



Global Burden of Diseases

Public Health. Lecture 7
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Learning objectives

- **At the end of the training, you will be able to:**
 - **Understand key terms: Disease, Disability, Burden, Disease Burden, Body Burden**
 - **Explain measures of Disease Burden, DALYs and QALYs**
 - **Discuss health inequalities**
 - **Discuss global diseases and Global Burden of Disease**



Disease

Health is compromised due to diseases

Diseases lead to death and/or disability

Quality and quantity of life is reduced due to disease

Mortality + Disability is proportional to the quantity of disease



Disability

Disability can be understood as:

- shortfall in an ideal health status
- an ideal health status minus actual health status
- Several definitions over time
- Definitions can be dictated by science and politics



Definitions

- **Impairment** is loss or abnormality of structure or function
- **Disability** is restriction or lack of ability to perform an activity in the manner of within the range considered normal for a human being
- **Handicap** is disadvantage that results from an impairment or disability that prevents the fulfillment of a normal role
 - Note that current definition mixes prior version of disability and handicap

<http://www.who.int/icidh/>



Examples

Disease/ Disorder	Impairment	Disability	Handicap
Polio	Paralyzed muscles of the legs	Inability to walk	Unemployed due to belief that person cannot work
Brain injury retardation at birth	Mild mental retardation	Difficulty learning	Social isolation



Key terms

- **Person-time:**
 - 1 person x 10 years of smoking (15 cigarettes /day x 365 days)
 - 2 person x 12 years of smoking
- **Person-distance**
- **Sentinel events are index cases which are taken as measures of problems in a health care process:**
 - The first cases or initial group of cases of an infectious disease
 - Death (in case of non-infectious disease)



What is burden?

- **Burden is load or taxing on individual or family, or society, or Nation, or the globe**
- **It could be cultural, chemical, pathological, economic, social or socioeconomic**
- **Disease burden is judged against disease events**
- **Disease burden could be due to factors driving from backend to frontend event of a Disease Causal Chain**
- **Disease investigator needs to understand variety of burdens**



Utility of estimating Disease Burden

- **Important input to health decision-making and planning processes**
- **Provides a framework for integrating, validating, analyzing and disseminating information needed to assess the comparative importance of diseases, injuries and risk factors in causing premature death, loss of health and disability in different populations**



Body burden

- **Body burden is the load of foreign chemicals in the body**
 - **Most of the chemicals could be toxic**
- **Some of these chemicals could alter the functions of genes**
 - **Some of these could disrupt endocrine system**

Burden of disease = Measurement of load or taxing due to disease in a population



Burden of disease

- To measure Burden of disease we use **DALY** (Disability-Adjusted Live Year)
- To measure benefits from intervention we use **QALY** (Quality-Adjusted Life Years)



Disability Adjusted Life Years (DALY)

DALYs = Life Years Lost due to premature mortality + Life Years Lost due to time lived in states of less than full health

One DALY = One lost year of "healthy" life

Basic measure (using “optimal” life tables) is a measure of burden of disease

Most interested in comparison of burden of disease without and with a new intervention

– Necessary for cost-effectiveness



Not all people are in perfect health their entire lives

Premature death



DALY = disability-adjusted life year

The number of years of healthy life lost due to premature death, disabling illness, or injury

DALYs are calculated for disease or health condition

$$\text{DALYs} = \text{YLL} + \text{YLD}$$

YLL = Years of life lost

The number of years of life expectancy remaining at time of death

YLD = Years of life lived with disability

The number of years of life spent unwell, weighted according to the severity of illness or injury

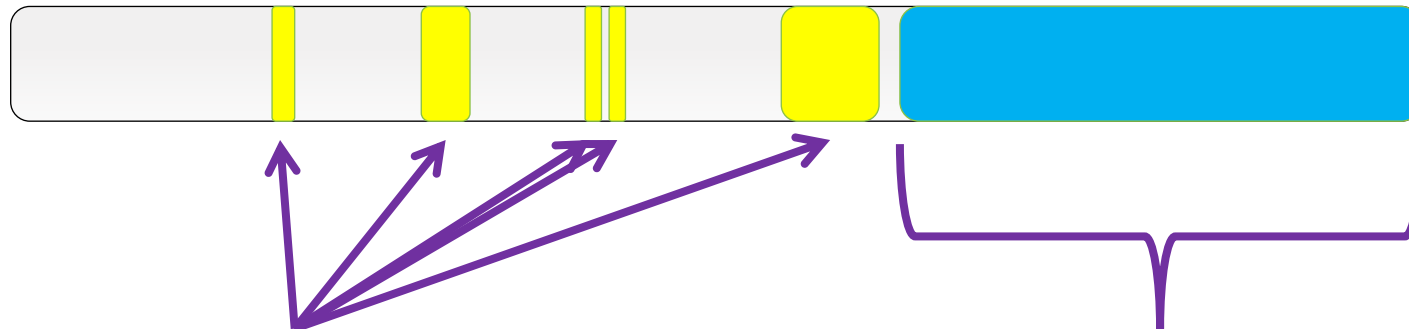
<http://www.healthdata.org>



$$\text{DALY} = \text{YLL} + \text{YLD}$$

YLL = years of life lost due to premature death

YLD = years of life lost to disability



YLD: the number of years of life spent unwell, weighted according to the severity of illness or injury

YLL: the number of years of life expectancy remaining at time of death

YLL

Years of Life Lost due to premature mortality in the population

$$YLL = N * L$$

where:

YLL - Years of Life Lost due to premature mortality in the population

N - number of deaths

L - standard life expectancy at age of death in years

YLL is a function of an age weighting factor, the age at death, the life expectancy at death, and a discount rate



YLD

The Years Lost due to Disability (YLD)

$$\text{YLD} = I * DW * L$$

where: **I** - number of incident cases

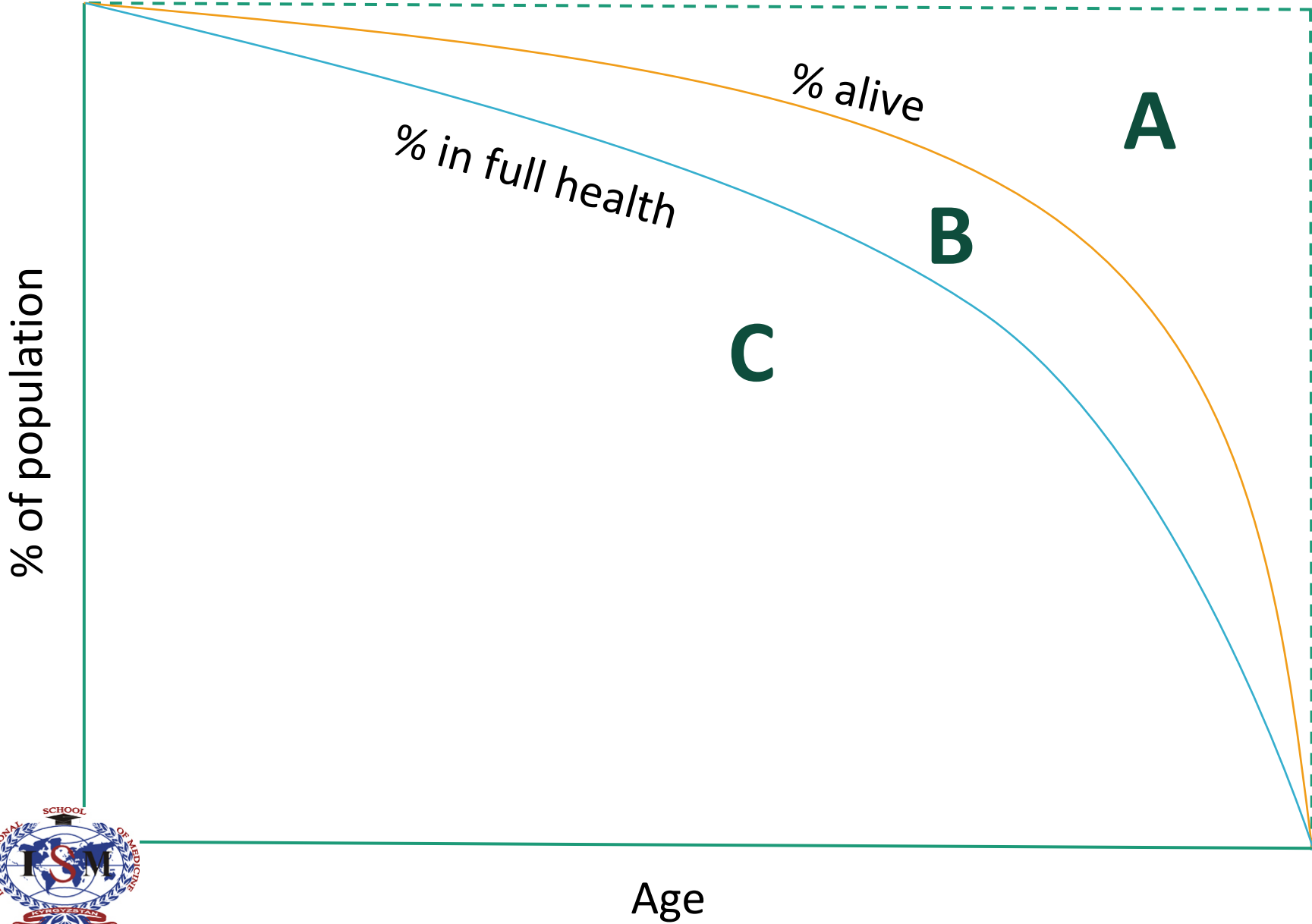
DW - disability weight

L - average duration of the case until remission or death (years)

YLD is a complex function of a similar list of factors plus the disability weight

Using only one life table allows for a uniform formula





Health loss

A = YLL

B = YLD

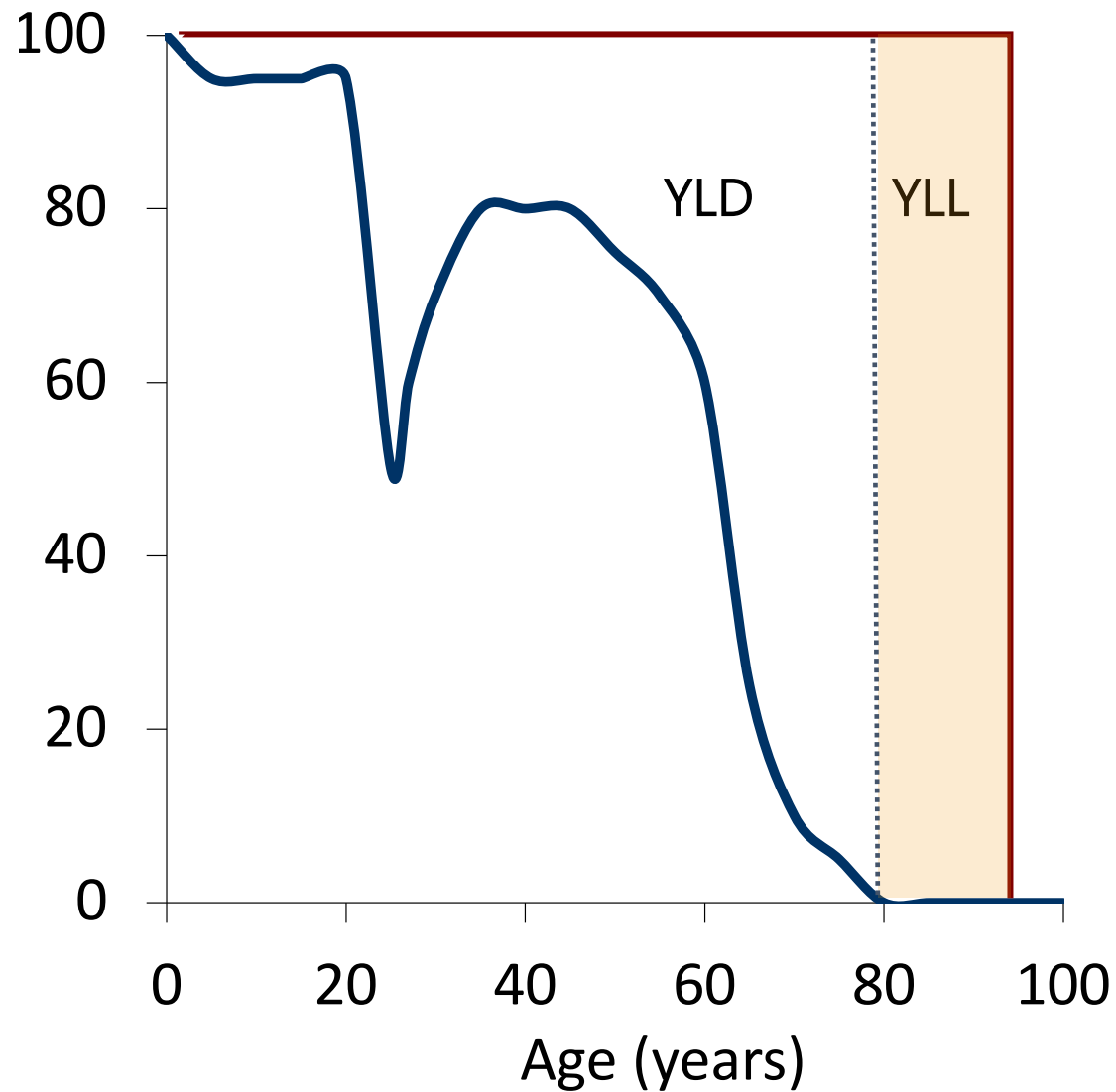
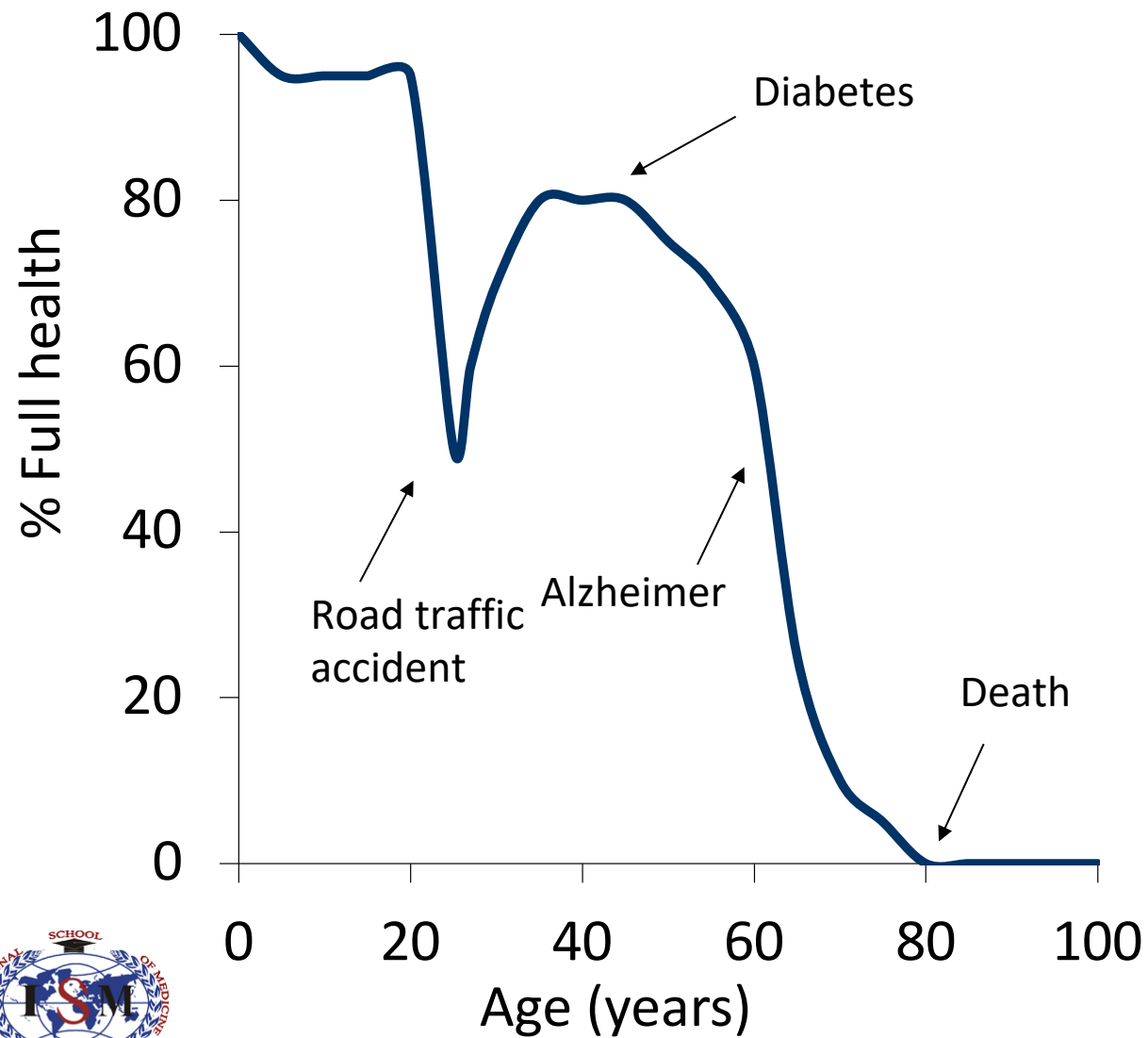
A+B = DALY

Health gain

C = HALE

B+C = Life Expectancy

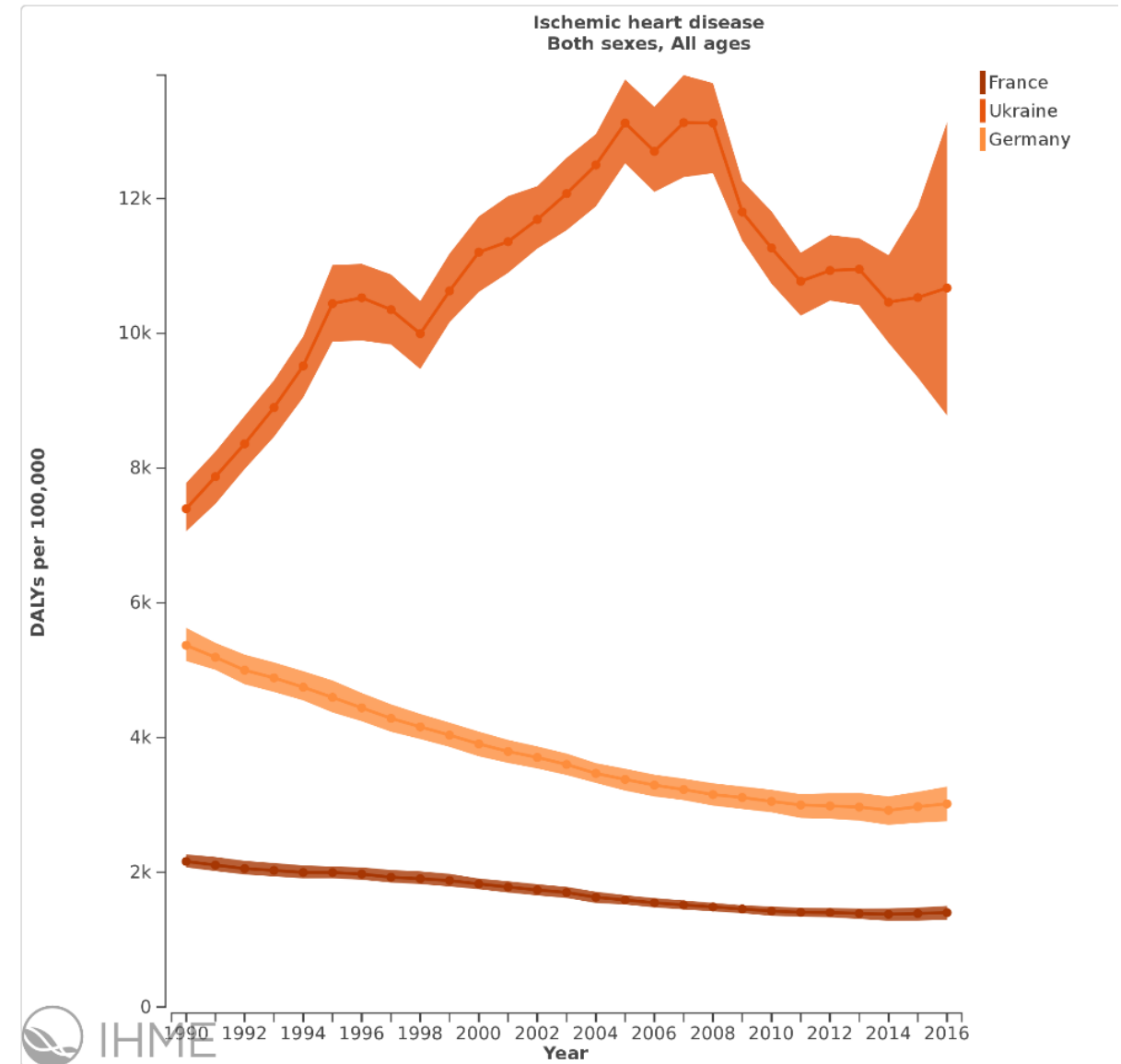




Uncertainly Intervals

**A range of values that is likely to
include the correct estimate.**

**(All GBD estimates are presented
with 95% uncertainty intervals)**



DALYs across the population

- Burden of disease is the sum of these DALYs across the population

Highest level of health



Least burden of disease



living to an advanced age, free of disease and disability



Quality Adjusted Life Years - QALY

- **By QALY we measure and analyze outcomes**
- **By QALY we measure quality and quantity of life combined or**
How long and how well a person lives



Problem

- A professor suffers a carpal tunnel syndrome in late autumn
 - Types a lot
 - Drives a car with manual transmission
 - Plays piano
 - Has two 5 and 15 years old children
- How will treatment affect quality of life over time?
- Assess how to compare treatments?



Complexity of QALYs

- The long-term effect of QALYs is a linear function of one year effect
- The effect of treating multiple individuals similarly is a linear function of the effect on one person



Data for calculation QALYs

- Utility values for the health status
- Health states over time
- Methods of summing health status values over time & population
 - Multiple measurements
 - Multiple individuals
 - Revisit discounting



Age weighting

- Hump shaped age weighting
- Based on need for support
- Short run effects greater for “prime age” individuals than for children
- Children’s effects include those during “prime age” but they are discounted
- Not required to use age weighting



Discounting

- 3% is the standard
- Formula allows for no discounting
- With no discounting
 - $\text{DALYs} = \text{Disability Weight} * \text{Duration of Disability} + \text{Life Expectancy at Death}$



Disease definition

Disease is usually defined by case definition that depends on

- Causation
- The disability weight
- The population incidence and
 - Prevalence



Disease mechanism

- YLD is estimated by cause
- For a particular disease there are several disease mechanisms
- Each mechanism is composed of several component causes
- There could be several case definitions for a particular disease



Disease event

- Usually it is described by signs and symptoms
- Pathophysiological changes at certain anatomical location
- Root causes are generally categorized as genetic, environmental or etiological



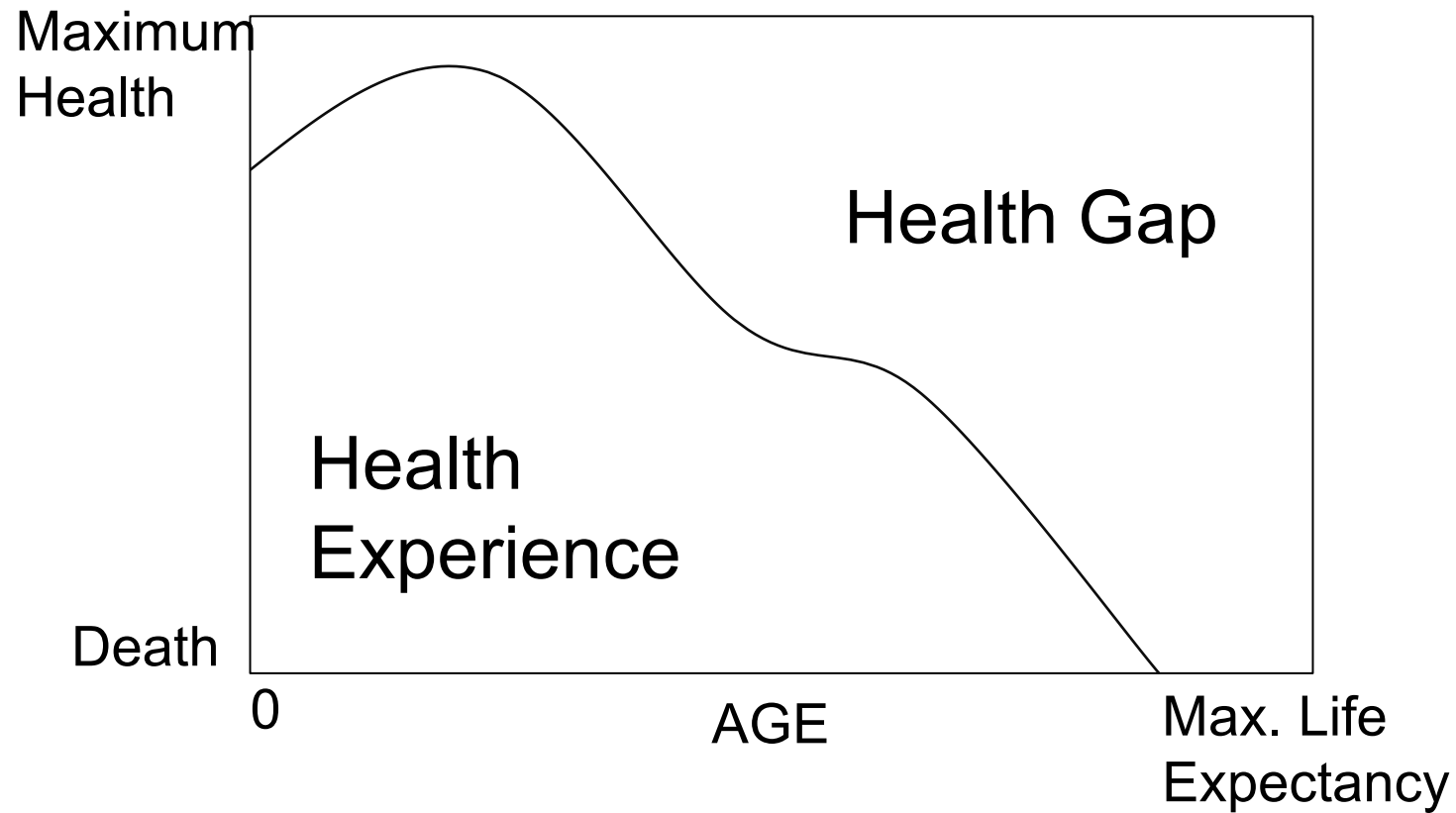
Severity of the disease (health gap)

Severity of the disease is scaled from 0 (perfect health) to 1 (death)

- Opposite of the QALY scale
- Compare to a life with no disability during the maximum life expectancy
 - Defined using life tables
 - Separate for female and male
 - For males, actually use a female table



Graphical interpretation of a health gap measure



Interaction of disabilities

- Additive
- Little initial exploration of interactions of a more complex nature
 - Could add up to more than “death”



Complex of risk factors

- Zinc deficiency affects mortality from diarrhea directly
- It also affects mortality by reducing growth
- It may also be correlated with underweight, other micronutrient deficiencies, and unsafe water and sanitation
- This might be a combination of effect modification (additive effects) as well as statistical interaction (multiplicative)



Clean hands save lives

- You may not find Panacea but you could probably find intervention to prevent several diseases
- Hand-washing has been shown to cut the number of child deaths from diarrhea (the second leading cause of child deaths) by almost half and from pneumonia (the leading cause of child deaths) by one-quarter
- Reference: Global Hand-washing Day: 15 October
- Conclusion: Backend measures uproot the disease while front end measures prune the disease



Interventions against diarrheal disease

Cost in proportion to hygiene promotion

• Cholera immunizations	1655
• Rotavirus immunizations	1627
• Measles immunization	804
• Oral rehydration therapy	450
• Hygiene promotion (including hand washing)	1

Reference: Global Handwashing Day, 15 October, Planner's Guide

The 2019 Global Handwashing Day theme is “Clean Hands for All”



Economic development

Hygiene promotion $\propto$ economic development

Lower infant mortality rates $\propto$ higher economic growth

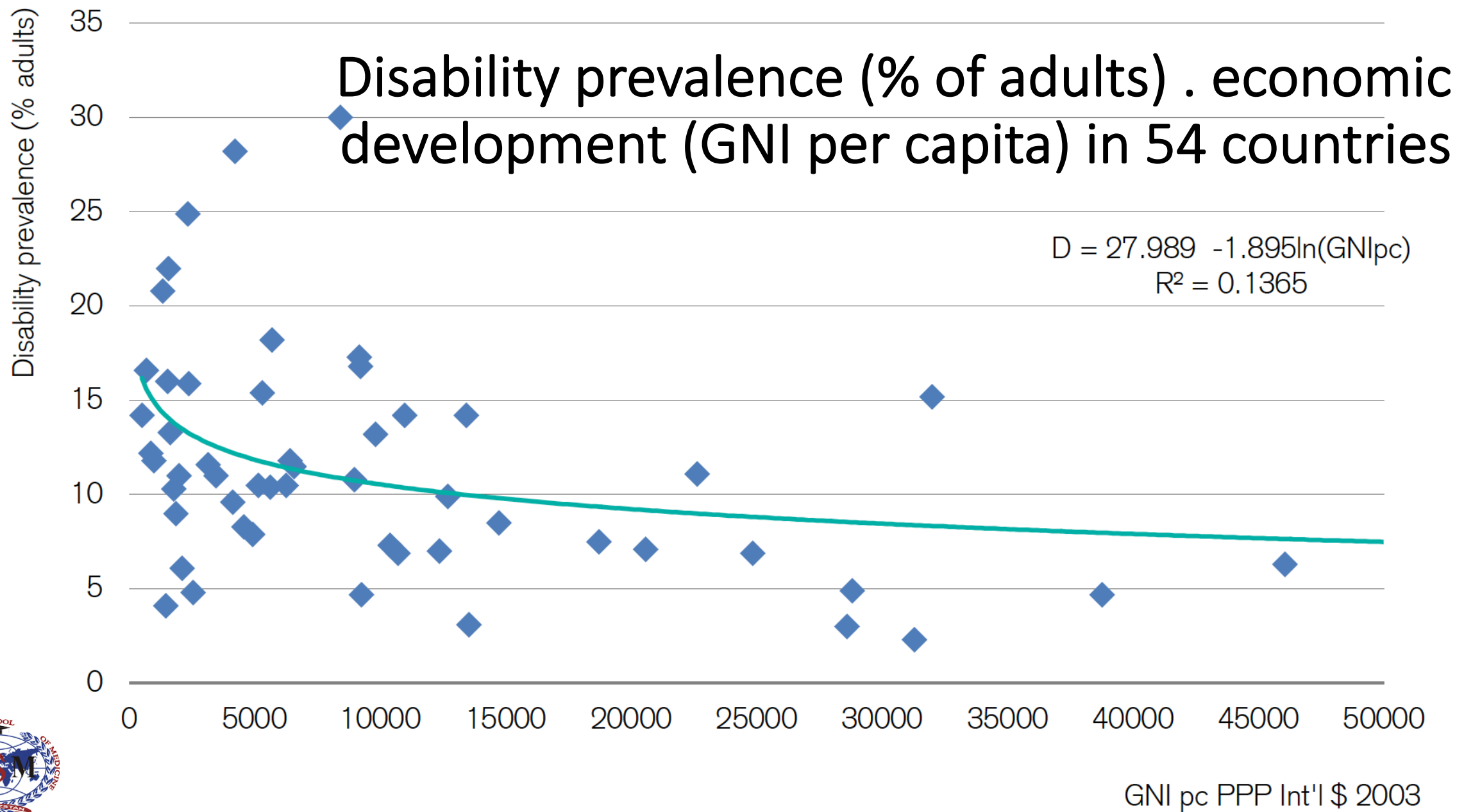
WHO estimates that a 10 year increase in average life expectancy at birth translates into a rise of 0.3 – 0.4% in economic growth per year



Hygiene and Sanitation, and diarrhea vaccine

- Good hygiene and sanitation prevents invasion of several “disease causing microorganisms”
- Monovalent vaccine causes selective invasion to prevent multiplication of a single serotype / species of microorganism in a responsive patient. The commercial life of vaccine may last till the microorganism mutates to gain resistance to vaccine
- Hence, backend measures uproot the disease while front end measures prune the disease

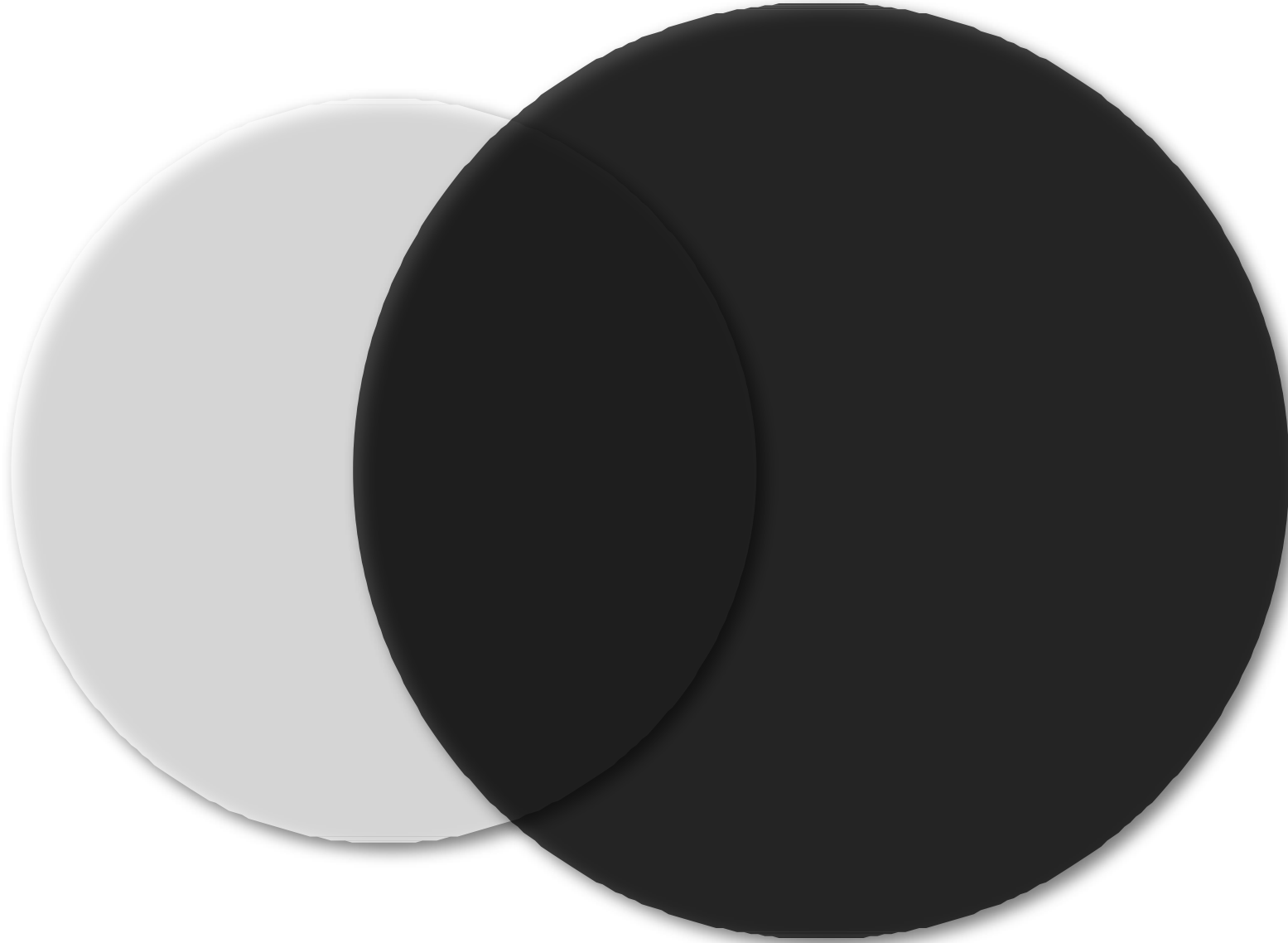




Source: Disability data from Mitra & Sambamoorthi (2014), Gross national income (GNI) per capita data from World Bank World Development Indicators (<https://data.worldbank.org/data-catalog/world-development-indicators>)



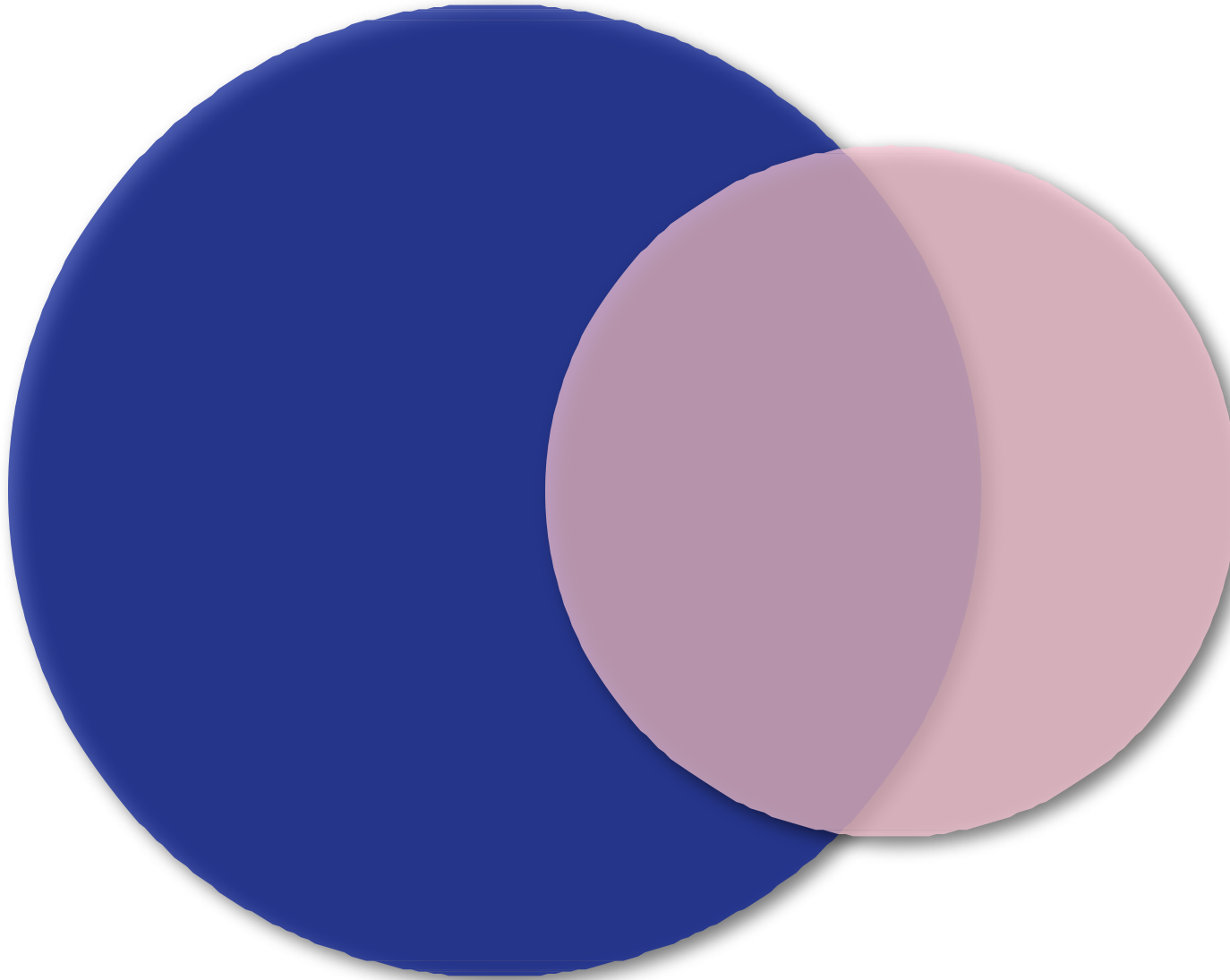
Health Inequalities: White-Black



Life Expectancy: 78.3 vs. 73.7

Age-Adjusted Mortality: 751.2 vs. 942.6/100,000

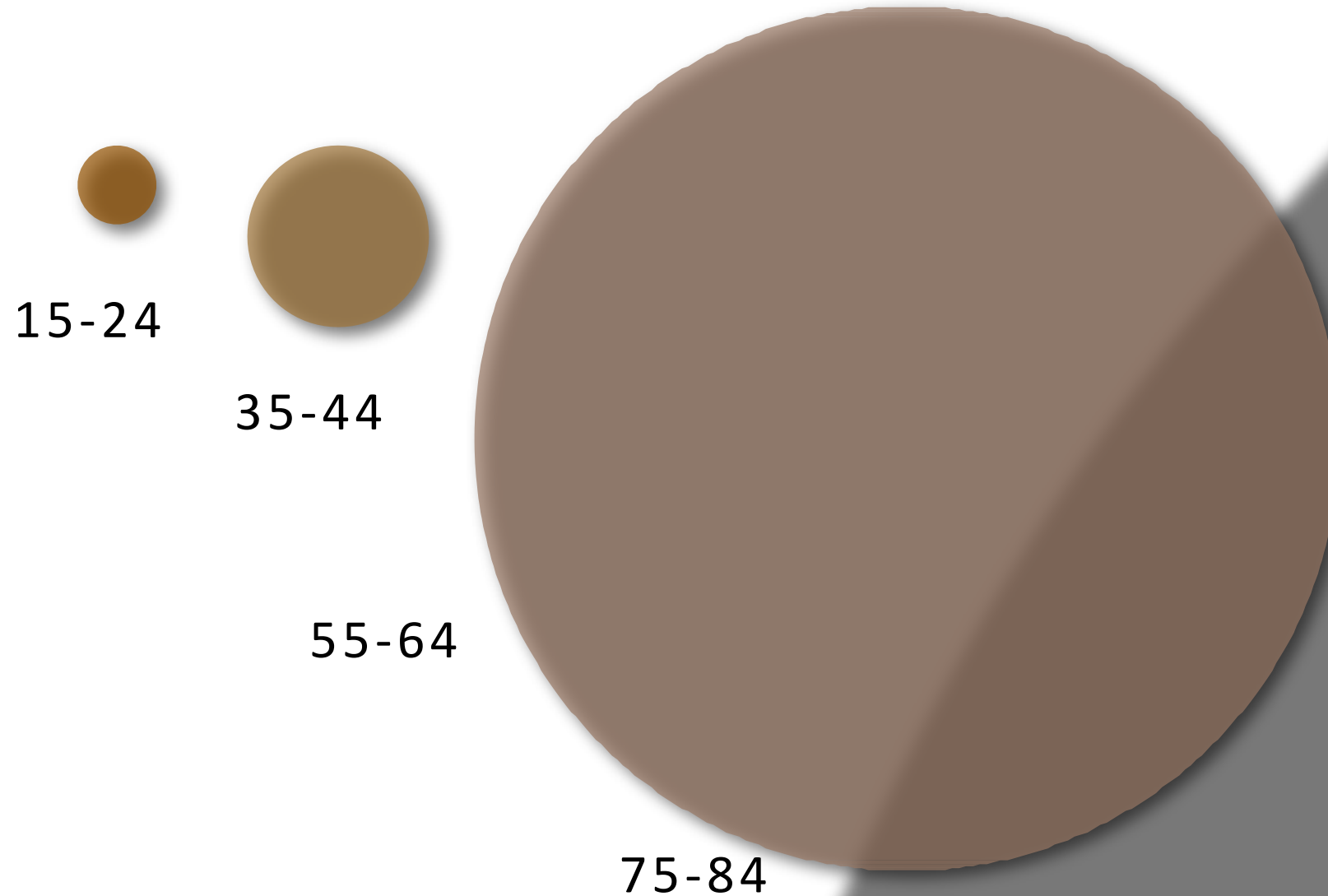
Health Inequalities: Men - Women



Life Expectancy: 75.3 vs. 80.4

Age-Adjusted Mortality: 905.8 vs. 643.4/100,000

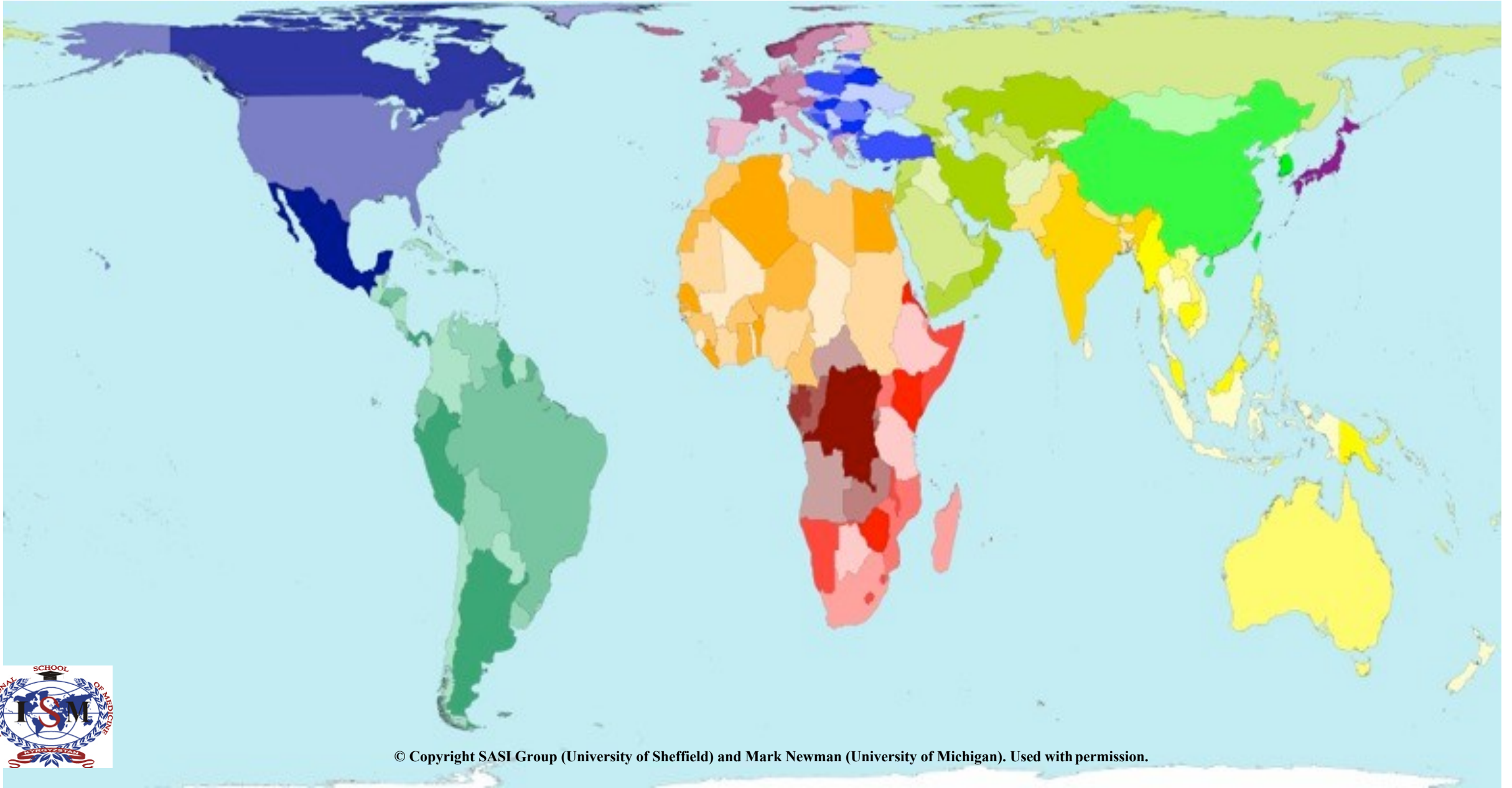
Health Inequalities: Age



Age-Adjusted Mortality: 80.2 vs. 184.3 vs. 875.7 vs. 5017.4

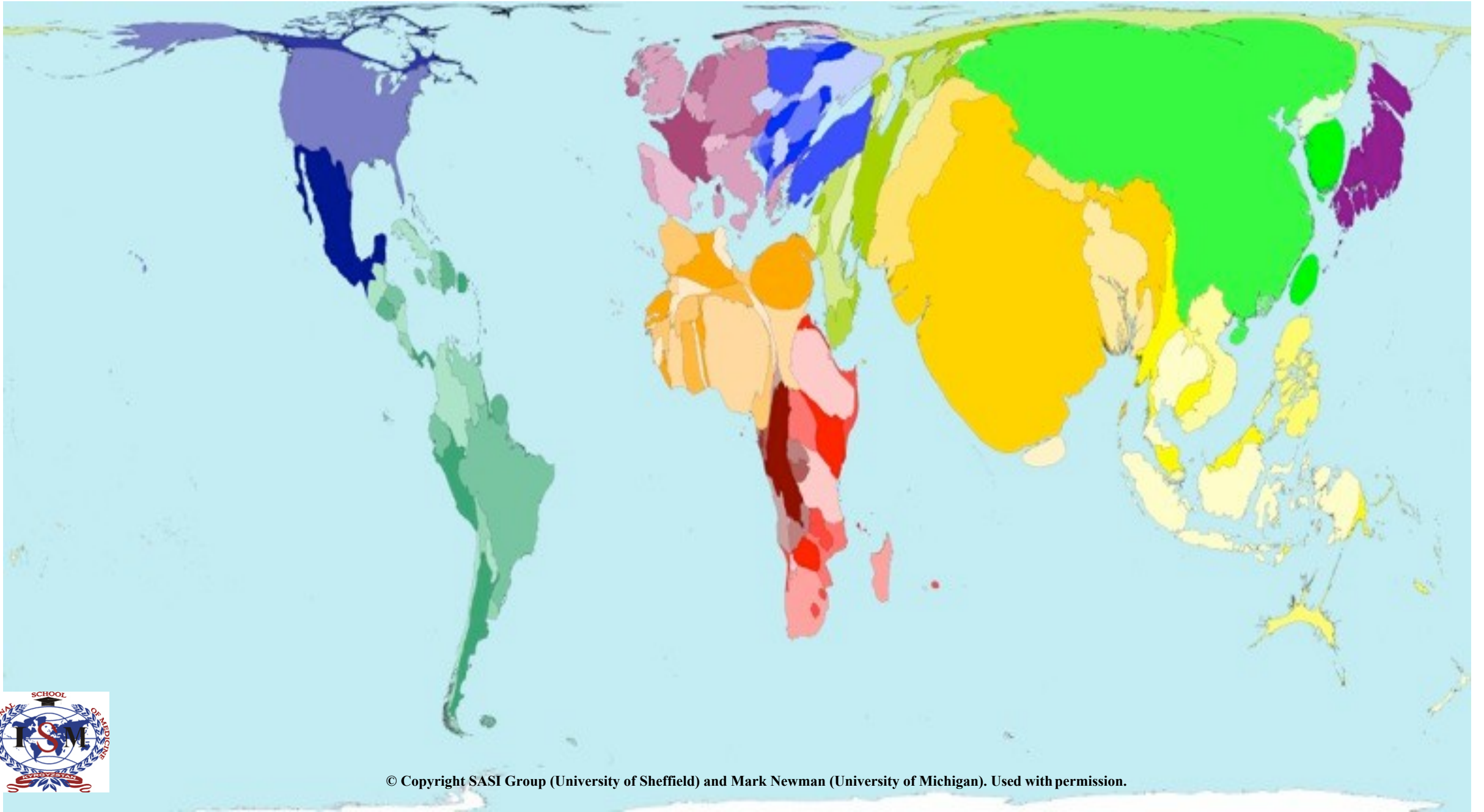


Worldmapper: Land Area



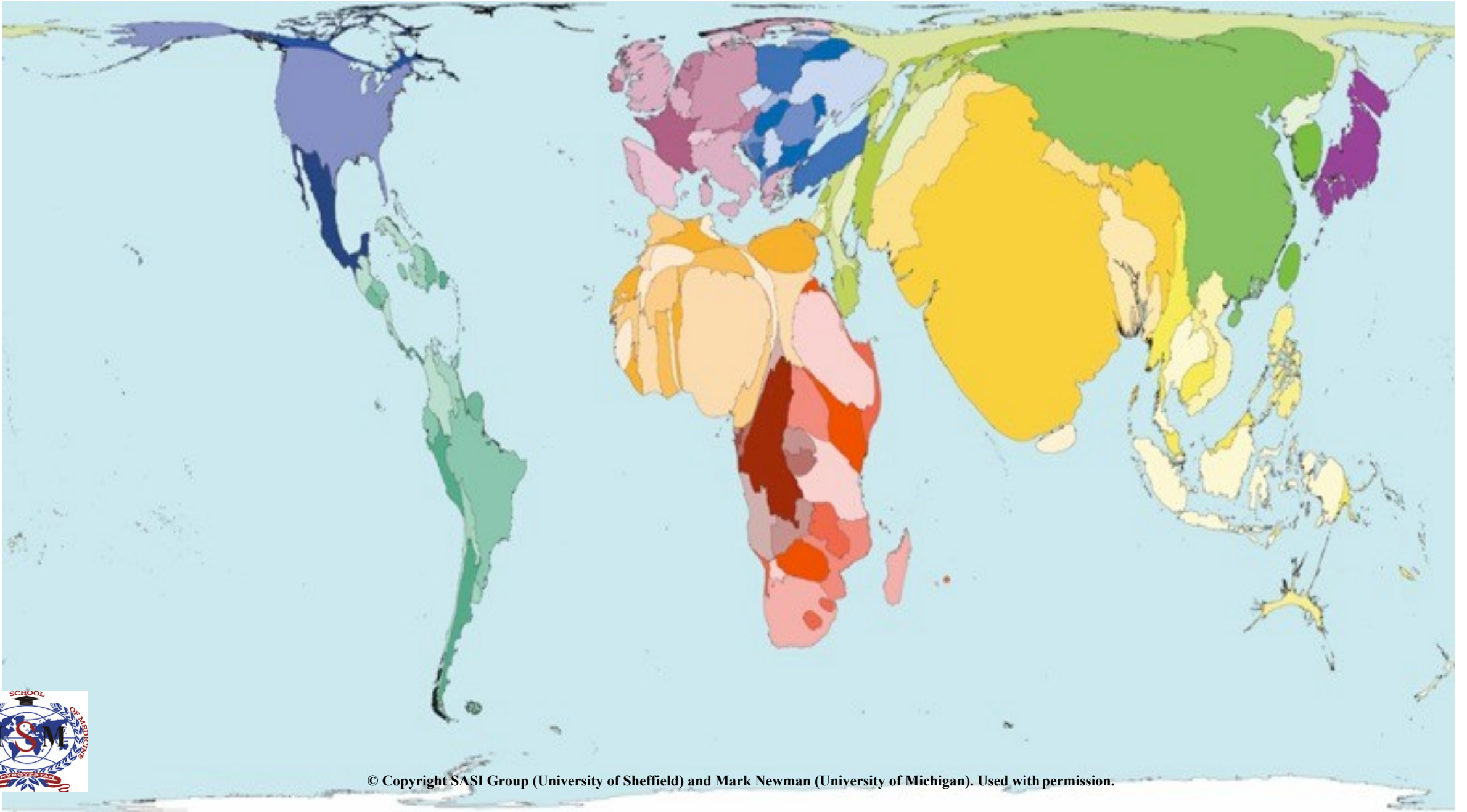
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Worldmapper: Population

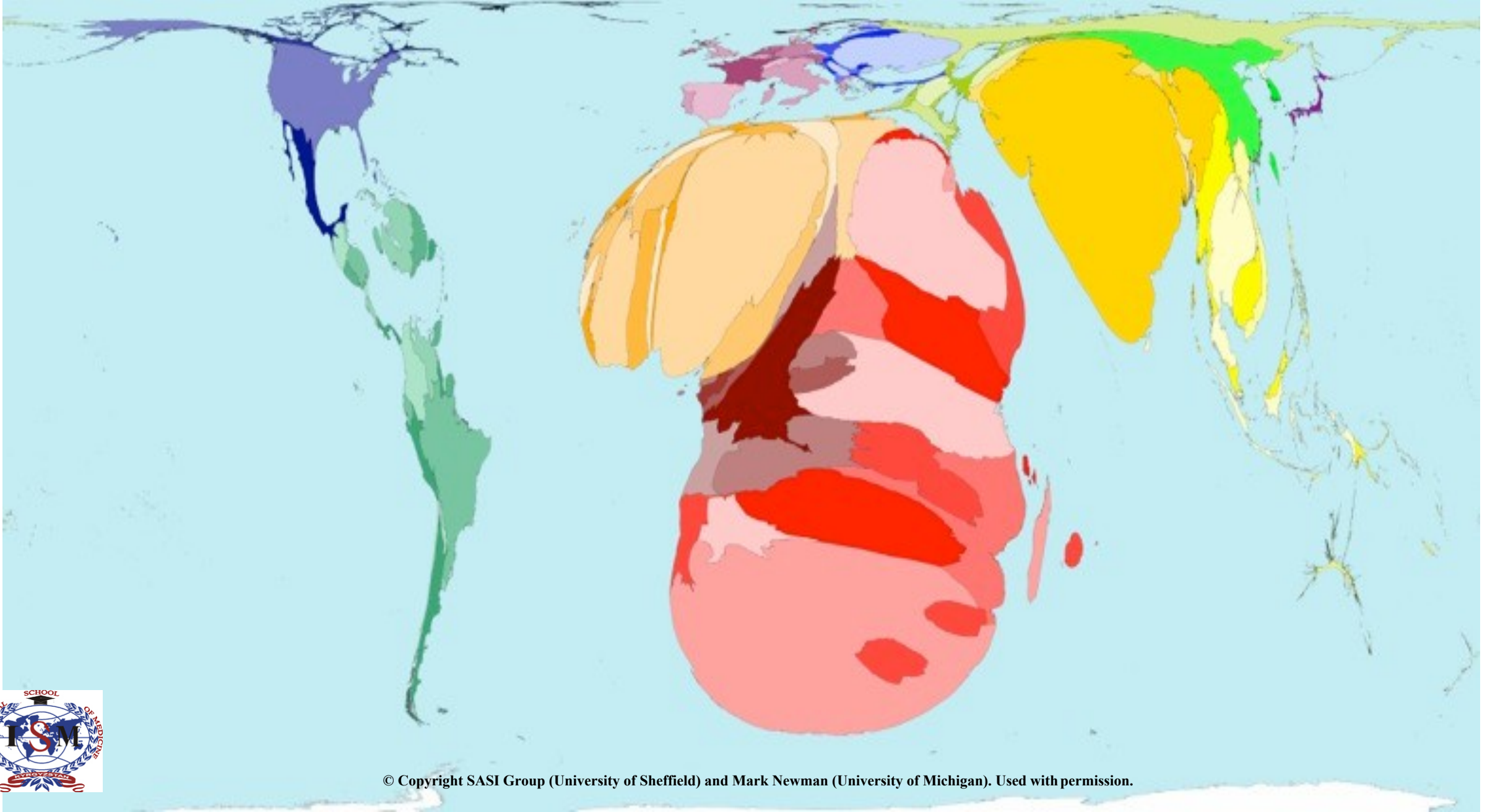


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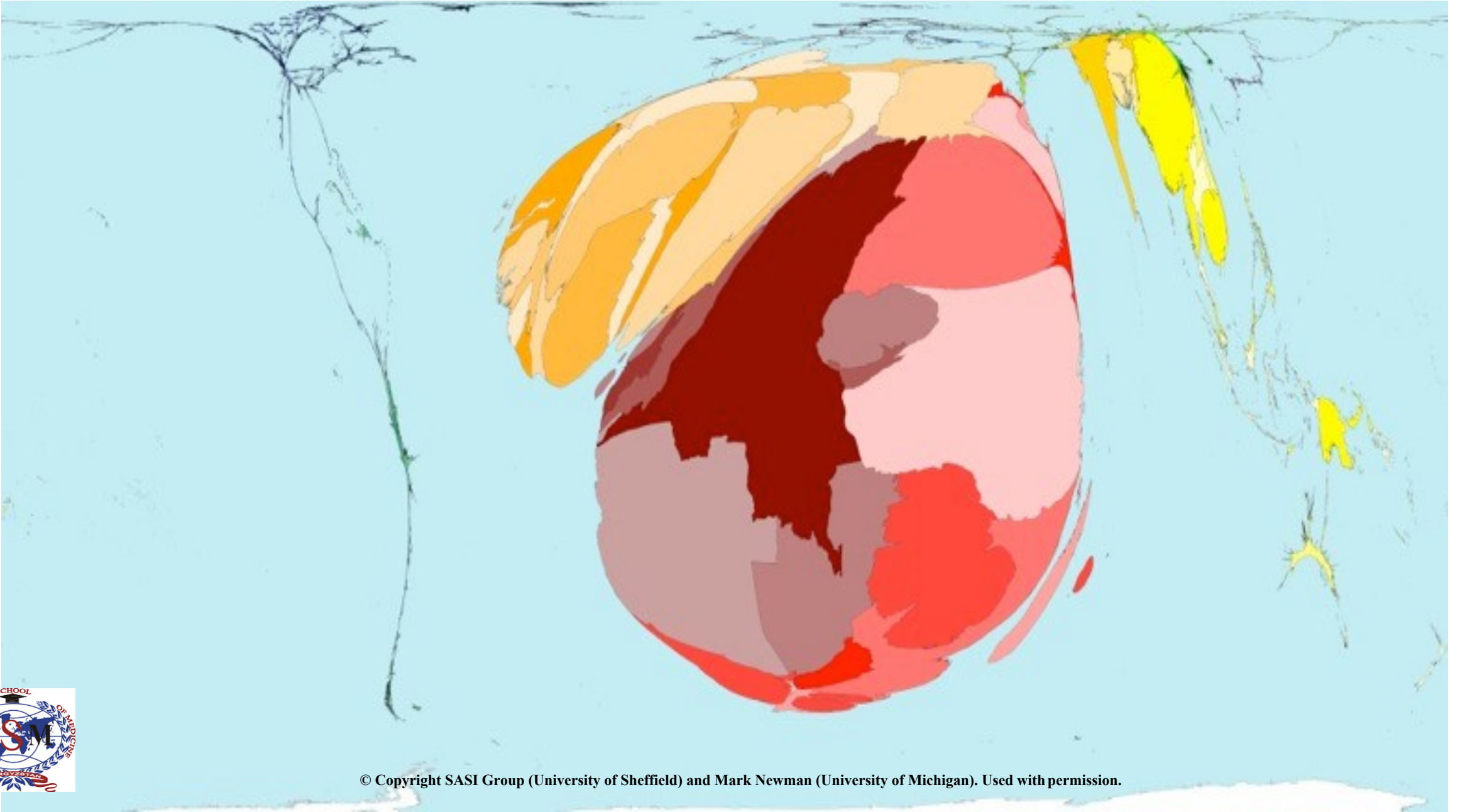
All Deaths



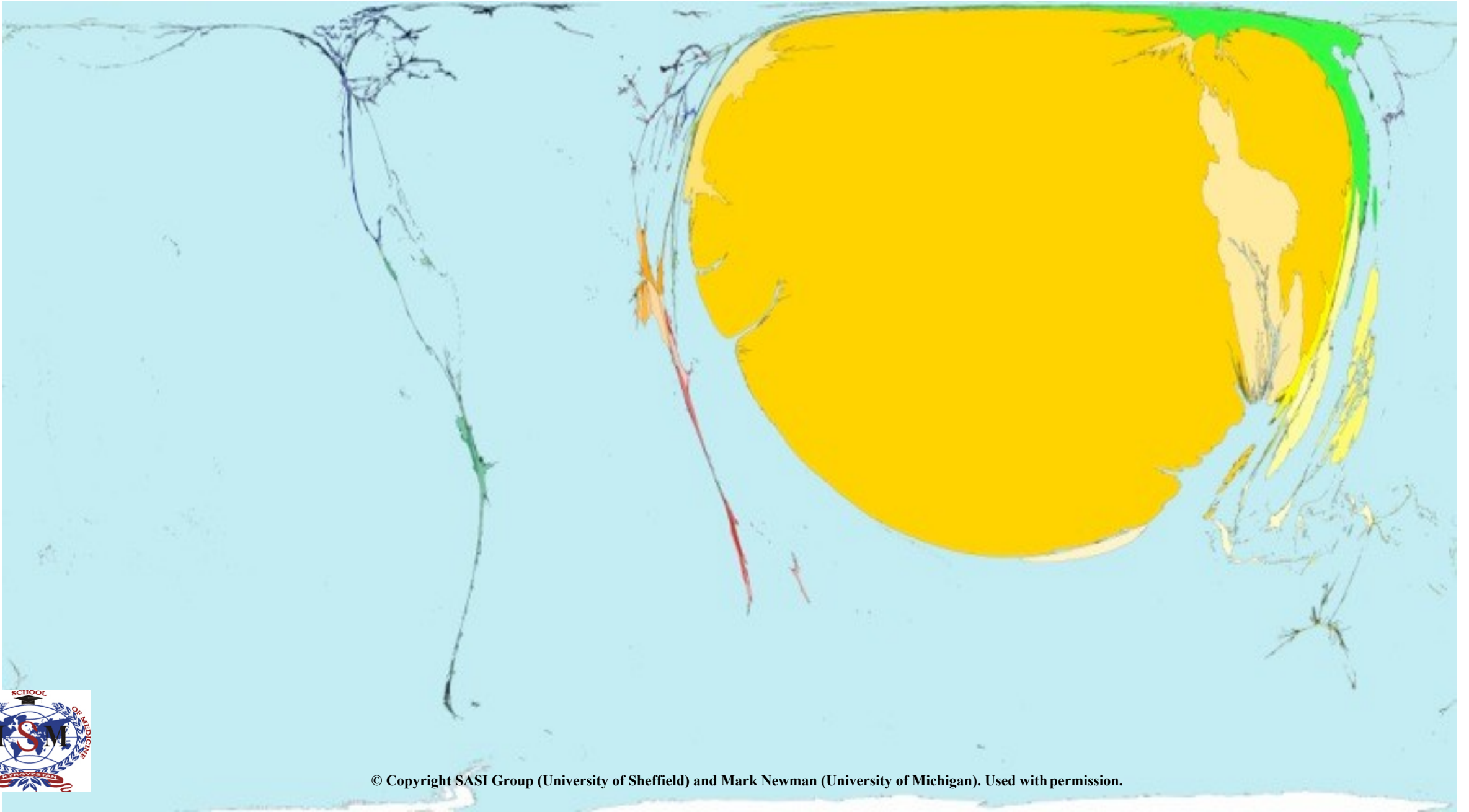
HIV Prevalence



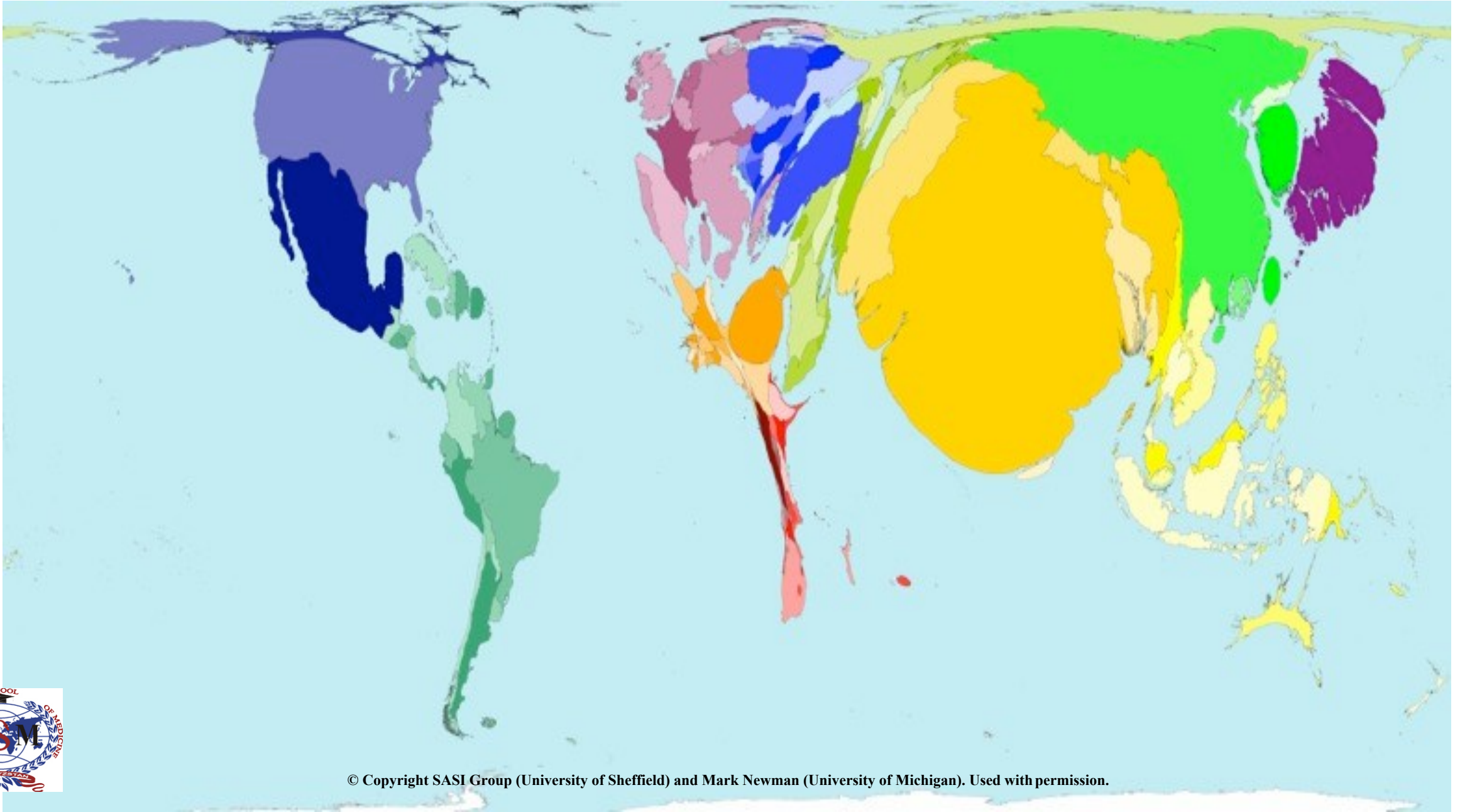
Malaria Deaths



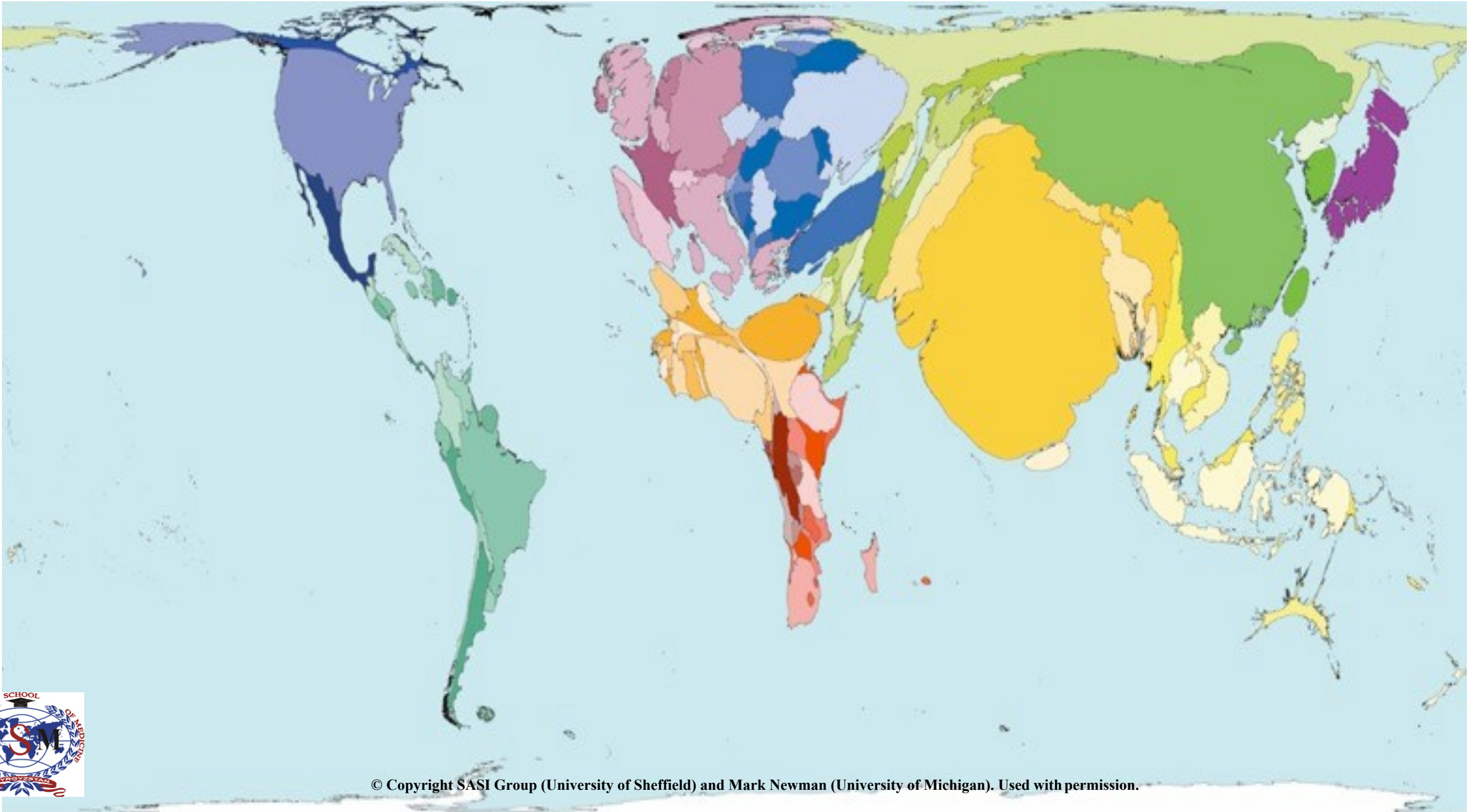
Any Guesses?



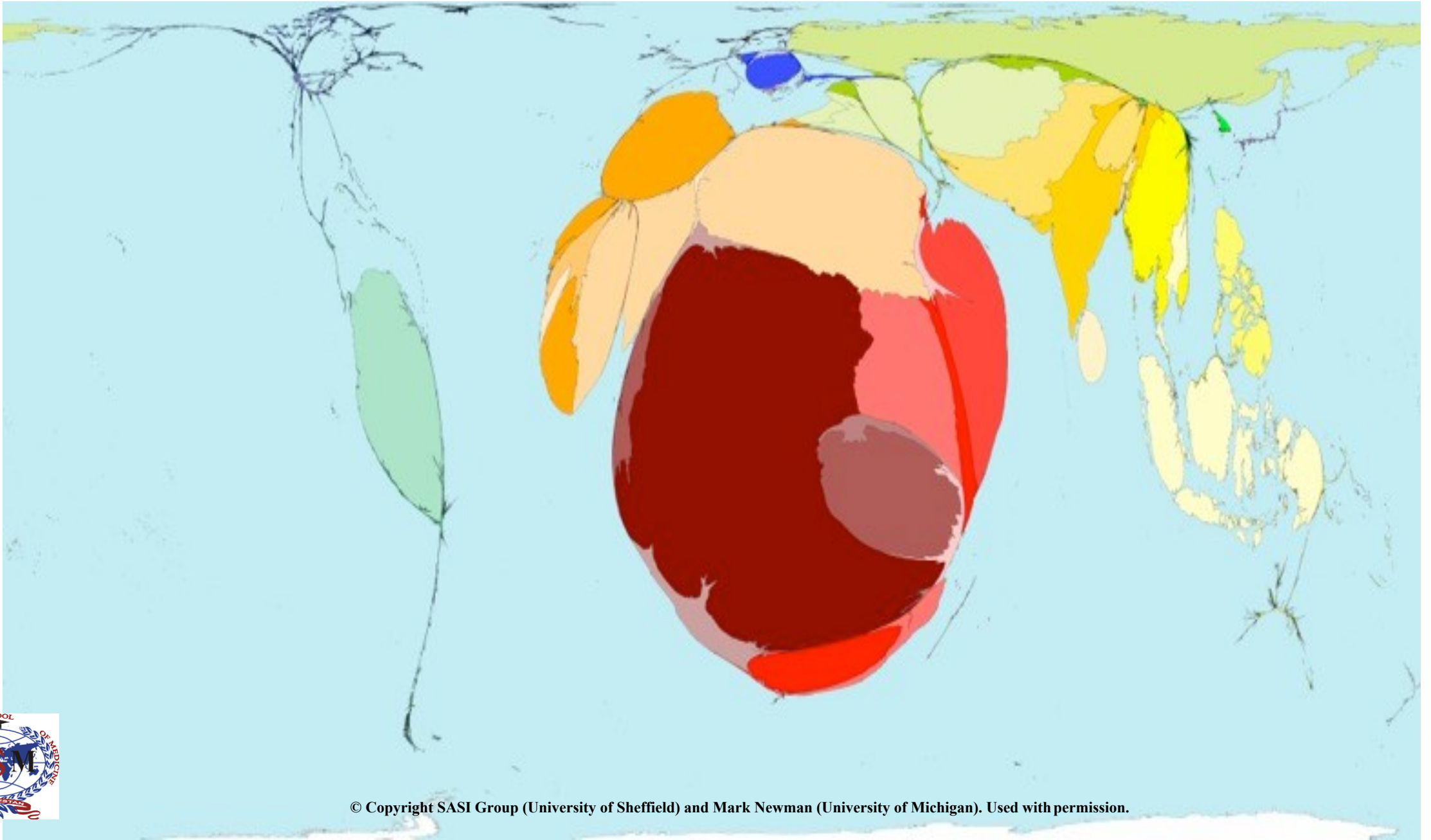
Diabetes Prevalence



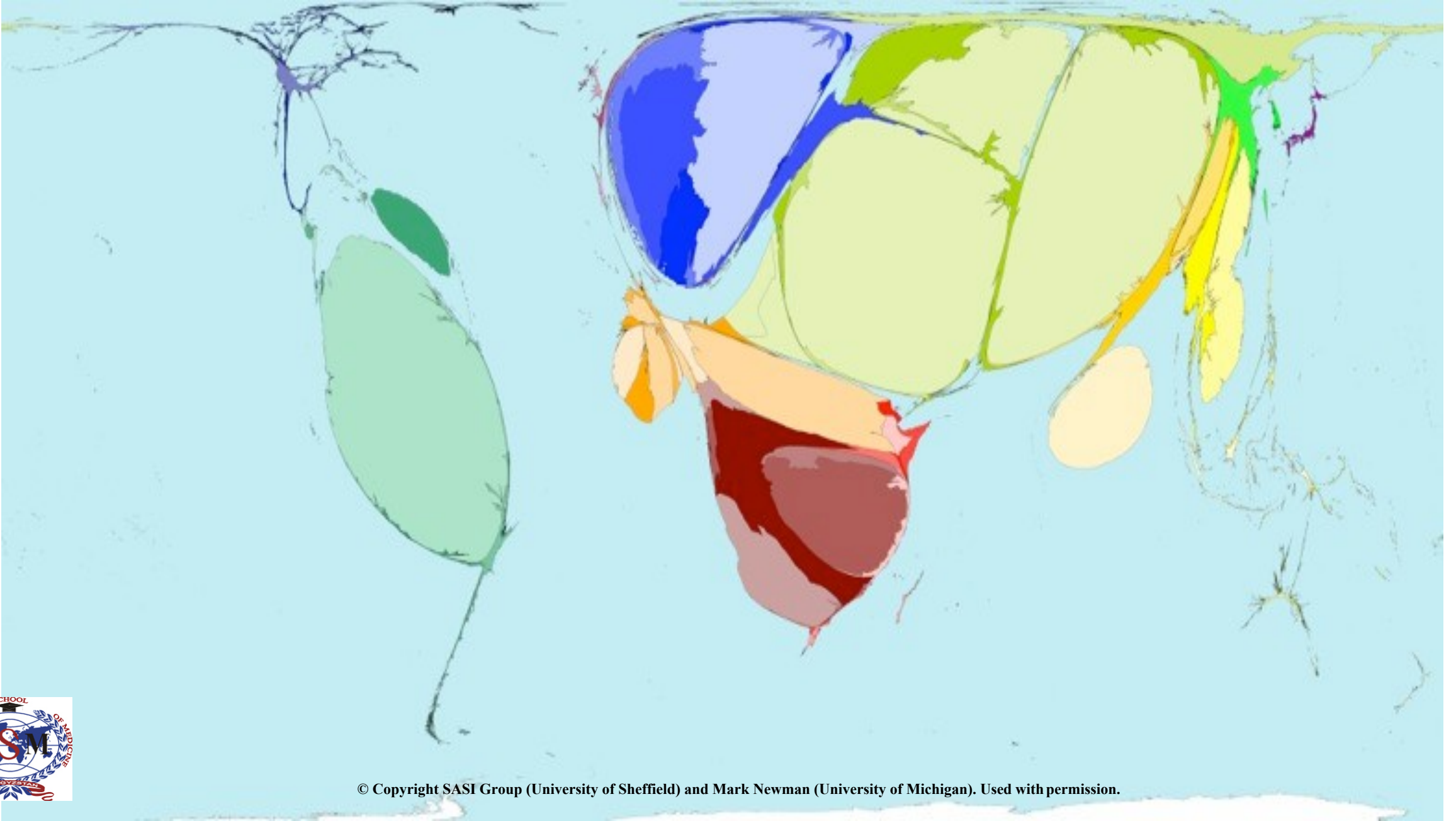
Cardiovascular Deaths



War Deaths



Refugee Origins



Health Inequalities: Rabies Deaths



"About 3.5 million dog bites are registered every year in India. The Government cannot give vaccine free of cost to all people. By 2006, the price of vaccine is expected to increase ..." K. Sandeep, 2002

Determinants of Disease:

Killed by Volcanoes

Of all the people killed by volcanoes between 1975 and 2000, 86% died in Colombia. Most of these people died in the town of Armero due to mud flows from the Nevado del Ruiz volcano, on 13th November 1985 - almost 22 thousand deaths were recorded there.

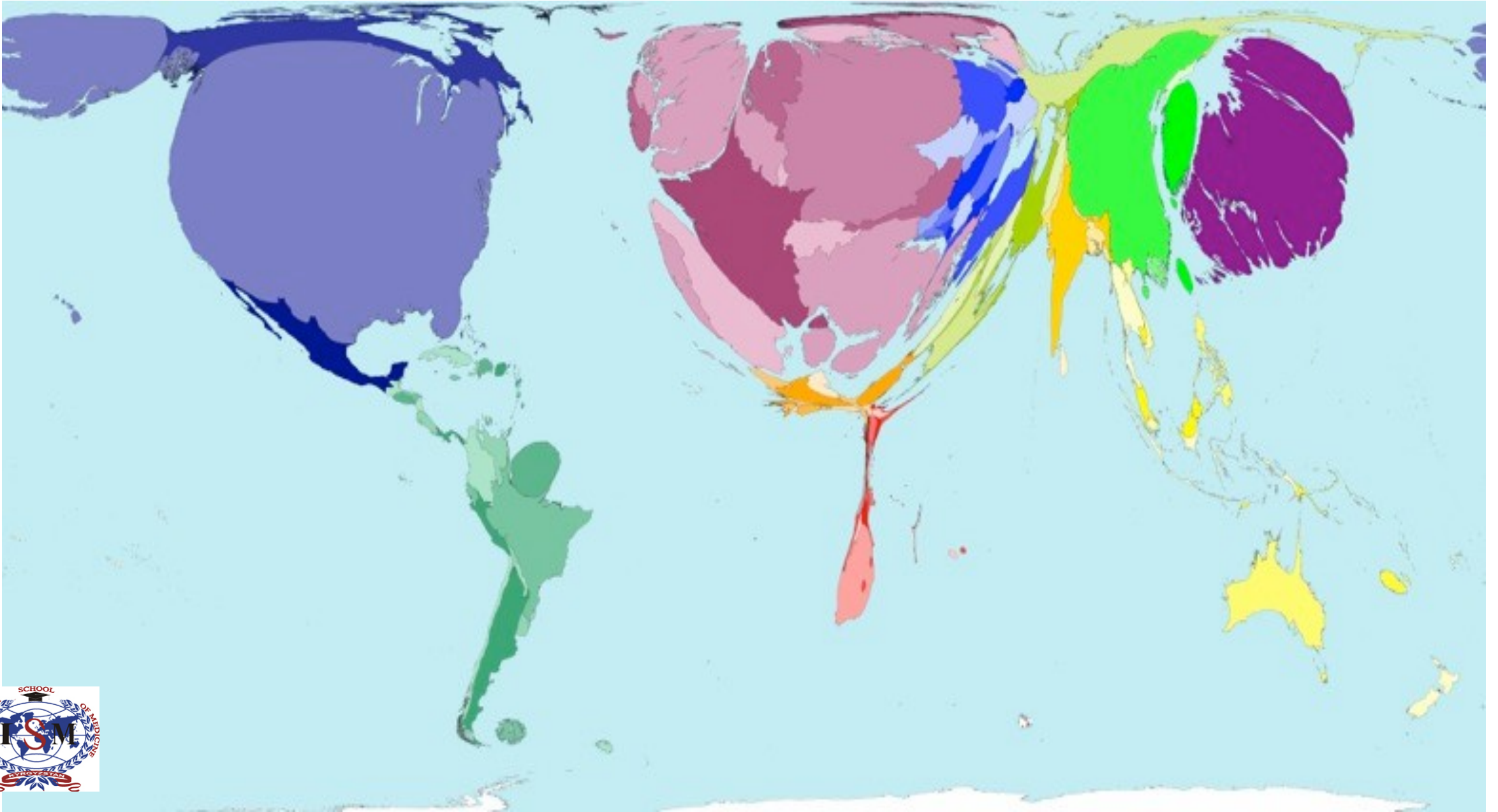
Volcanic activity can endanger human life in various ways: mud flows, lava flows, pyroclastic flows (super-heated toxic gas and debris), collapses and landslides, and the settling of ash and dust. Earthquakes and tsunamis caused by volcanic activity are not included here.

There were no deaths caused by volcanoes between 1975 and 2000 in 183 of the 200 mapped. Volcano-related deaths occurred most frequently in Indonesia, in 9 of the 26 years shown.

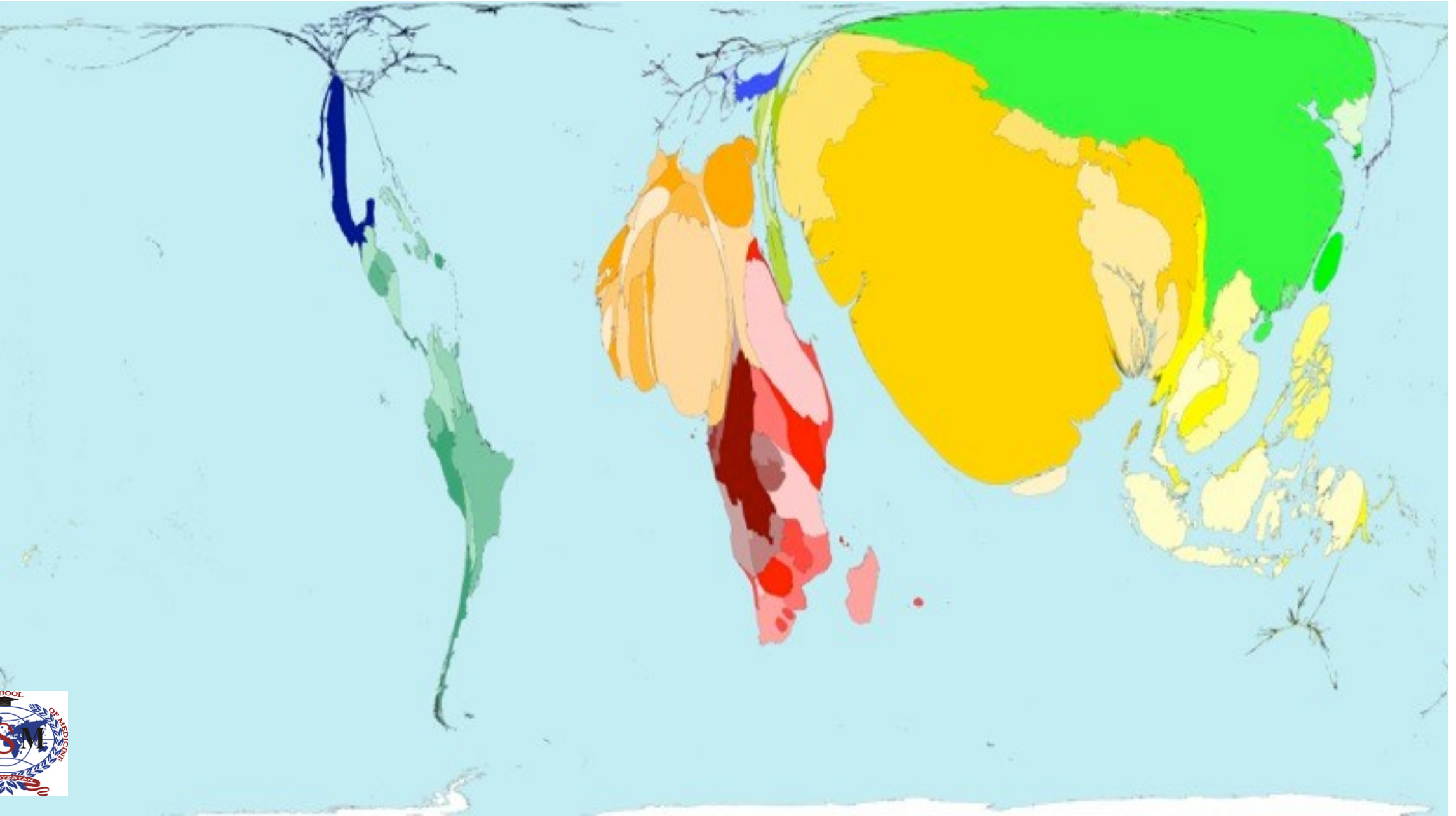
Territory size shows the proportion of all people killed by volcanoes between 1975-2000, that died there.



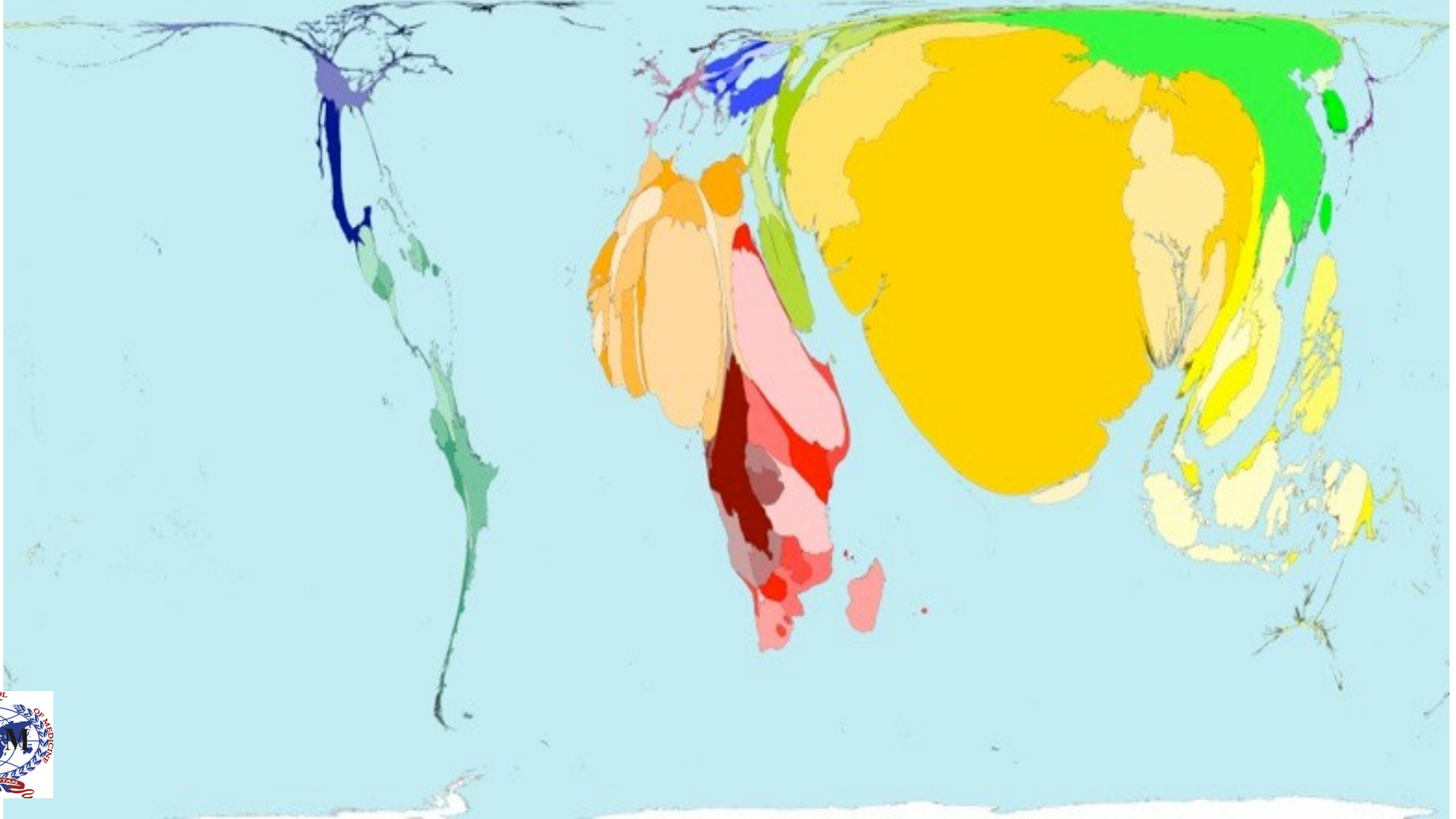
Government Health Spending



Proportion Living on \$2 / day



Underweight Children



What is the Global Burden of Disease?

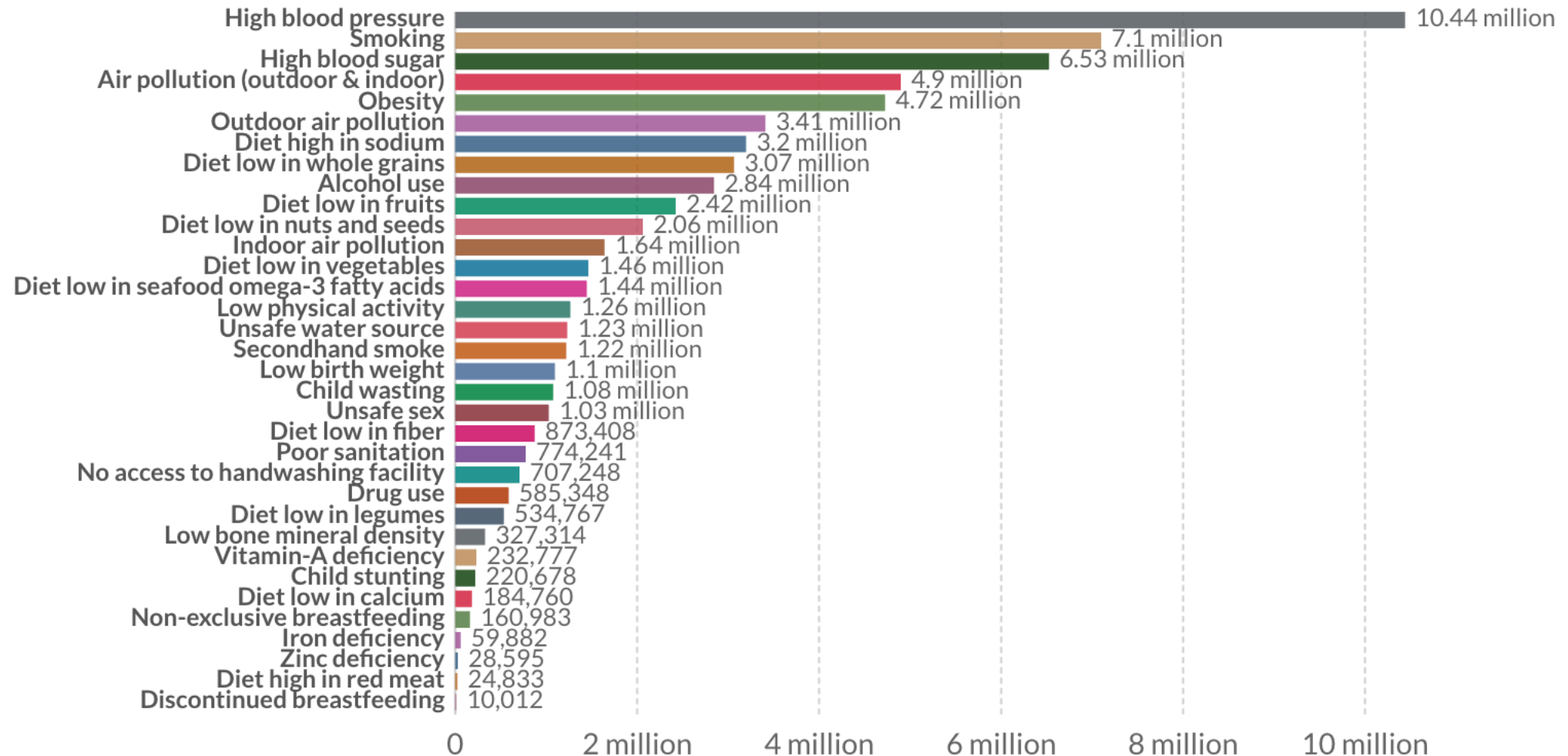
A ***systematic, scientific*** effort to quantify the ***comparative*** magnitude of ***health loss*** due to diseases, injuries, and risk factors by age, sex, and geographies for specific points in time.

<http://www.healthdata.org>



Number of deaths by risk factor, World, 2017

Total annual number of deaths by risk factor, measured across all age groups and both sexes.



Global Burden of Diseases



Single

Explore

Compare ▾

Settings

Display Cause

Measure Deaths

Locations Switch location Add/Remove

Year

Age All

Units # Rate %

Take tour ▶

By Year

By Age

By Sex

By Cause

By Risk

By Location

Cause to Risk

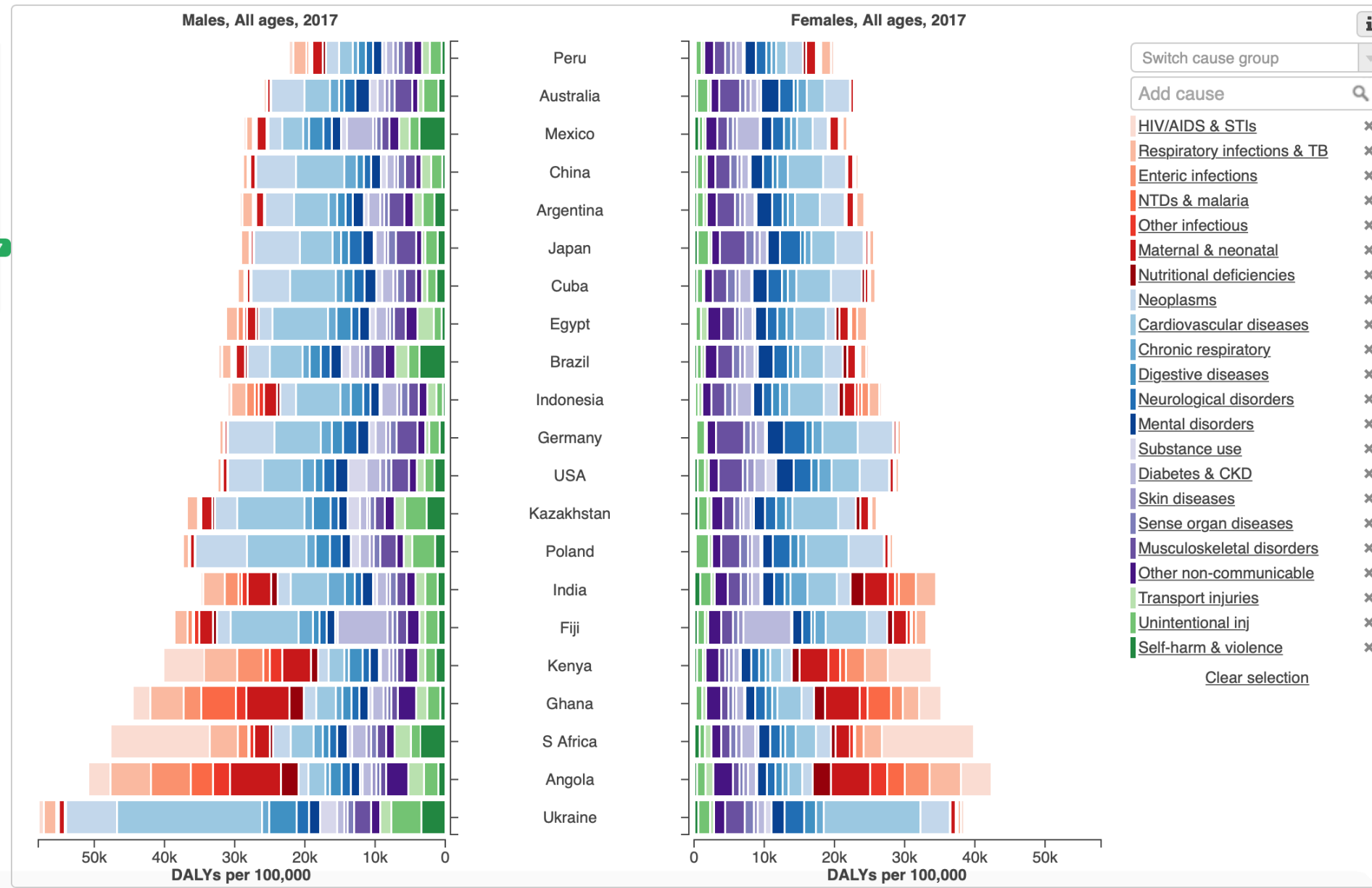
Observed to Expected

15-49

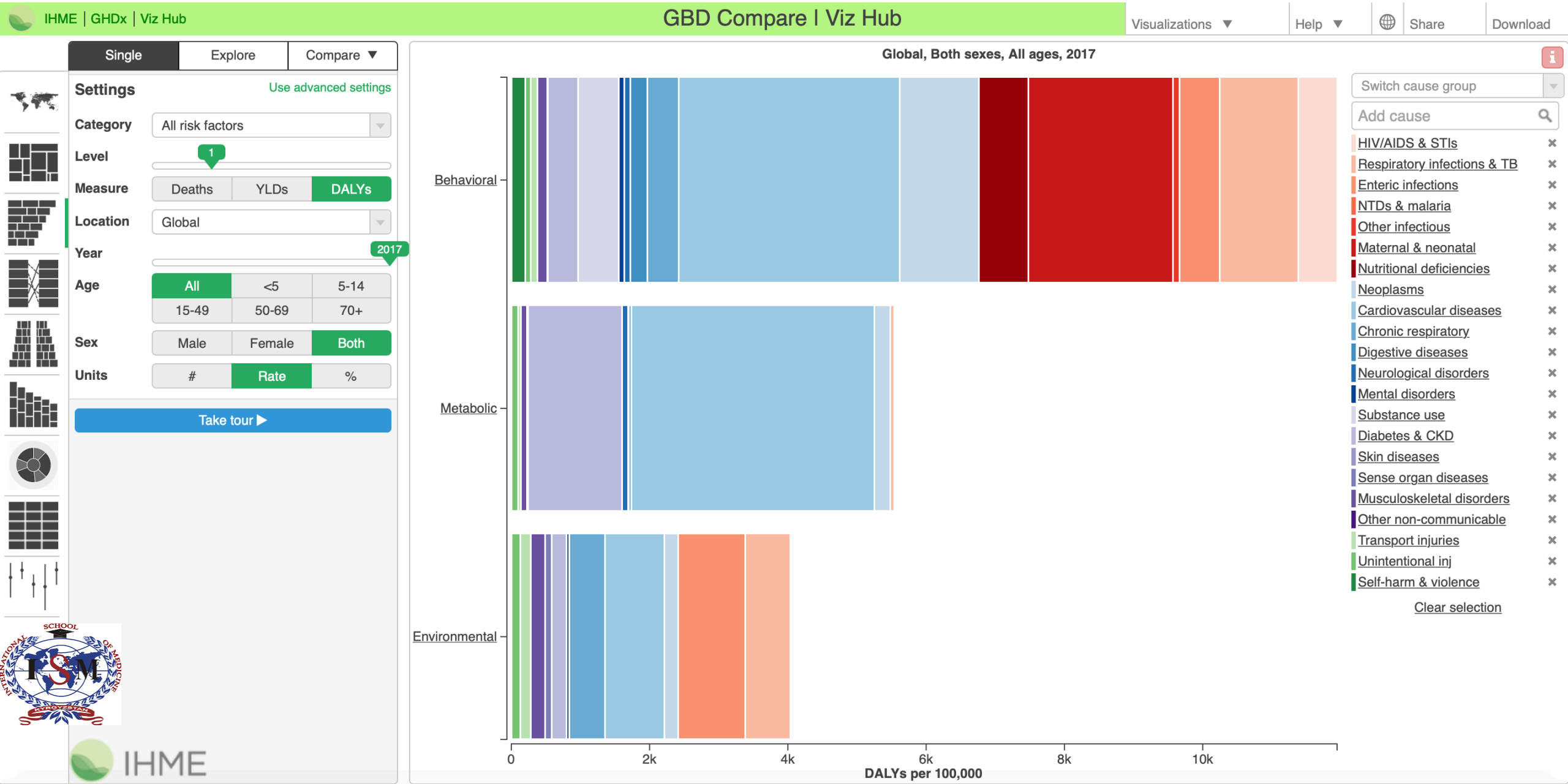
50-69

70+

7



Global Burden of Diseases by Risk factors



Global Burden of Cardiovascular Diseases

Single

Explore

Compare ▾

Settings

Use advanced settings

Display

Cause

Risk

Measure

Deaths

YLDs

DALYs

Locations

Switch location group

Add/Remove locations (21) × ▾

Year

2017

Age

All

<5

5-14

15-49

50-69

70+

Units

#

Rate

%

Take tour ▶

