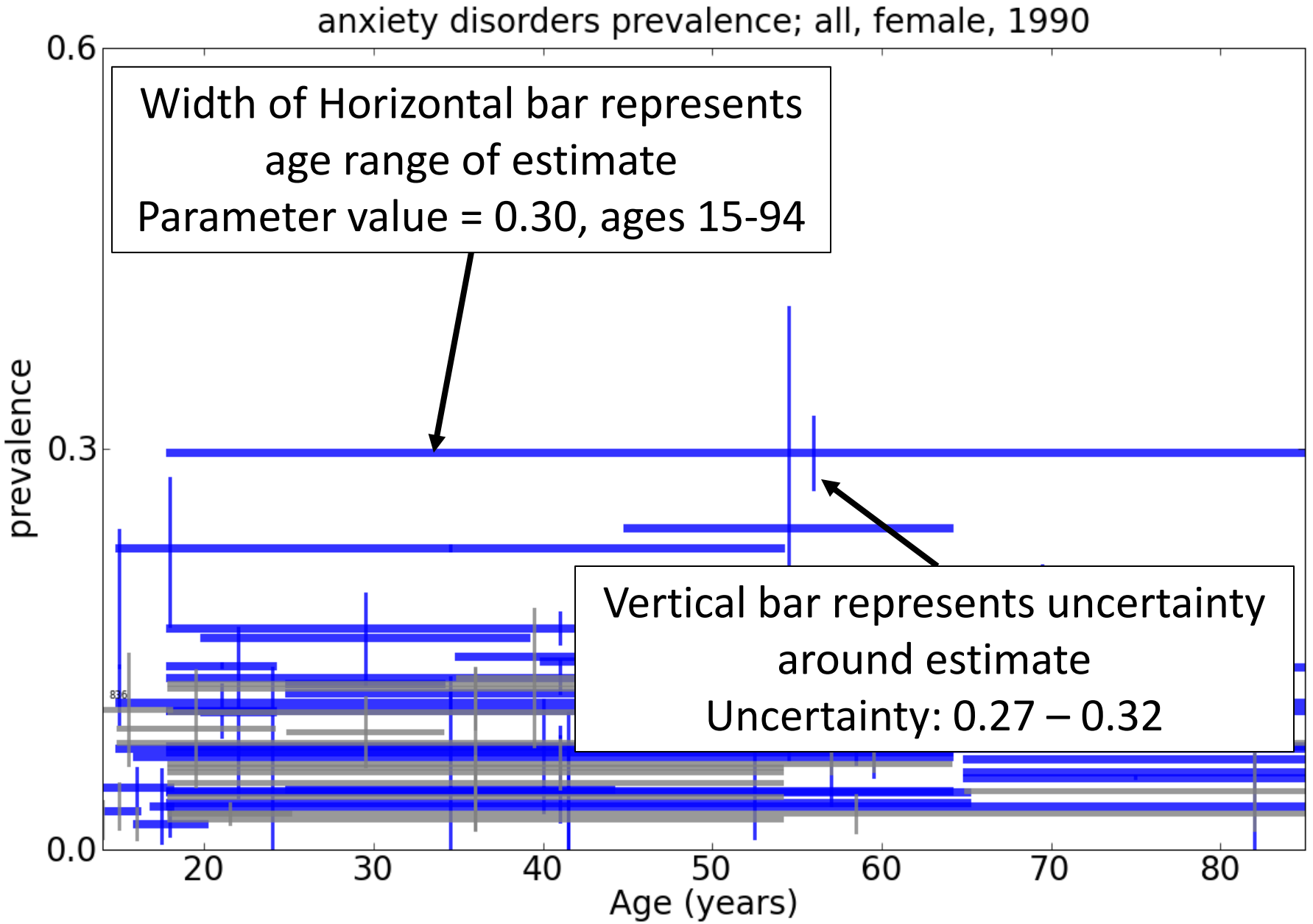

5554:Nexus1
10:44 PM
ODK Collect > Adult Module
2.3-2.6: Details of Fever
2.3: How many days did the fever last?
Days (enter below)
Number of days
3
Refused to answer
Don't know
2.4: How severe was the fever?
Mild
Moderate

Figure 7. GBD 2010 Data and Model Flow Chart

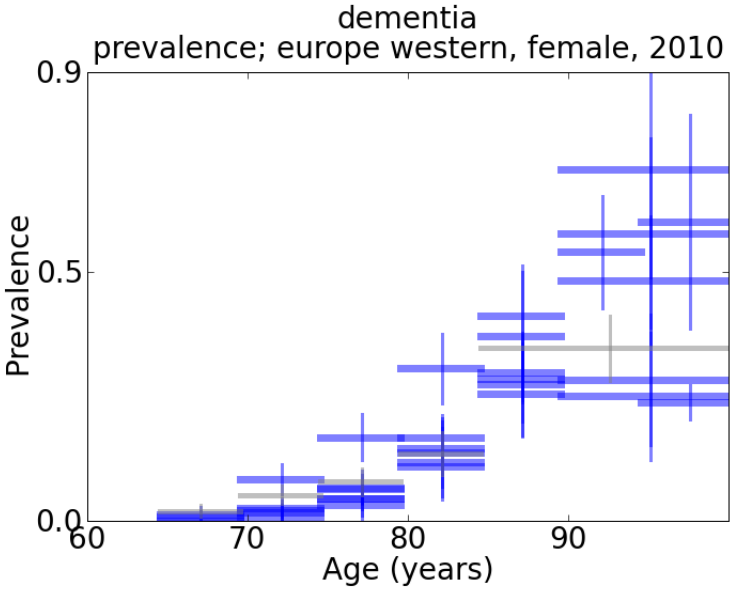


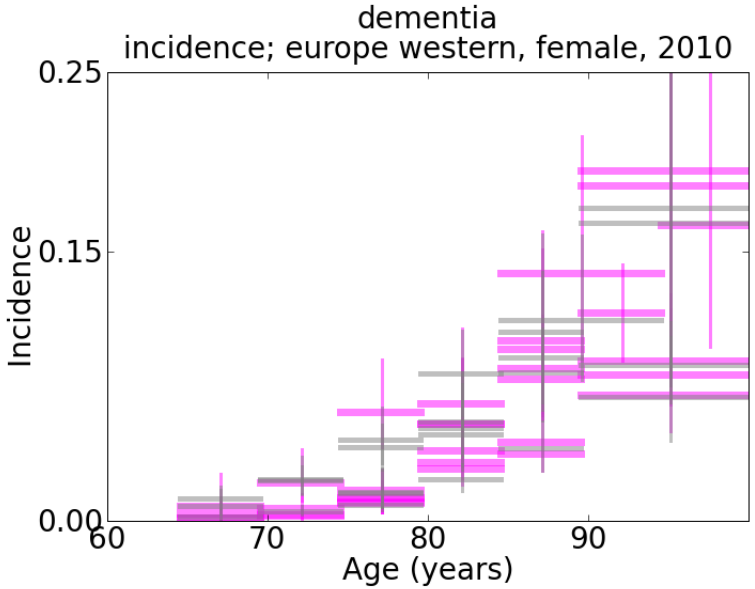
Descriptive Epi Systematic Review

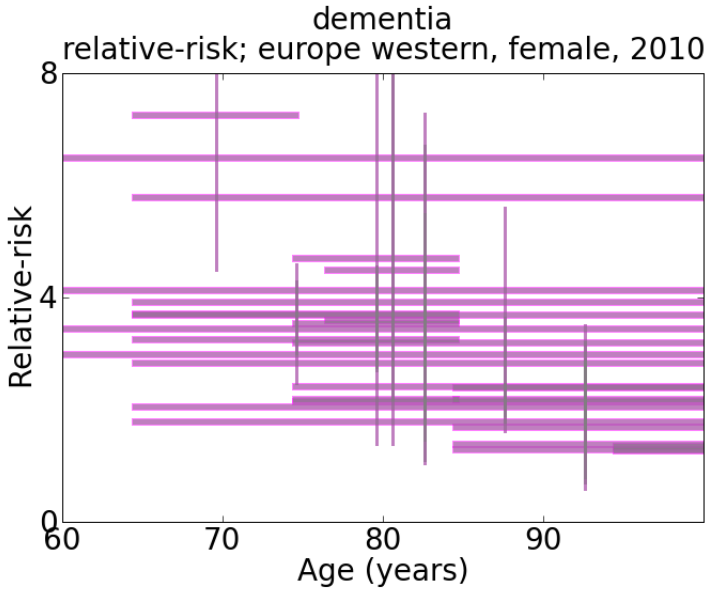


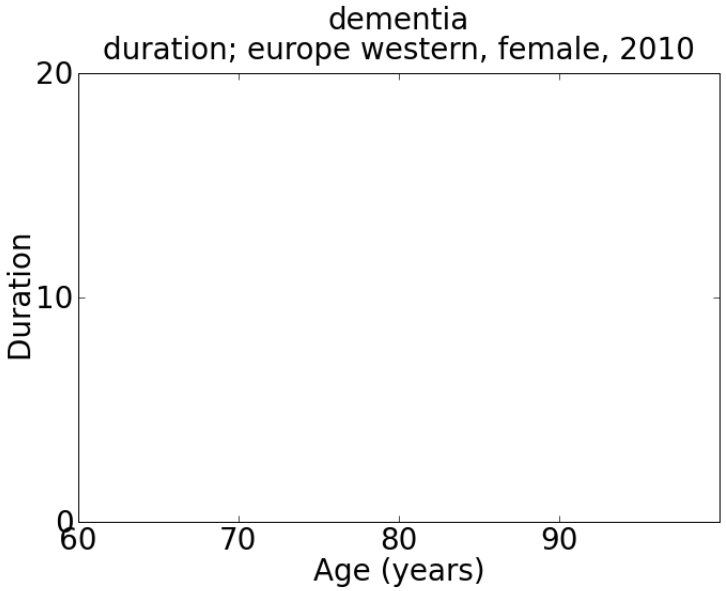

anxiety disorders prevalence; all, female, 1990
Width of Horizontal bar represents age range of estimate
Parameter value = 0.30, ages 15-94
Vertical bar represents uncertainty around estimate
Uncertainty: 0.27 – 0.32
prevalence
0.6
0.3
0.0
20
30
40
50
60
70
80
Age (years)

Example data – Dementia

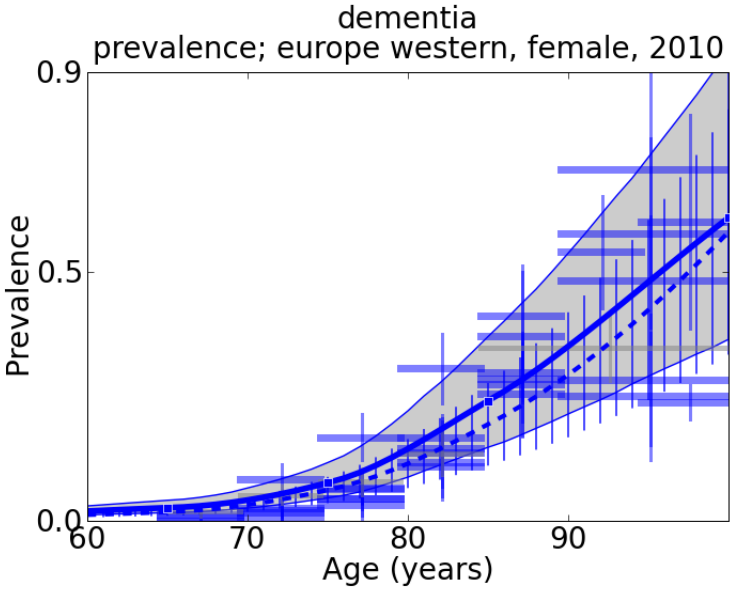


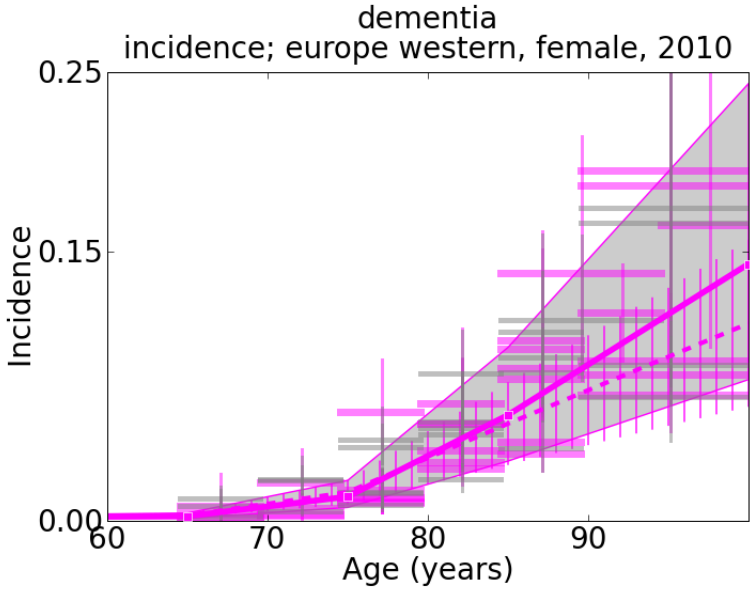


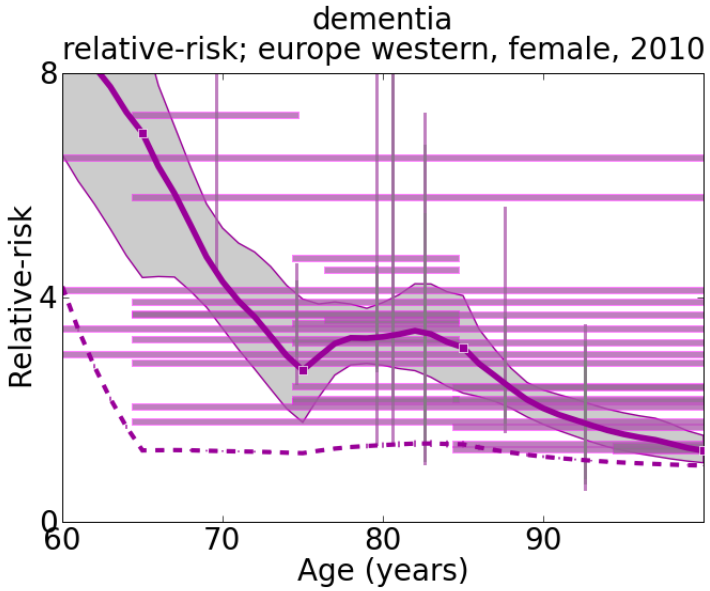


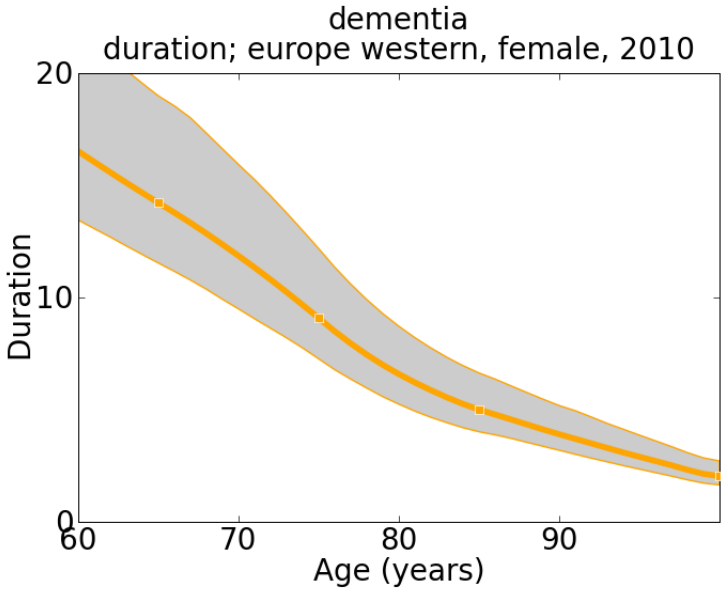


Example estimates – Dementia





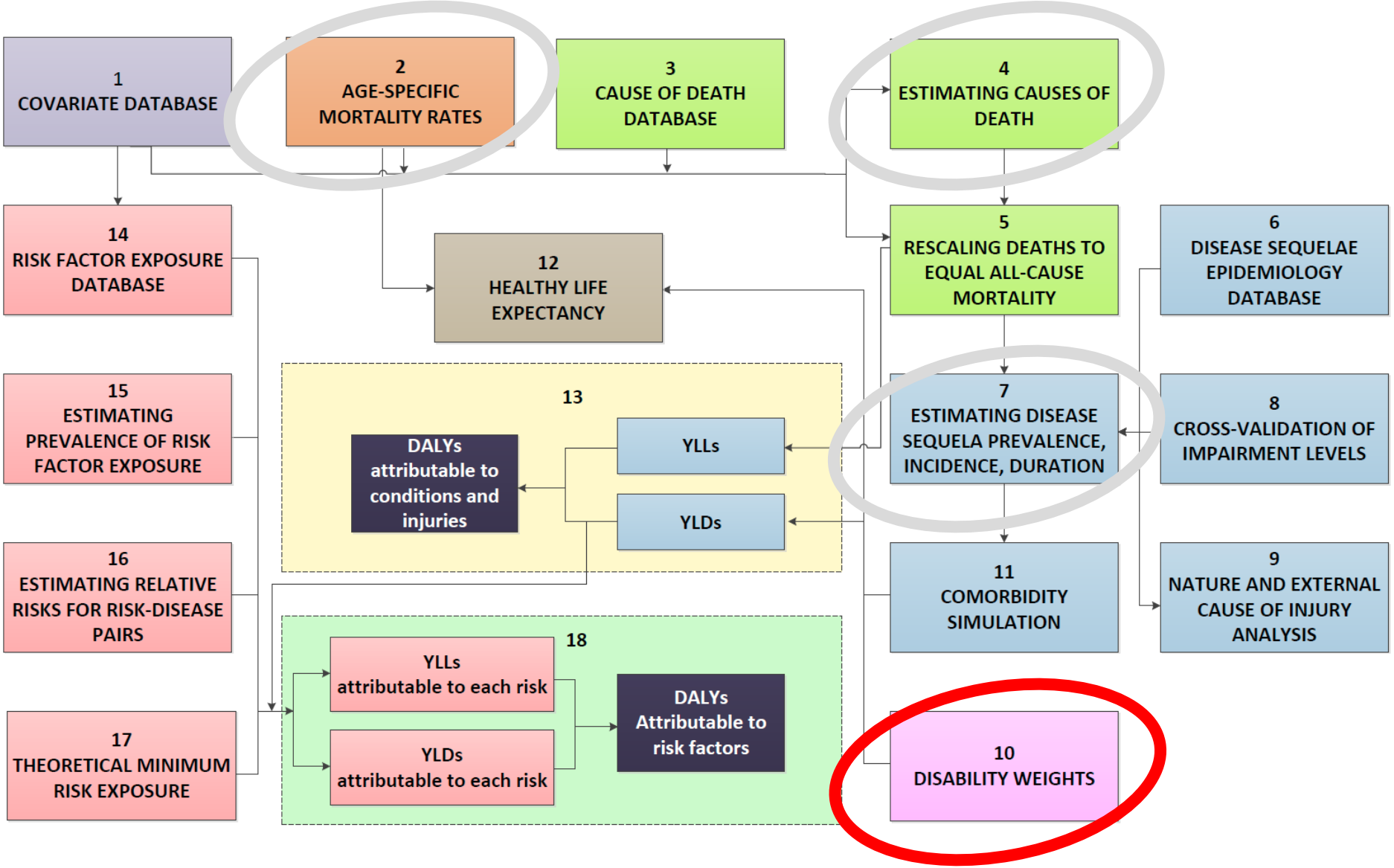




Integrative Systems Model (ISM)

- **Model of Process**
  - **Compartmental model of disease progression**
  - **Spline models for disease as a function of age**
  - **Expert priors on age pattern**
- **Model of Data**
  - **Negative binomial rate models**
  - **Heterogeneous age groups**
  - **Covariate modeling**
    - **fixed effects for explanatory variables**
    - **random effects for unexplained variation**

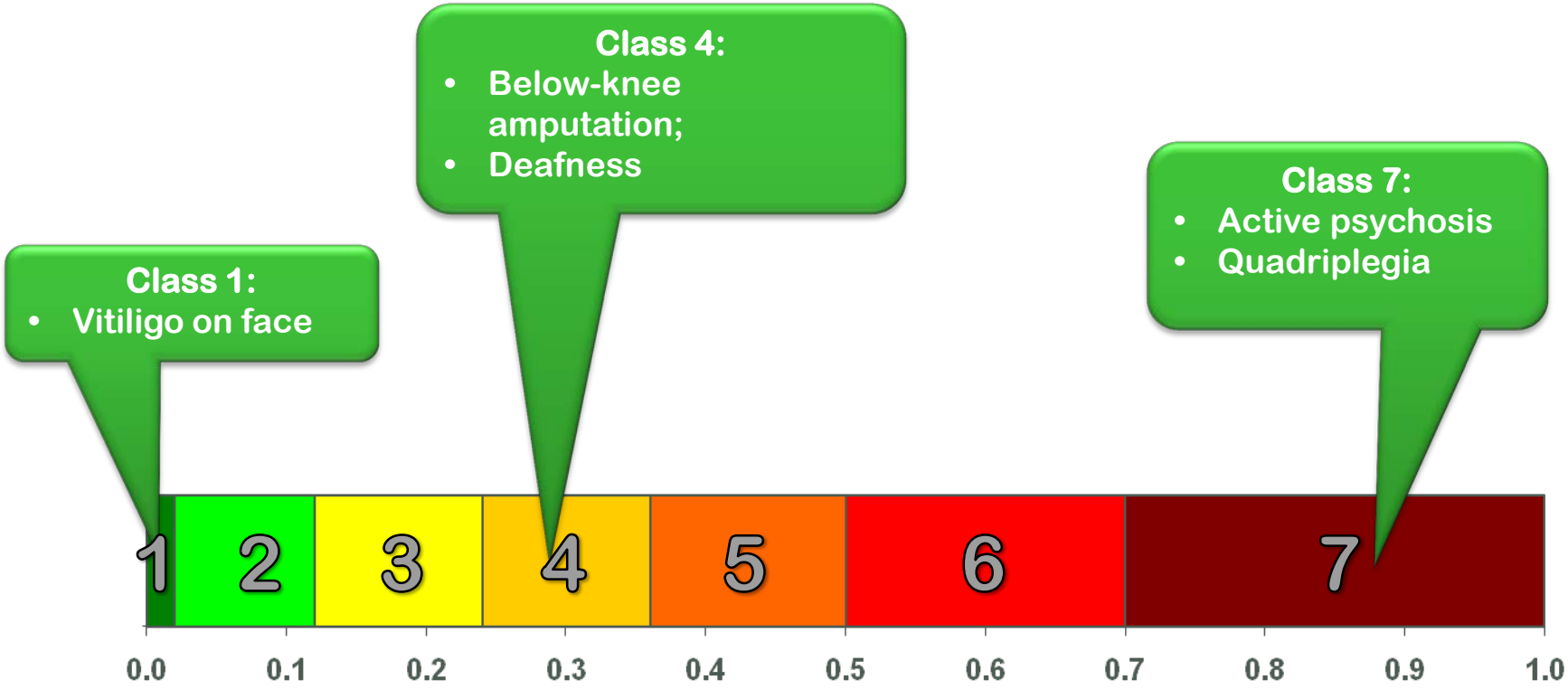
Figure 7. GBD 2010 Data and Model Flow Chart




DALYs = YLL + YLD

$$YLD = \text{Disability Weight} \times \text{Prevalence}$$

Disability weights in GBD 1996



home
winningest kittens
losingest kittens
newest kittens
add your kitten

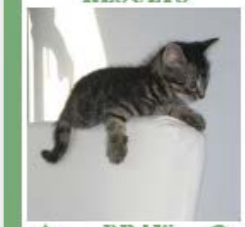
facebook group
kittenwar myspace

faq
e-mail us

kitten search:
Go

t-shirts and stuff

RESULTS



DRAW

CLICK PICS FOR STATS

65% of people agree that Ramses is cuter than Freddie & Marley.

kittenwar

Cowwy 1 and Cowwy 2

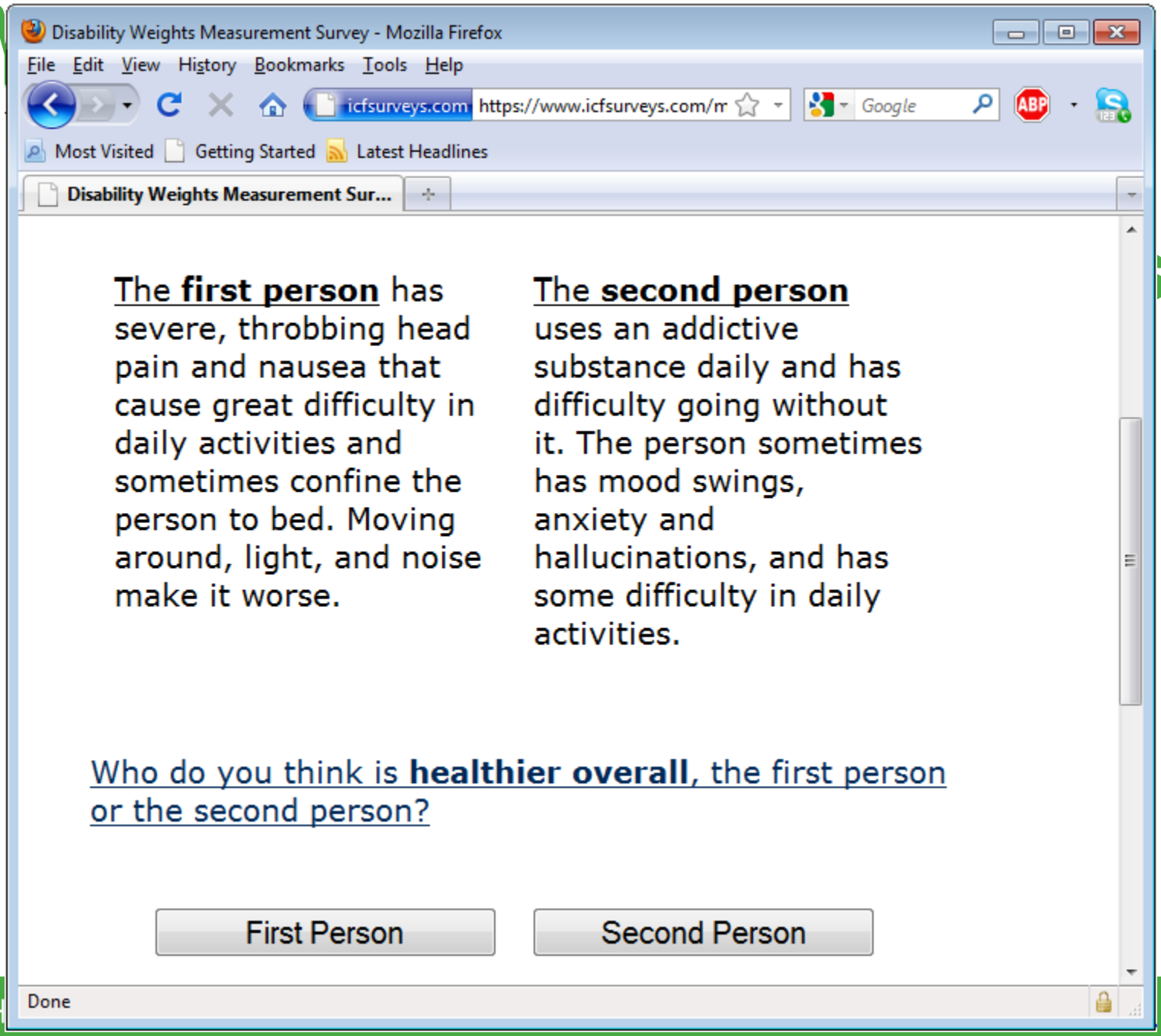
VS.

Jaffa

Click the cutest kitten picture!

Can't decide? Refresh the page for a draw.

Kittenwar has a brilliant new server, check it out! Thank you!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File Edit View History Bookmarks Tools Help
icfsurveys.com https://www.icfsurveys.com/r
Google
Most Visited Getting Started Latest Headlines
Disability Weights Measurement Sur...
The first person has severe, throbbing head pain and nausea that cause great difficulty in daily activities and sometimes confine the person to bed. Moving around, light, and noise make it worse.
The second person uses an addictive substance daily and has difficulty going without it. The person sometimes has mood swings, anxiety and hallucinations, and has some difficulty in daily activities.
Who do you think is healthier overall, the first person or the second person?
First Person
Second Person
Done

Population health equivalence question

The last questions will ask you to compare the overall health benefits produced by two different programs. Imagine there were two different health programs.

- The first program prevented 1000 people from getting an illness that causes rapid death.
- The second program prevented _____ people from getting an illness that is not fatal but causes the following lifelong health problems: _____.

Which program would you say produced the greater overall population health benefit?

Characteristics of the study population

	Bangladesh	Indonesia	Peru	Tanzania	United States	Web survey
By age group (years)						
18-29	908	733	1,025	1,004	181	5,186
30-49	1,256	1,382	1,454	1,063	870	6,660
50-69	557	469	687	457	1,412	4,127
70+	158	87	1	146	852	355
By sex						
Men	1,671	1,385	1,672	1,548	1,230	5,268
Women	1,208	1,286	1,495	1,122	2,092	11,011

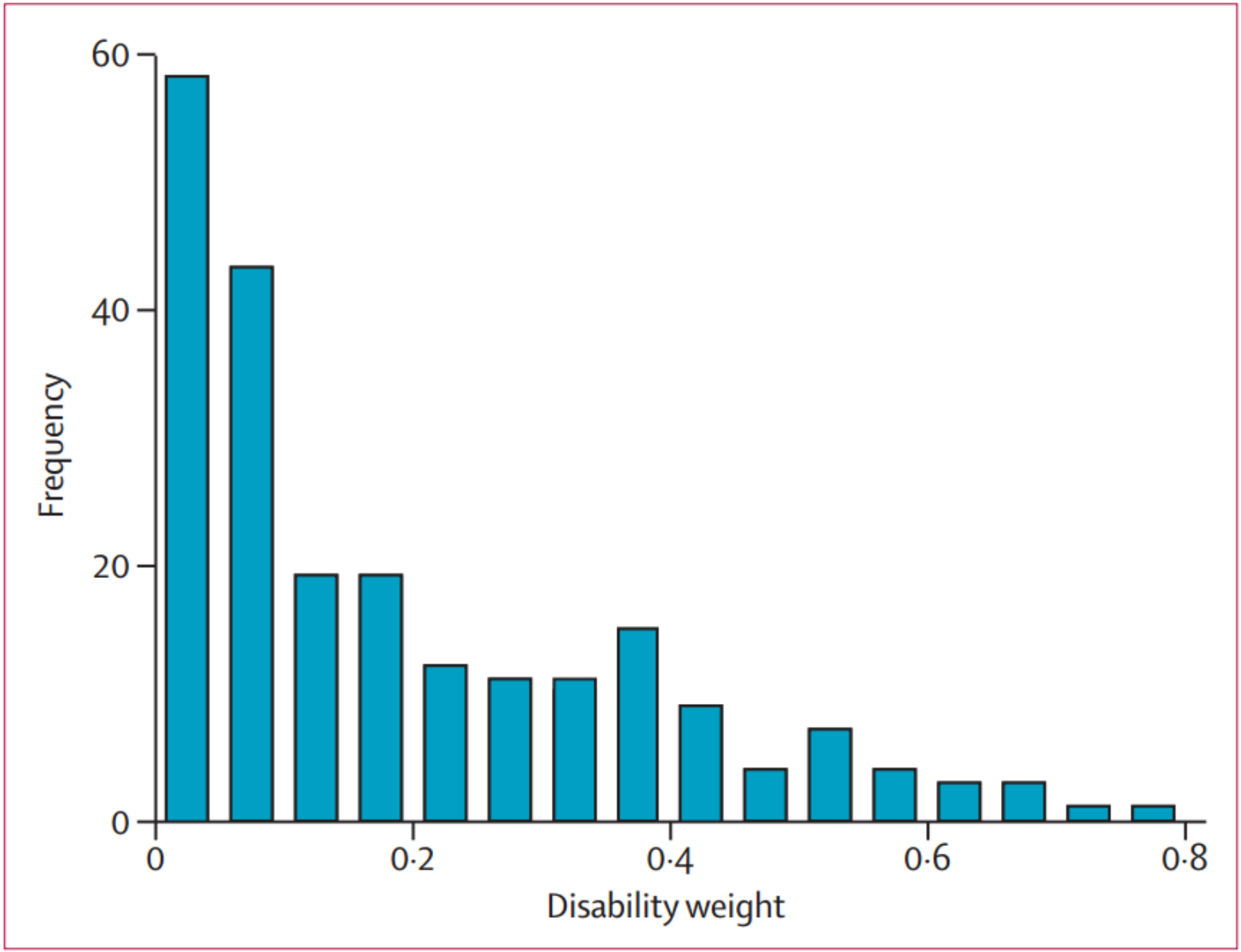


Figure 4: **Frequency distribution of disability weights for 220 health states**

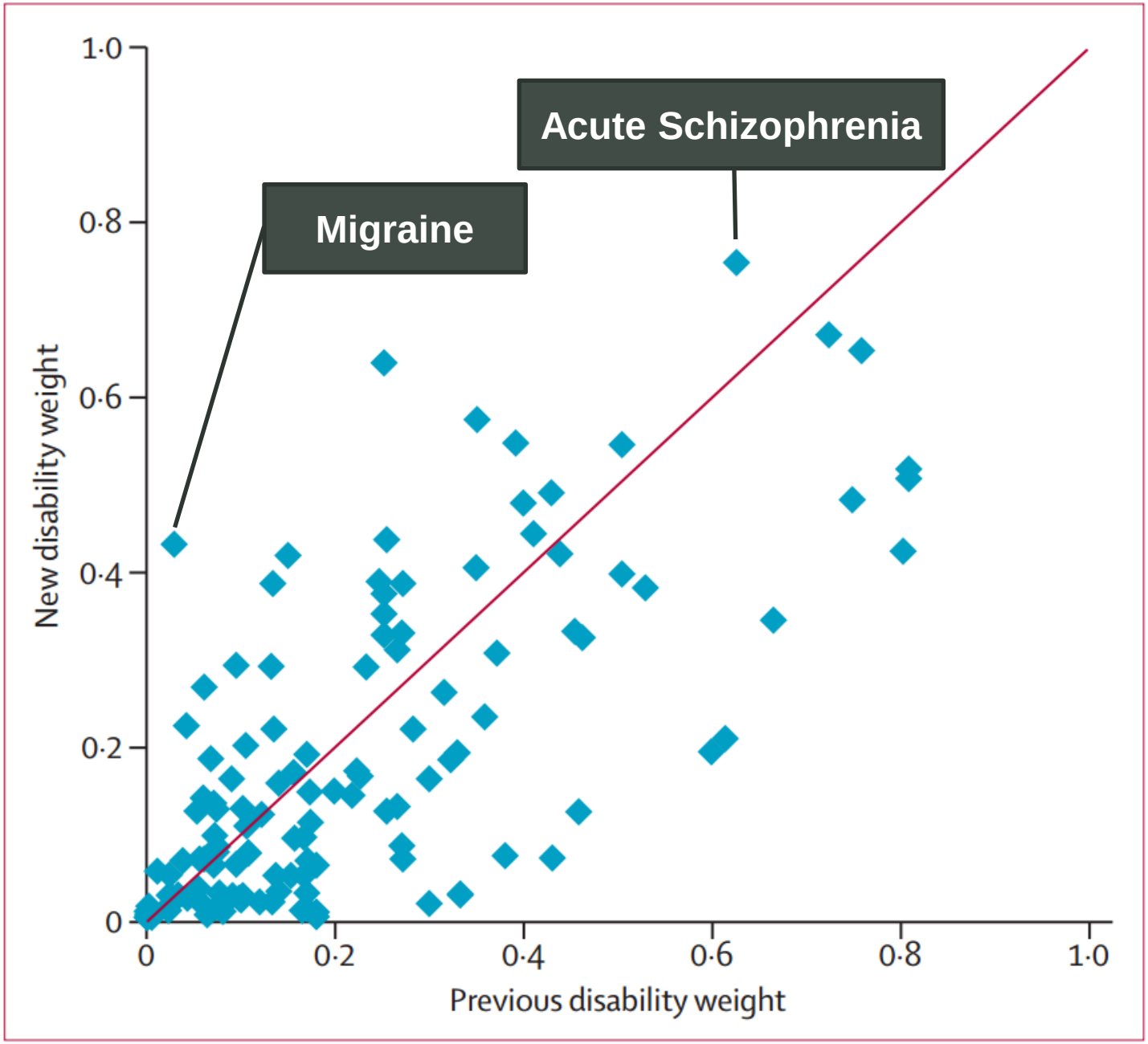
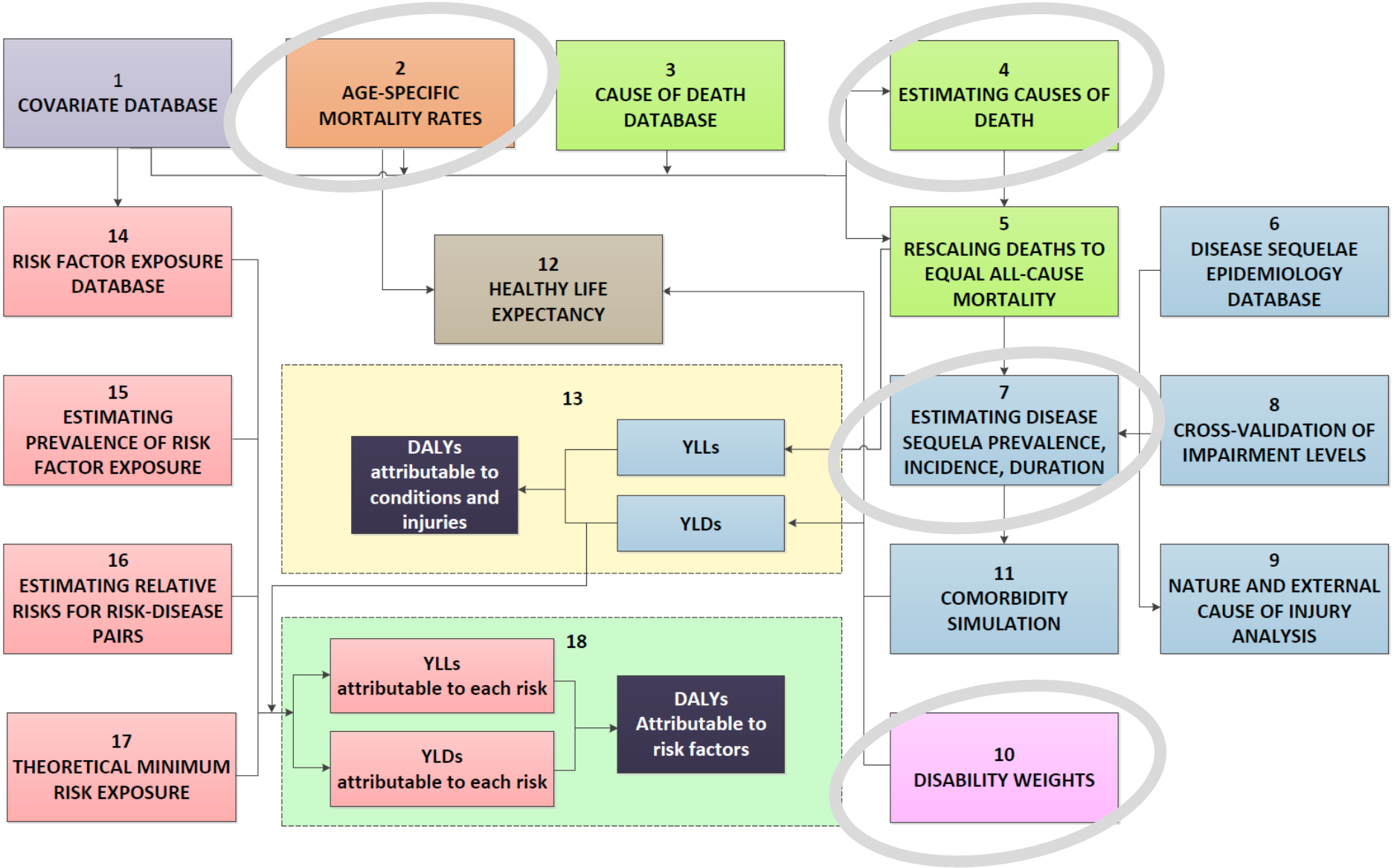


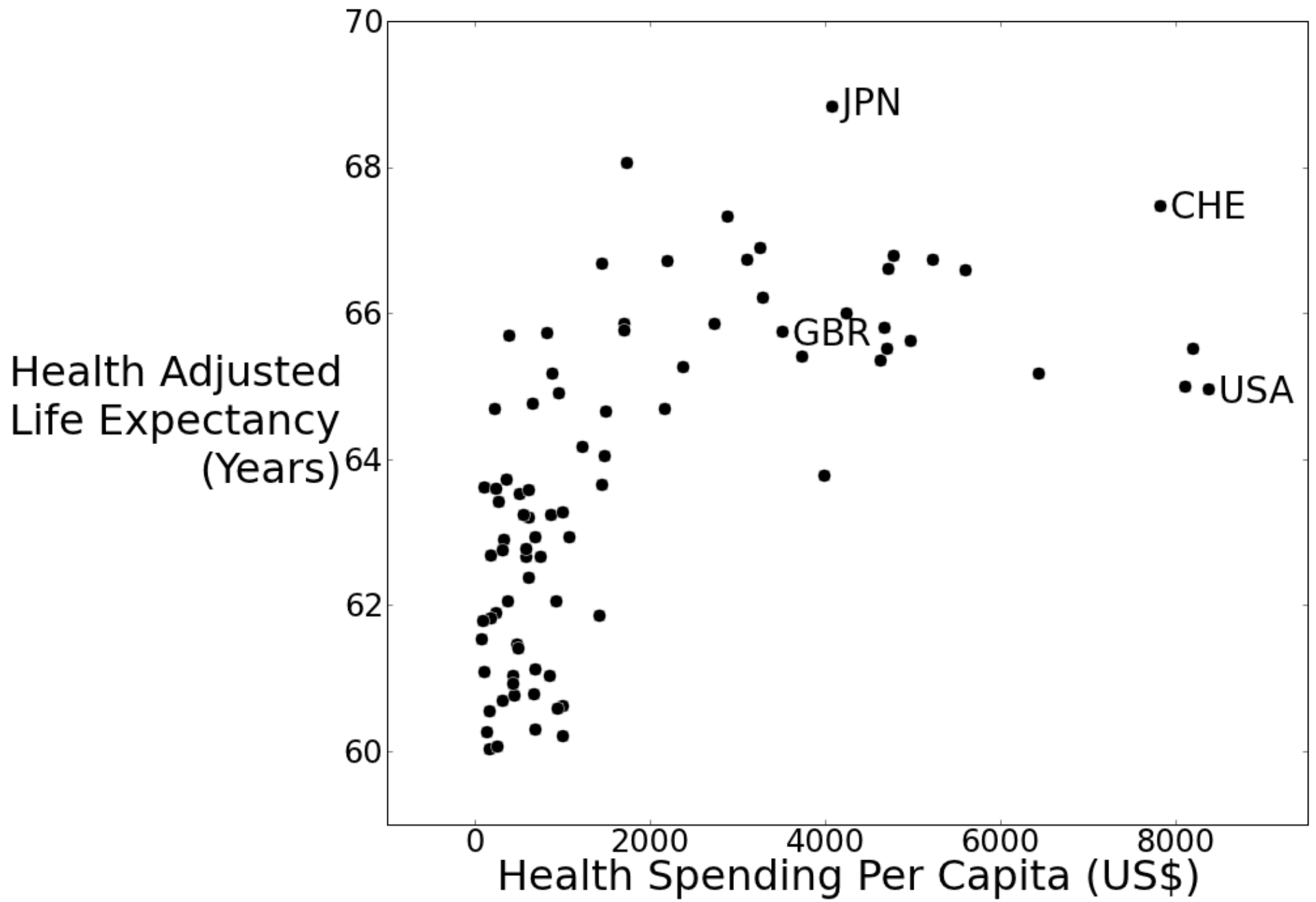
Figure 5: Comparison of disability weights in this study and from WHO's update of the Global Burden of Disease Study for 2004

Figure 7. GBD 2010 Data and Model Flow Chart



What comes next?

- GBD up-to-date
- Subnational burden
- Matching dollars to burden


70
68
66
64
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Health Adjusted
Life Expectancy
(Years)
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Health Spending Per Capita (US$)