Hodnocení a měření zdraví

Hynek Pikhart

Outline

- What is health and what is population health?
- Rate, proportions, incidence and prevalence

What is health?

- Health is a multifaceted concept and not easily measurable.
- WHO definition:
  - Health is a state of complete physical and mental well-being and not merely the absence of disease or infirmity (WHO, 1948)
  - *stav kompletní fyzické, duševní a sociální pohody a nikoliv pouhé nepřítomnosti nemoci či vady*

Criticisms of the WHO definition

- Is it achievable?
- Can it be measured?
- Change in the burden of health since 1948

- But various estimates show that among 70-95% of individuals could be classified as unhealthy on the basis of WHO definition

A better definition?

- Bircher (2005): “a dynamic state of well-being characterised by a physical and mental potential, which satisfies the demands of life commensurate with age, culture and personal responsibility”

OR

- Huber et al (2011): “the ability to adapt and self manage in the face of social, physical and emotional challenges”

What is population health?

- "The health outcomes of a group of individuals, including the distribution of such outcomes within the group." Kinding and Stoddart (2003)

What do we mean by outcomes?

What do we mean by groups?

What do we mean by distribution?

Population health outcomes

- Mortality
  - Rates of death
  - Life expectancy
- Morbidity
  - Disease: biochemical (e.g. blood glucose), physiological (e.g. blood pressure), and pathological (e.g. tumour size)
  - Disability or impairment
  - Self-reported and patient-based measures
- General and composite measures

Tools of measurement (I)

- **Numbers** – actual number of events
  - Example: 100 cases of TB in Camden in 2003

Tools of measurement (II)

- **Proportion** – a type of ratio in which the numerator is included in the denominator, often expressed as a percentage
  - Example: proportion of diabetics in the population
- **Rate** – frequency with which an event occurs in a defined population, usually in a specified period of time
  - Example: mortality rate in 2014

Numerators and denominators

- The number of cancer cases in the UK is 247,667 whereas in Belgium it is 47,948.
- The UK has a bigger problem in numerical terms.
- But do Belgians have lower risk of getting cancer?
  - Numerators alone are meaningless
  - We need both **numerators** AND **denominators**

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  - We need both **numerators** AND **denominators**
- UK: 247 667 / 60 000 000 = 0.00413 = 413 per 100 000
- Belgium: 47 948 / 10 000 000 = 0.00479 = 479 per 100 000

Type of rates

- **Crude rates**: apply to the total population in a given area
- **Specific rates**: apply to specific subgroups in the population (e.g. age, sex) or specific conditions
- **Standardised rates**: used to permit comparison of rates in the population in which differ in structure (e.g. age structure)

Population at risk

- People who are potentially susceptible to the event
- Populations are not static as a result of births, deaths and migration

“Conventional” measures

- Prevalence of a disease / exposure
- Incidence of a disease
- Mortality
  - all causes vs. cause-specific rates
  - all ages vs. age-specific rates
- Life expectancy
  - At birth
  - At specific age

Prevalence

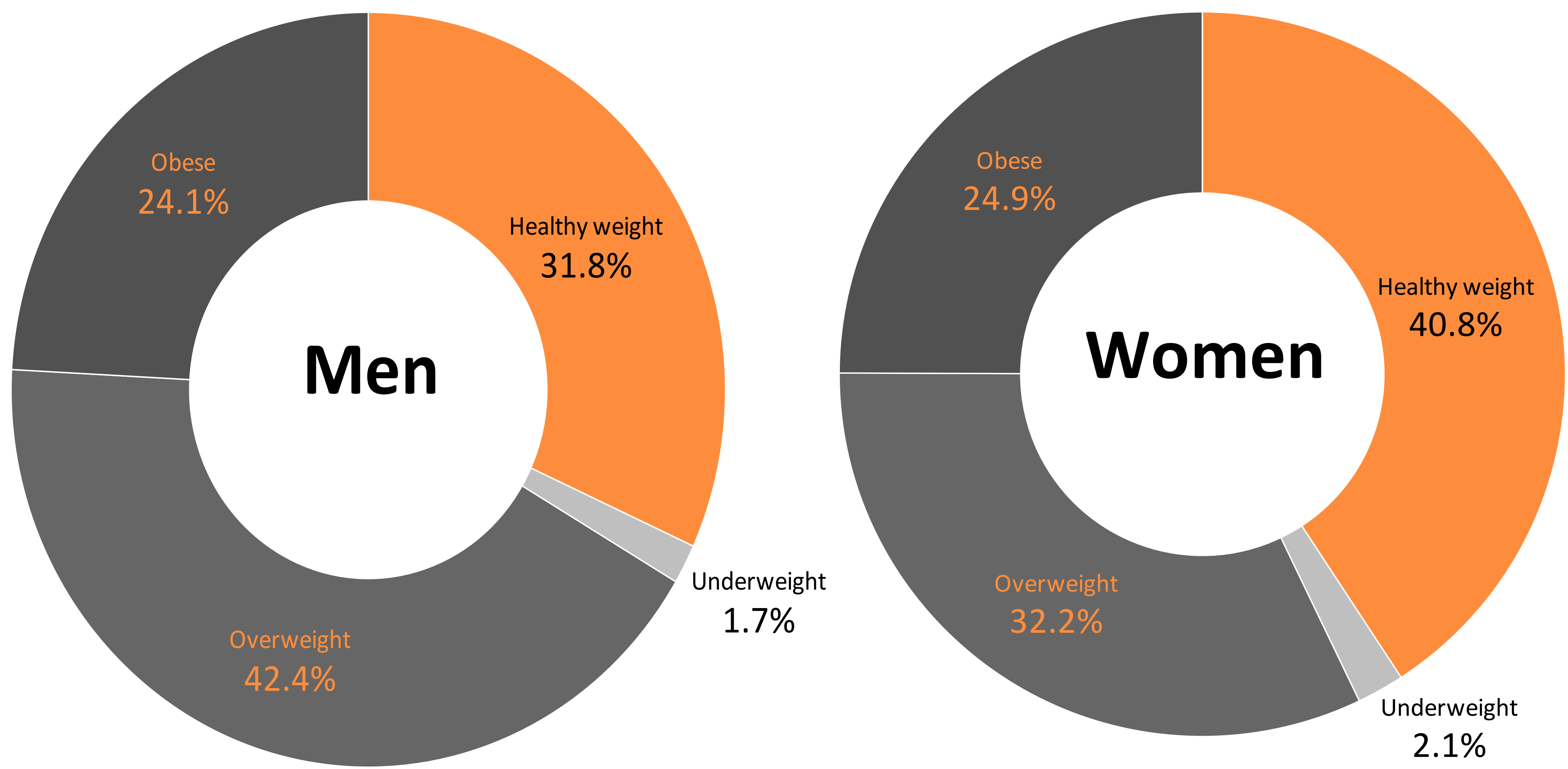
- No. of **existing** cases / number of persons in study
- Per 100 (=%), per 1000 etc

Prevalence

- Prevalence
  - Frequency of existing cases in a defined population at a given point in time.
  - Measure of disease burden
  - Can tell us point prevalence: the probability of people with a condition at a given point in time, or over a short period of time, period prevalence
  - All person with a condition/total population at risk
  - Often expressed per 1000 when frequency is small relative to population

Adult prevalence by BMI status

Health Survey for England (2008-2010 average)



Adult (aged 16+) BMI thresholds

Underweight: <18.5kg/m^2

Healthy weight: 18.5 to <25kg/m^2

Overweight: 25 to <30kg/m^2

Obese: ≥30kg/m^2

Incidence

- No. of **new** cases / number of persons in study
- Denominator:
  - **Free of disease** at the beginning of follow up
  - **At risk:** can develop the disease (e.g. non-vaccinated)
- Per 100 (=%), per 1000 etc.

Incidence

- Incidence
  - Number of new events in a defined population within a specified period of time.
  - Direct measure of risk that healthy people will develop a condition during a specified period of time
  - Tells us the rate at which new conditions occur in a defined, previously condition-free group of people
  - Number of new cases/ total population at risk

Relationship between prevalence and incidence

- The prevalence of a health-related outcome depends both on the incidence rate and the time between onset and recovery or death.
- **Prevalence = Incidence x Average disease duration**
- E.g. volume of water in watertank depends on
  - Inflow
  - Outflow

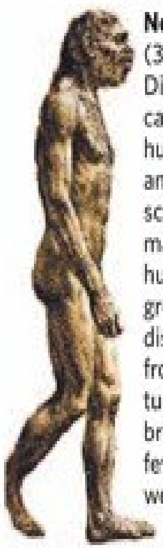
Life expectancy

LIFE EXPECTANCY THROUGH THE AGES

Early humans did not generally live long enough to develop heart disease, cancer or loss of mental function. A snapshot of how life expectancy has changed, and the big killers of each era:

AVERAGE LIFE EXPECTANCY

30 years



Neanderthals (30,000 years ago): Died of injuries caused by rock falls, hunting accidents and conflicts. Food scarcity led to malnutrition. These hunter-gatherer groups contracted diseases that spread from animals. Rabies, tuberculosis, brucellosis, yellow fever and encephalitis were widespread.

38

Neolithic (8500 BC to 3500 BC): Agriculture, irrigation and urbanization brought problems associated with settled populations, such as fecal contamination of water and diseases such as cholera, smallpox, typhoid, polio and influenza. Malaria and other diseases carried by mosquitoes and insects, which fed on domesticated animals, appeared.

35 **Classical Greece and Rome** (500 BC to 500 AD): Tuberculosis, typhoid fever, smallpox and scarlet fever spread among the denser urban populations. Malnutrition, gastro-enteritis and violence were also big killers.

48 EARLY MEDIEVAL **38** LATE MEDIEVAL

Medieval period (500 AD to 1500 AD):

Life expectancy grew with urbanization, but famine caused by crop failures and bubonic plague were the big killers. The Black Death (1347-1351) wiped out 25 million people in Europe and 60 million in Asia, returning several times, culminating in the Great Plague of London (1664-1666). By 1500, life expectancy had dropped back to 38.

40

Victorian (1850s to 1900): Typhus, typhoid fever, rickets, diphtheria, tuberculosis, scarlet fever and cholera raged in crowded cities.

MEN **70** WOMEN **75**

1900s: Better health care, sanitation and living conditions boosted life expectancy to 70 for men and 75 for women by 1950.

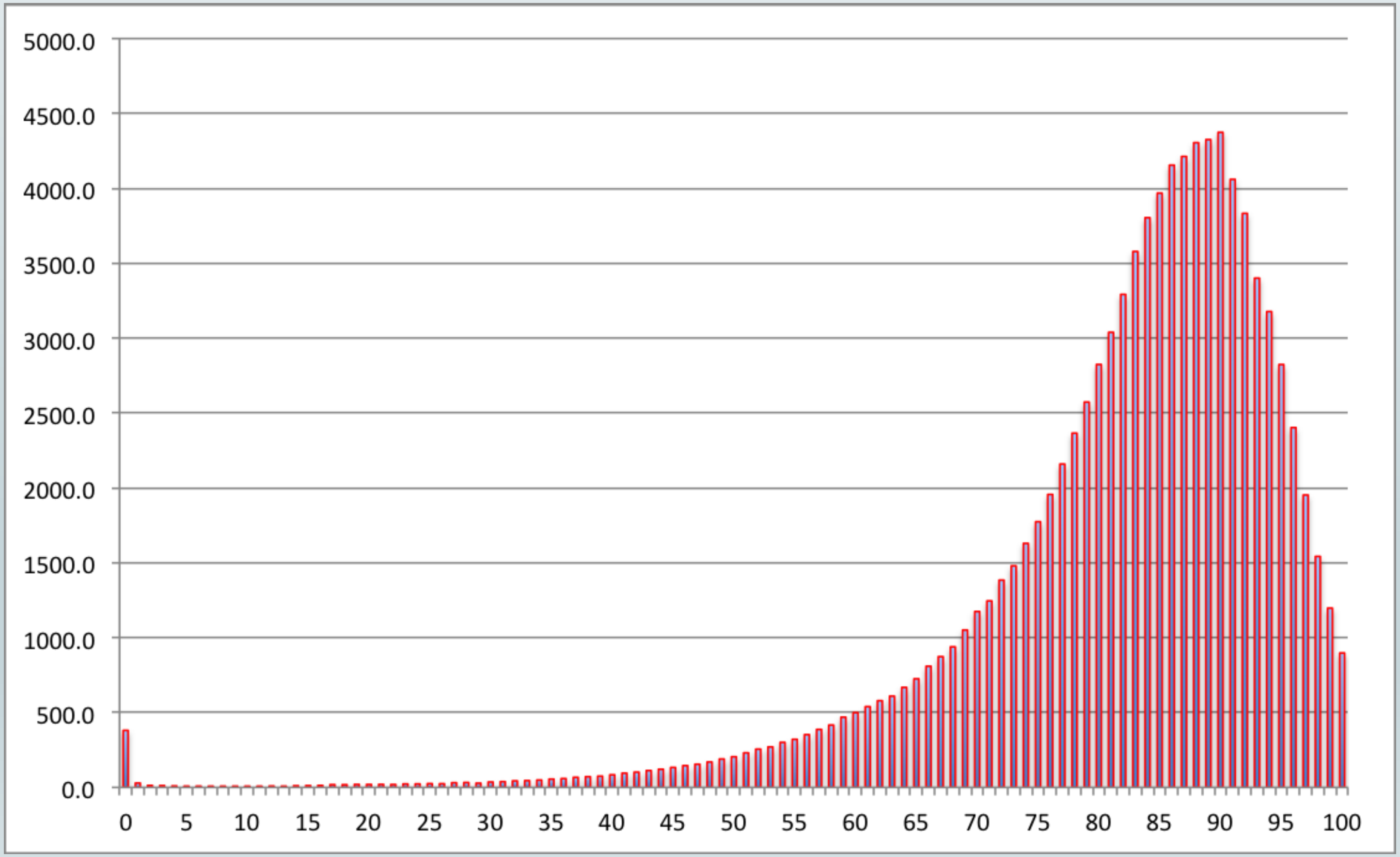
CANADA: MEN **82** WOMEN **85**

Today: Cancer, heart disease and stroke are the biggest killers in the developed world. Our longer lifespan also comes with unprecedented loss of mental function and mobility problems.

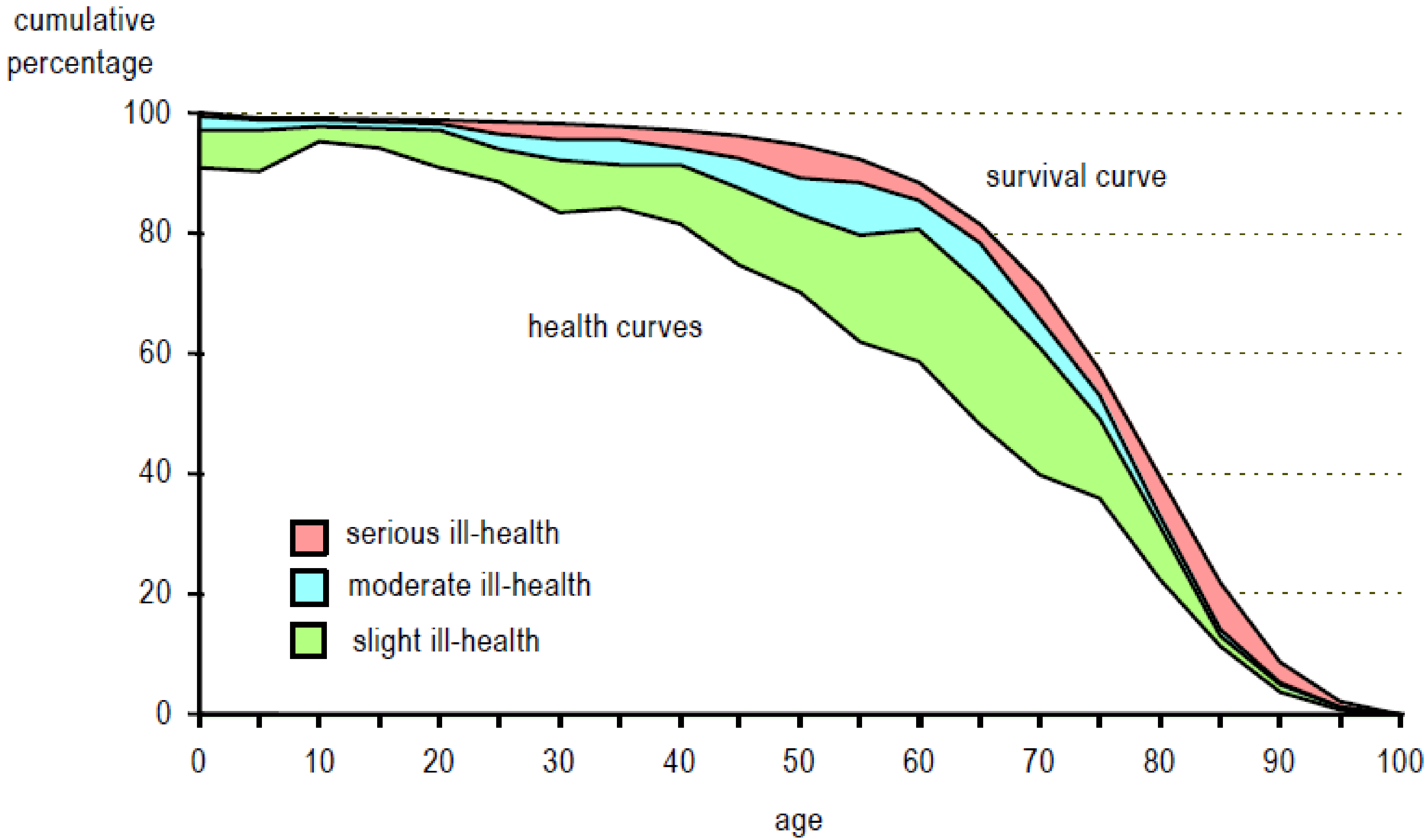
RESEARCH BY RICK SZNAJDER/TORONTO STAR LIBRARY

SOURCES: JOURNAL OF POPULATION RESEARCH, PRINCETON UNIVERSITY, STANFORD UNIVERSITY, WORLD HEALTH ORGANIZATION

Numbers of women expected to die at each age, out of 100,000 born, assuming mortality rates stay the same as 2010-2012. The expectation is 83 (mean), median 86, the most likely value (mode) is 90.



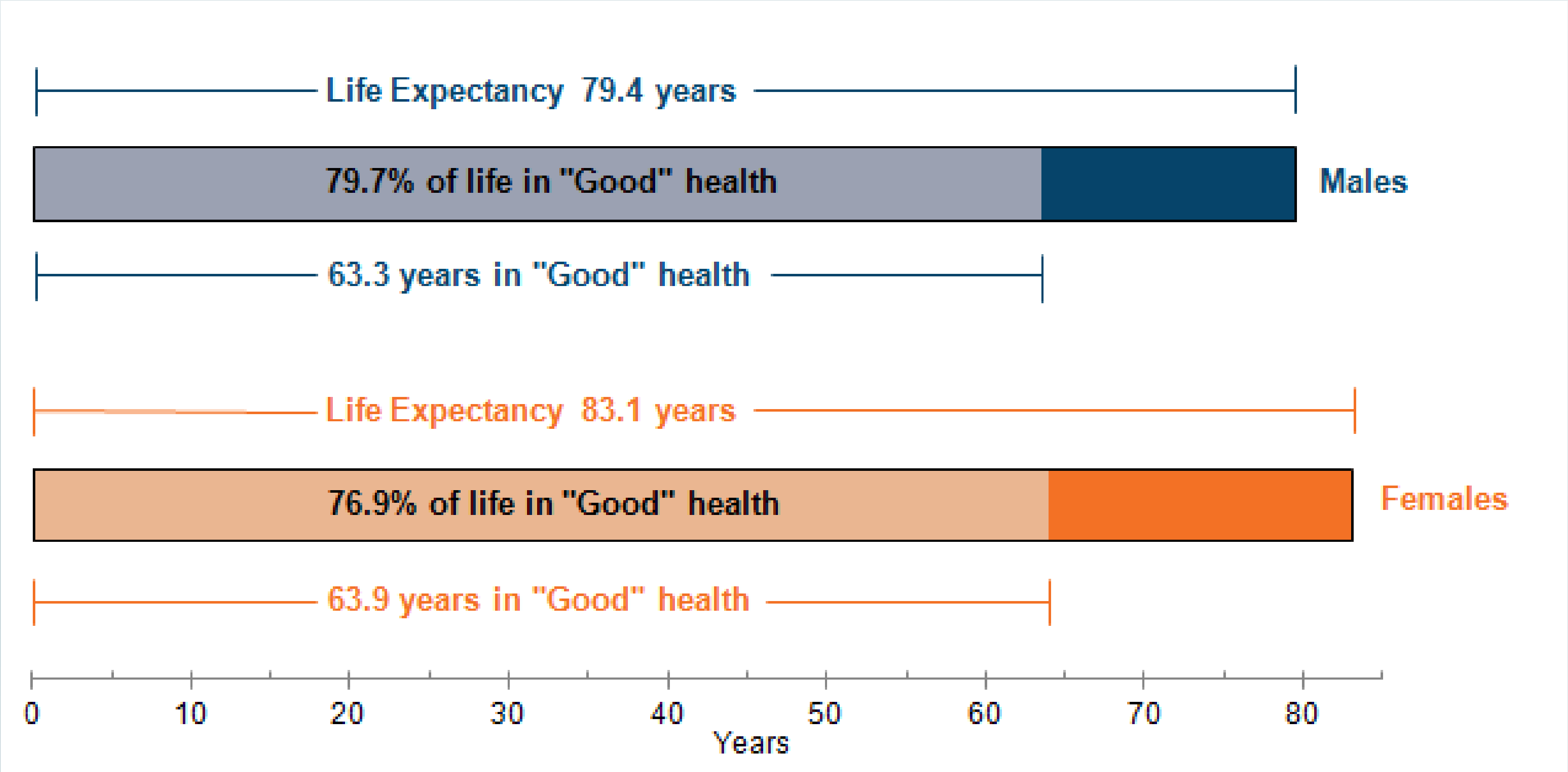
Survival and health curves



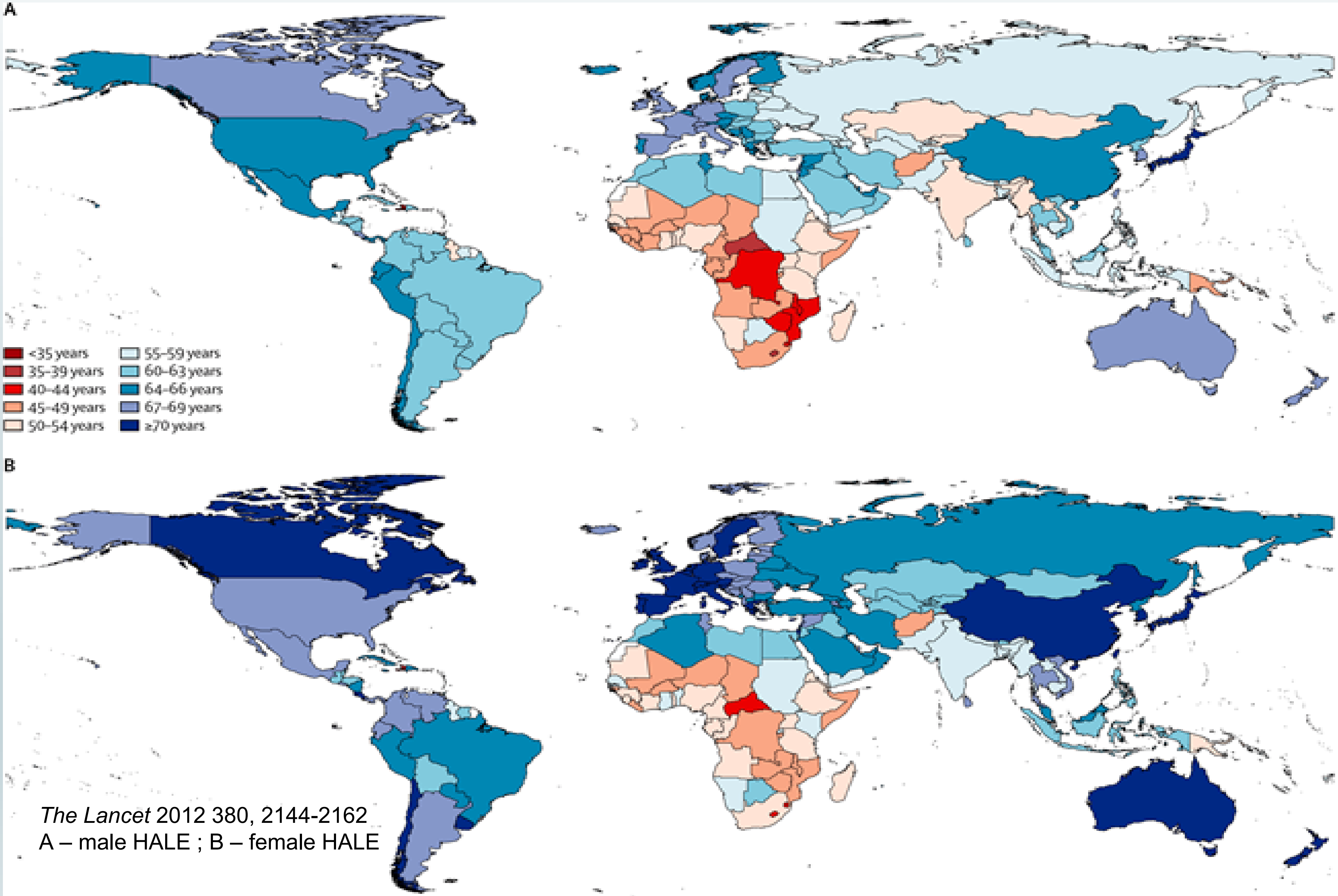
Healthy life expectancy (HALE)

- **Healthy life expectancy (HLE), or health-adjusted life expectancy (HALE)** measures the number of years that a person at a given age can expect to live in good health, accounting for mortality and disability
- = the average number of years that a newborn can expect to live in "full health"—in other words, not hampered by disabling illnesses or injuries.
- Summarises mortality and non-fatal outcomes in a single measure of average population health
- Can compare health between countries or measure changes over time
- Can inform policy questions dependent on how morbidity changes as mortality decreases

Life expectancy (LE), healthy life expectancy (HLE) and proportion of life in "Good" health for males and females at birth in England, 2011 to 2013 (ONS 2015)



Healthy life expectancy at birth by country, 2010



The Lancet 2012 380, 2144-2162
A – male HALE ; B – female HALE

Epidemiology

- The study of the **distribution** and **determinants** of the **frequency** of health-related outcomes in specified populations

- Quantitative discipline

- Measurement of disease / condition / risk factor frequency is central to epidemiology

- Comparisons require measurements

Much of epidemiological research is taken up trying

- to establish associations between exposures and disease rates
- to measure the extent to which risk changes as the level of exposure changes
- to establish whether the associations observed may be truly causal (rather than being just consequence of bias or chance)

Measures of association

- Risk of disease, rate of disease in different groups of population
- Comparison of risks/rates

Measures of effect

We have 2 groups of individuals:

- An **exposed** group (group with risk factor of interest) and **unexposed** group (without such factor of interest)
- We are interested in comparing the amount of disease (mortality or other health outcome) in the exposed group to that in the unexposed group

Risk ratio

- we calculate the risk ratio (RR) as:

$$RR = r_1 / r_0$$

Risk difference

- the absolute difference between two risks (or rates)

$$RD = r_1 – r_0$$

Example: cohort study of oral contraceptive use and heart attack

	Myocardial infarction		
	Yes	No	Total
OC use			
Yes	25	400	425
No	75	1500	1575
Total	100	1900	2000

Risk (exposed) = 25/425=0.059
Risk (unexposed) = 75/1575=0.048

Relative risk = 0.059/0.048 = 1.23

Risk or rate difference

Measure of the absolute effect

the absolute difference between two risks (or rates)

$$RD = r_1 - r_0$$

Similar for rates = rate difference = incidence rate in exposed – incidence rate in unexposed

Measures of population impact

- **Population attributable risk (PAR)** is the absolute difference between the risk (or rate) in the whole population and the risk or rate in the unexposed group

$$PAR = r - r_0$$

Population attributable risk fraction (PARF or PAR%)

- It is a measure of the proportion of all cases in the study population (exposed and unexposed) that may be attributed to the exposure, on the assumption of a causal association
- It is also called the aetiologic fraction, the percentage population attributable risk or the attributable fraction

- If r is rate in the total population

$$PAF = PAR/r$$

$$PAR = r - r_0$$

$$PAF = (r-r_0)/r$$

References

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