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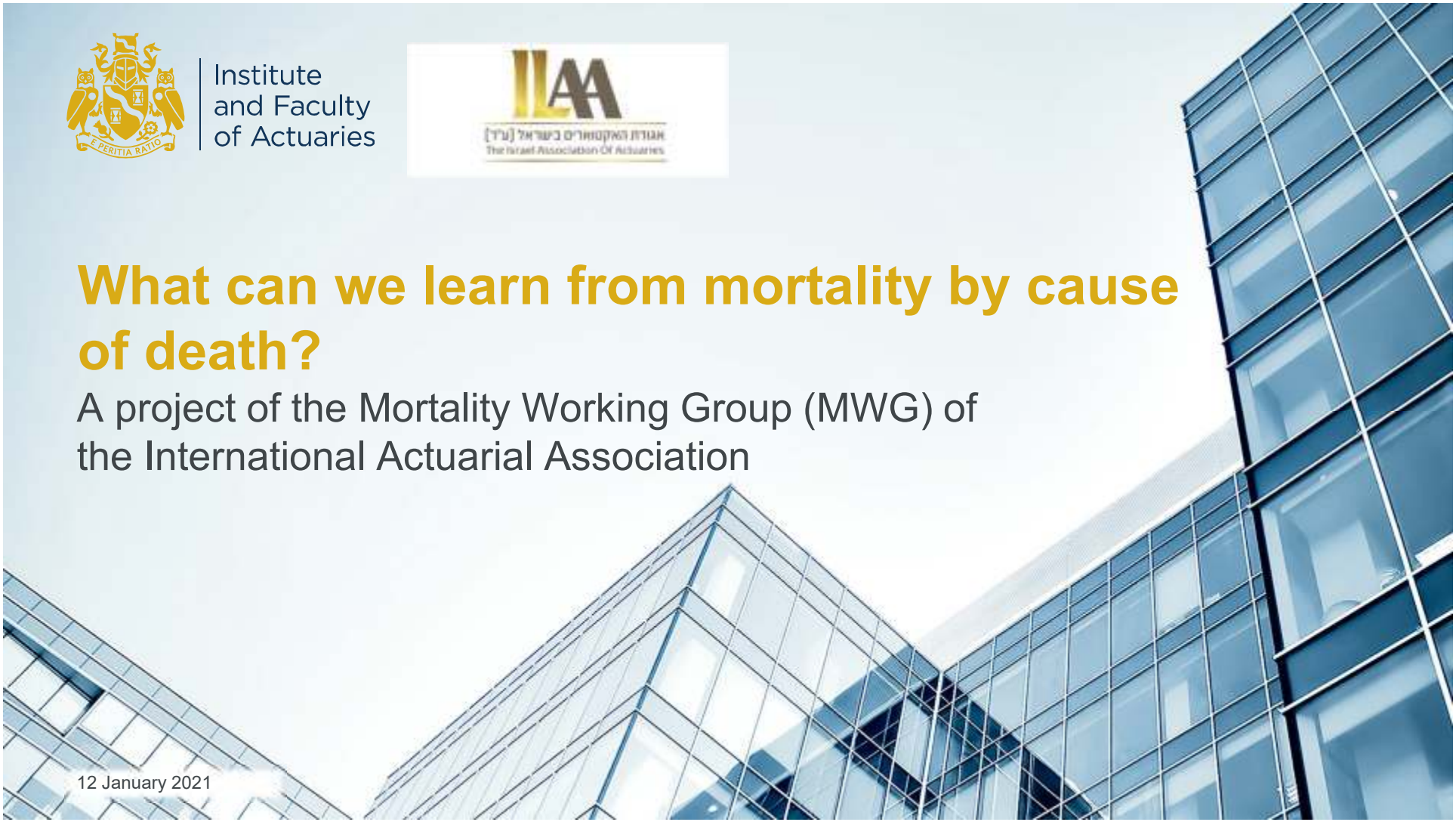
What can we learn from mortality by cause of death?

Dov Raphael

12 January 2021



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What can we learn from mortality by cause of death?

A project of the Mortality Working Group (MWG) of the International Actuarial Association

12 January 2021

Content of the presentation

- The Mortality Working Group
- Introduction – why are causes of death important?
- Sources of information
- The Excel model
- Examples of results
- The cohort effect
- Data consistency and reliability
- Conclusions and summary

Latest news

https://www.worldometers.info/coronavirus/country/israel/

Last updated: January 12, 2021, 05:58 GMT

Israel

Coronavirus Cases:

504,269

Deaths:

3,704

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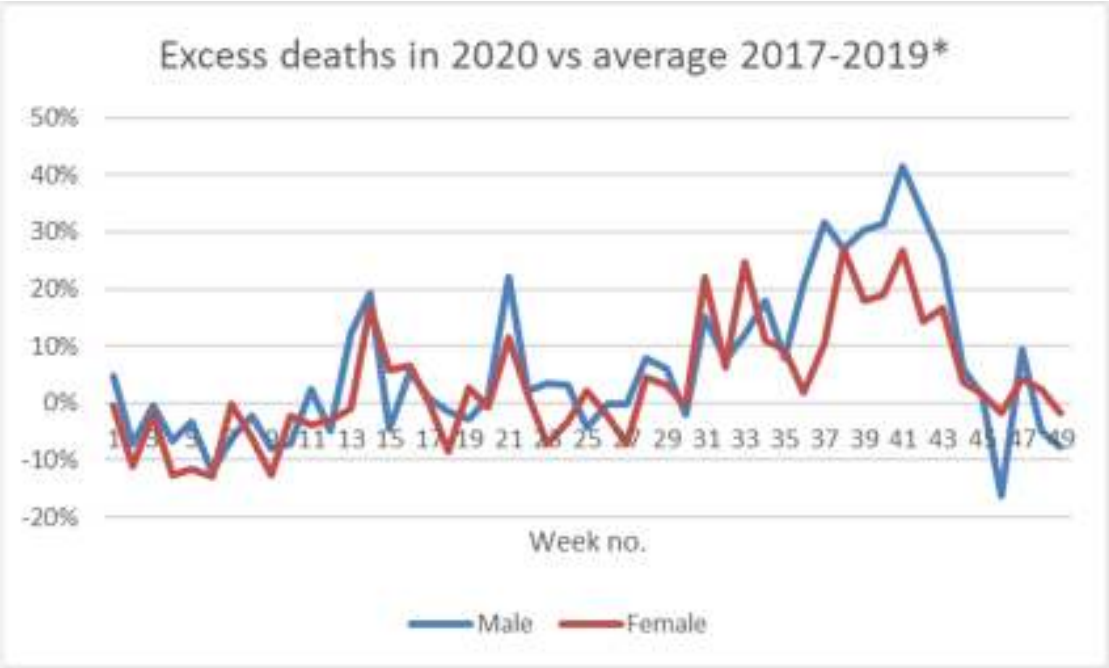
Updates for Israel (9 Dec 2020) – excess deaths in 2020



* Adjusted for population increase (but not change in age distribution)

Source: Calculated from www.mortality.org (data retrieved 11 Jan 2020)

Excess deaths (adjusted for population increase) up to week 49: ~1200 males, ~560 females – about 4% of all deaths

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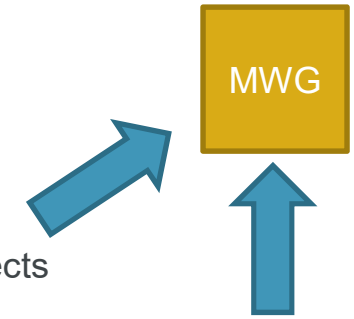
The Mortality Working Group

- A forum of the International Actuarial Association
- Exists to promote and support international actuarial research in mortality and longevity
- Purpose: To serve as a working group within the IAA devoted to the worldwide study of mortality, particularly mortality impacts on insurance (including life, pension and living benefits) products or on government or world organisation (such as WHO and the UN) sponsored programs. Studies of the mortality experience of general populations, insured life and other population subsets are within the scope of the MWG
- Currently has 45 members from 31 countries on 5 continents [IL:2], and another 54 “Interested persons” [IL:2]

www.actuaries.org/mortality



Knowledge
Country reports
Research updates
Sharing at meetings
Conferences
Visiting speakers

Resource library
Open access on web to -
Minutes and papers
Country reports
Information Base
www.actuaries.org/mortalityinfo

Research
MWG research projects
Own research
Papers
Presentations
International: HMD, supranationals

Fellowship
Joint projects
Dinners
Shared research
Worldwide contacts

Dissemination
Updates in 13 languages
promoted to associations
Actuarial educators
IAA seminars with PIWG
In-country seminars
Supranational meetings

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Some recent projects of the MWG

- E-cigarettes (Sam Gutterman)
- Recent Developments in Longevity Internationally (Brian Ridsdale)
- Drivers of Future Mortality by (Al Klein)
- The search for new sources of mortality improvement - moving from remedial to curative medicine (Daniel Ryan)
- Underwriting Around the World (Al Klein)
- Epidemics and Pandemics – an Actuarial View (Sam Gutterman)

The current project on **Mortality by Cause of Death (COD)** was compiled by Dr Ayse Arik, Prof.Yair M. Babad and Dov Raphael

The paper is in process of approval by the IAA.

Content of the presentation

- The Mortality Working Group
- **Introduction – why are causes of death important?**
- Sources of information
- The Excel model
- Examples of results
- The cohort effect
- Data consistency and reliability
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What can we learn from mortality by Cause of Death? - Objectives

- To catalogue, assess and analyse existing data on mortality by cause of death (COD), including: comparisons by country, trends over time, and possible implications for mortality forecasting
- To investigate to what extent the data are consistent, and how they might be influenced by changes in categorization or reporting preferences
- The database and its associated graphs and tables were created for this study as a compilation of existing actuarial data, in order to enable users to make effective use of the information available while being aware of its limitations.

Why are CODs important?

Mortality forecasting models look for patterns in overall mortality rates

e.g. APC (Age-Period-Cohort):

$$\text{logit}(q_{x,t}) = \beta_x + \kappa_t + \gamma_{t-x}$$

Lee-Carter

$$r_{x,t} = \ln(m_{x,t}) = \alpha_x + \beta_x k_t + \varepsilon_{x,t}$$

- Why is there a combination of period/cohort?
- Why do periodic improvements vary by age?

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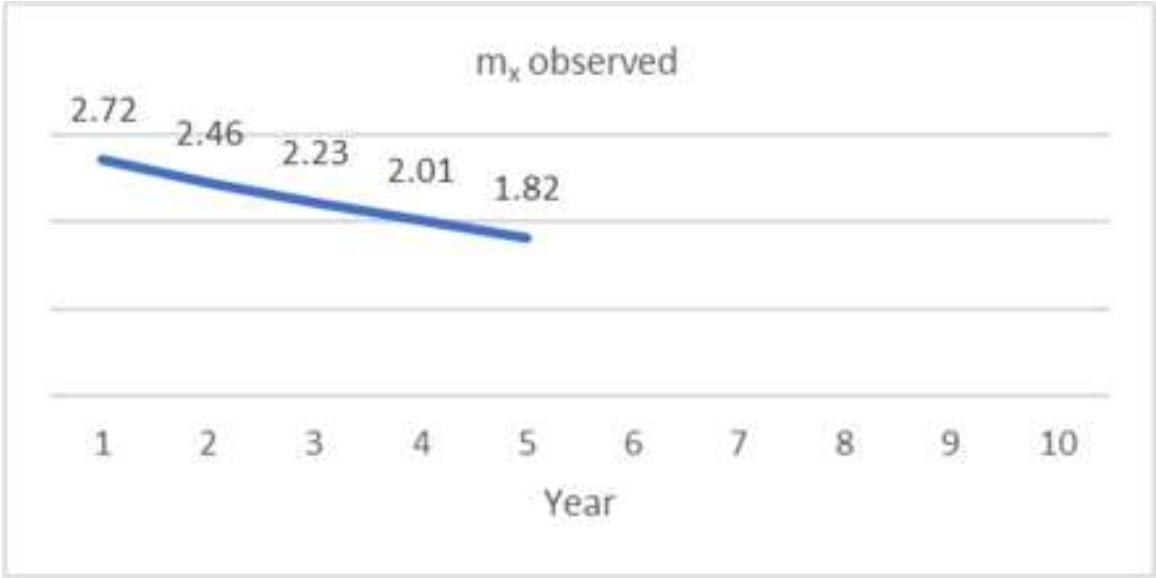
Why are CODs important?



A fictitious example of mortality rates over time – years 1-5 (observed)

The overall mortality rates in Fig. 1.1 are log-linear (e, $e^{0.9}$, $e^{0.8}$ ….)

What happens if we extrapolate for the next 5 years?

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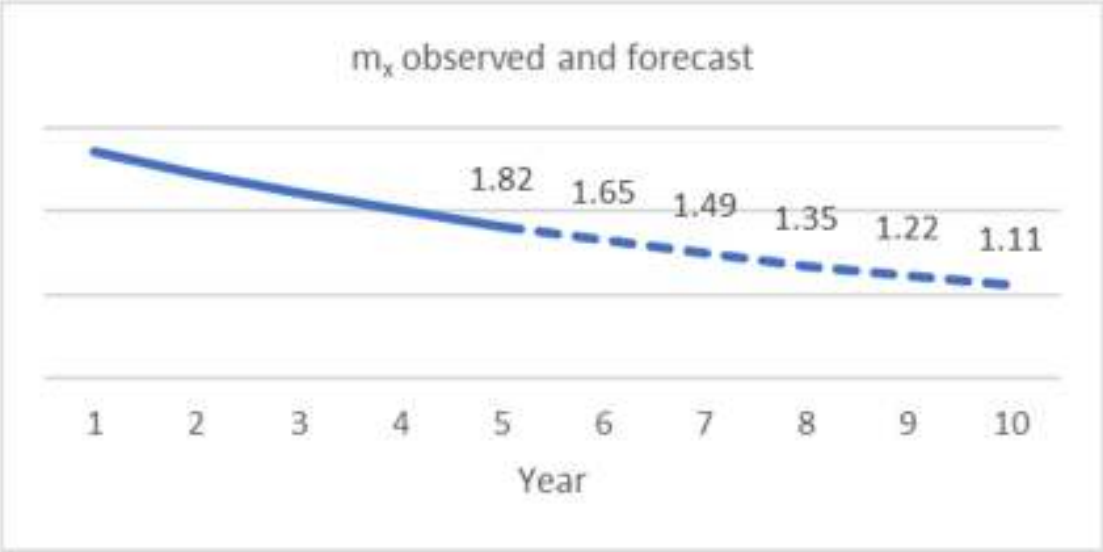
Why are CODs important?



Extrapolation of previous example for the next 5 years

Now, let us suppose that the mortality in Fig. 1.1 is a result of two CODs, Cause A and Cause B.

Each cause behaves differently.

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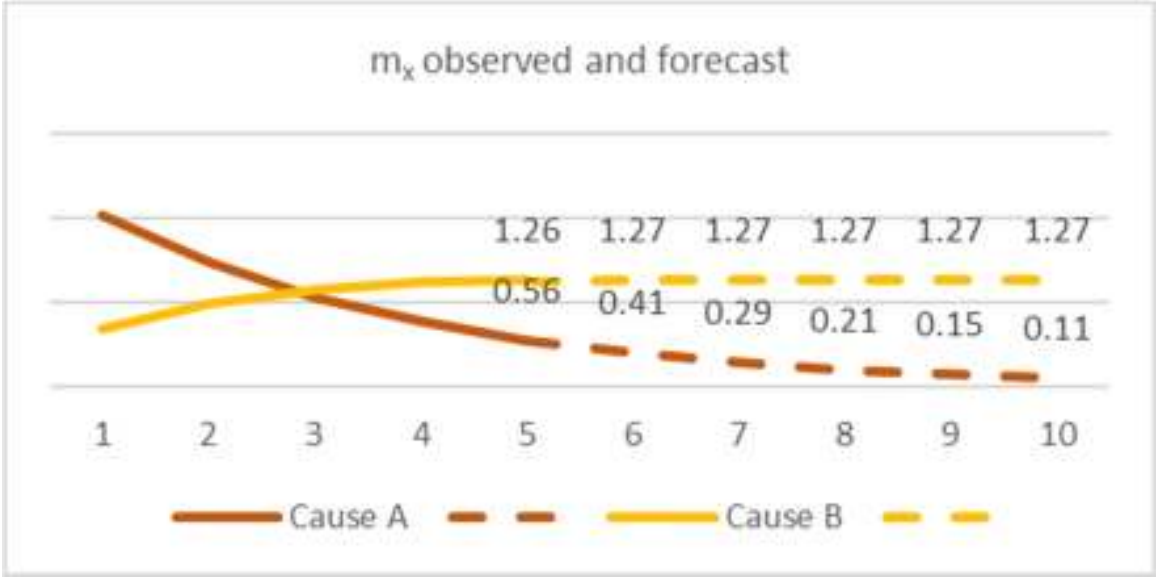
Why are CODs important?



Mortality for Cause A and Cause B, observed (years 1-5) and projected (years 6-10)

Cause A decreases log-linearly but more rapidly.

Cause B has been increasing but is now close to stability.

The combined result is 1.38 instead of 1.11 !

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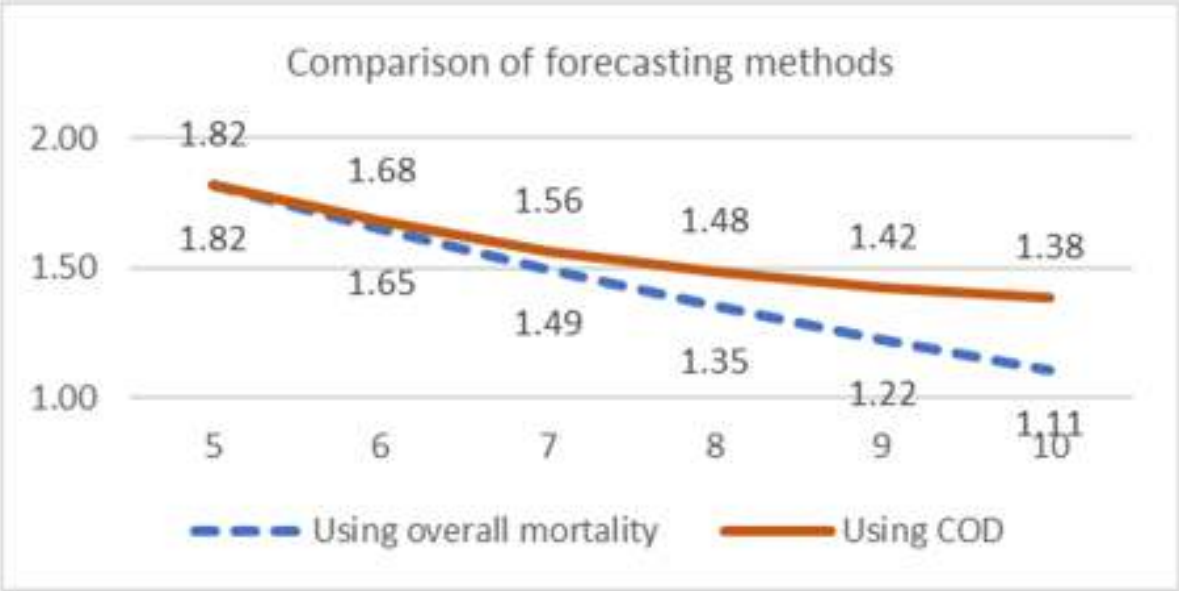
Why are CODs important?



Why are CODs important?

Other considerations:

- Some COD are important at older or younger ages: looking at overall mortality obscures this.

  → Examine CODs by age group

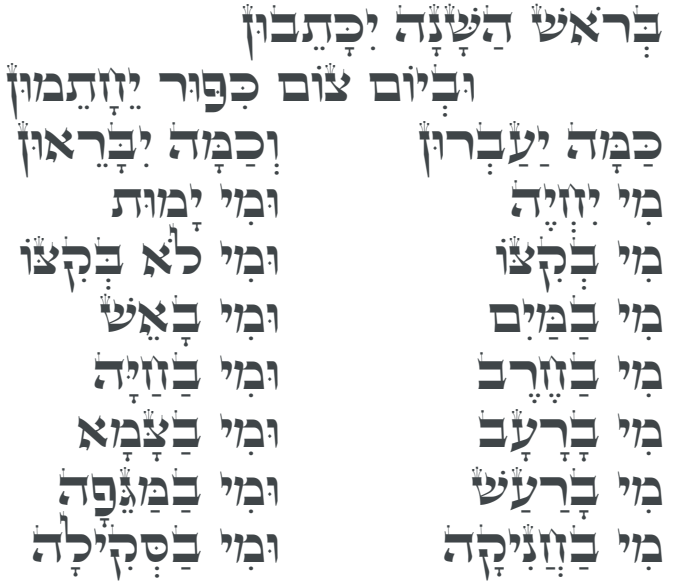
- The cohort effect is relevant to specific causes

  → We developed a measure of “cohortness” to identify the relevant CODs and countries.

Early interest in causes of death

- Ancient Jewish prayer, source of Leonard Cohen's "Who by fire":

On the New Year will be inscribed and on the Day of Atonement will be sealed – how many will pass from the earth and how many will be created; who will live and who will die; who will die after a long life and who before his time; who by water and who by fire, who by sword and who by beast, who by famine and who by thirst, who by upheaval and who by plague, who by strangling and who by stoning...



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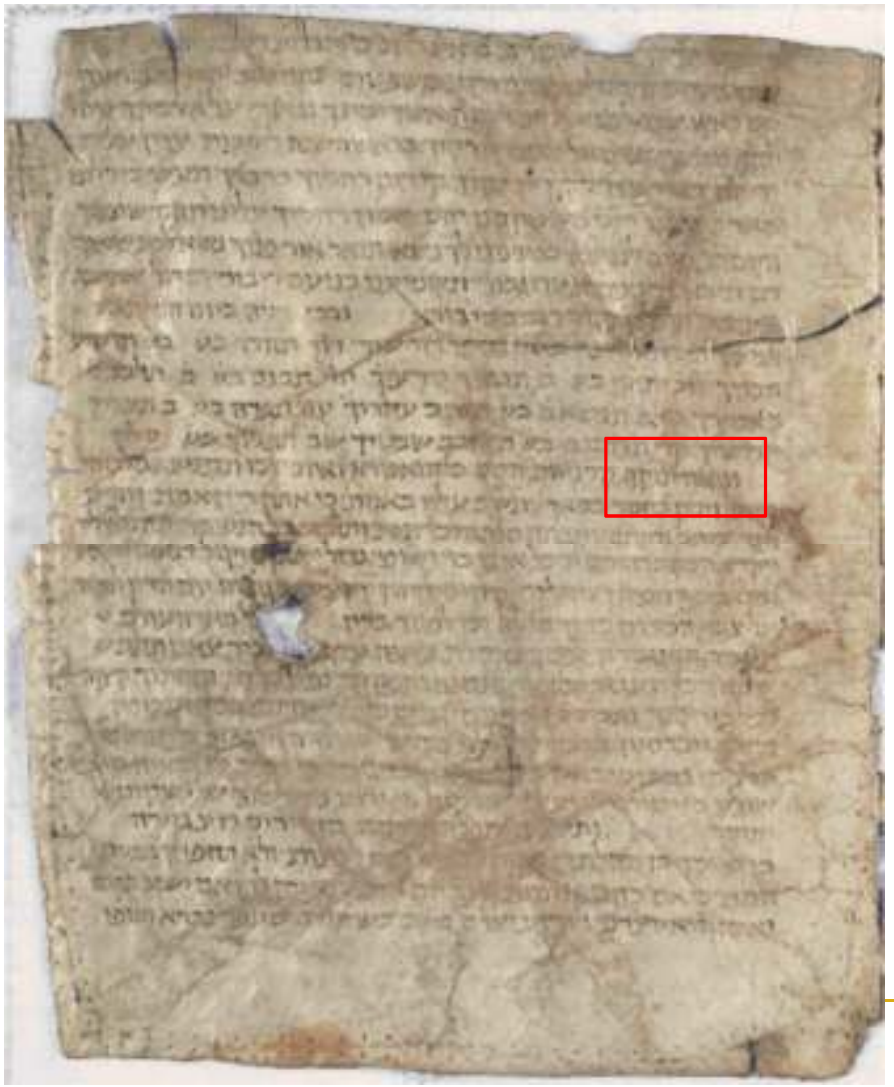

Early interest in causes of death

‘ונתנה תוקף' בקטע גניזה
קדום, בצד פיוטי יניי: כ"י
קמברידג' T-S H 8.6

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Early interest in causes of death

- John Graunt's mortality table – London, 1662

"[Graunt] observed that about one-third of all deaths occurred from 'Thrush, Convulsion, Rickets, Teeth, Worms, Abortives, Chrysomes, Infants, Overgrown and Overlaid', which he guessed all related to children under four or five years old. He guessed also that perhaps half of the deaths from 'Smallpox, Swinepox, Measles and Worms without Convulsions' might be children under six years old … About 7 per cent of the total deaths were described as 'aged', which he guessed as meaning over age 70."

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International Classification of Diseases (ICD)

- International standard for reporting diseases and health conditions
- Diagnostic classification standard for all clinical and research purposes
- Allows easy storage, retrieval and analysis of health information for evidenced-based decision-making
- Allows data comparisons in the same location across different time periods
- The current “standard” for reporting is ICD-10, which was approved in 1990
- There are conversion tables from previous versions of ICD in order to capture data from earlier periods.

International Classification of Diseases (ICD)

- **Immediate cause of death: "**The final disease or condition resulting in death"
- **Underlying cause of death**: "The disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury"
- **Multiple causes**: causes of death including not only the underlying cause but also immediate cause of death and all other intermediate and contributory conditions entered by the certifying physician
- On death certificates, causes of death are entered sequentially starting with **immediate cause** and ending with the **underlying cause**
- The physician may also record "**other significant conditions** contributing to death but not resulting in the underlying cause".

International Classification of Diseases (ICD)

An example from A. Minino, MPH (Centers for Disease Control and Prevention) –

	Cause	ICD-10 code	Onset to death
Immediate cause	Cerebral haemorrhage	I61.9	1 month
Underlying cause	Nephritis	N05.9	6 months
Initiating underlying cause	Cirrhosis of liver	K74.6	2 years

Cause-of-death groupings

What kinds of cancer?

Cause	Descriptor	Corresponding cause in HCD	Corresponding cause in WHO
0	All		
1	Infectious	1	1
2	Malignant neoplasms	2	2
3	Other neoplasms		
4	Blood	3	3
5	Endocrine	4	4
6	Mental	5	5
7	Nervous system	6	6
8	Heart	7	9
9	Cerebrovascular	8	
10	Circulatory	9	
11	Respiratory	10+11	10
12	Digestive	12	11
13	Skin	13	12
14	Musculoskeletal		13
15	Genitourinary	14	14
16	Childbirth	15	15
17	Perinatal		16
18	Congenital		17
19	Unknown	16	?
20	External		20

Low incidence, not interesting

Accidents
Suicide
Homicide

Cause-of-death groupings

Major category		Minor category	
1	CANCER	1.01	Cancer of digestive system and oral cavity
		1.02	Colorectal cancer
		1.03	Cancer of trachea, bronchus and lung
		1.04	Cancer of breast, uterus and ovary
		1.05	Cancer of prostate and urinary organs
		1.06	Other malignant neoplasms
2	HEART AND CIRCULATORY	2.01	Hypertensive/rheumatic heart disease
		2.02	Ischaemic heart disease
		2.03	Other heart disease
		2.04	Cerebrovascular
		2.05	Circulatory
3	OTHER MEDICAL	3.01	Infectious diseases
		3.02	Diabetes mellitus
		3.03	Other metabolic
		3.04	Substance abuse
		3.05	Mental
		3.06	Nervous system
		3.07	Acute respiratory
		3.08	Other respiratory
		3.09	Digestive
		3.10	Musculoskeletal
		3.11	Genitourinary
		3.12	Other/ unknown
4	EXTERNAL	4.01	Suicide
		4.02	Homicide
		4.03	Road accidents
		4.04	Accidental poisoning
		4.05	Other accidents

Sources of information

Existing sources:

1. The Human Cause of Death Database (HCD) (16 countries)
2. The Cause-of-Death section of the Human Mortality Database (HMD-COD) (8 countries)
3. The WHO mortality database (over 140 countries)

In the WHO database, for many countries the population size is too small, or the data period is too short or not continuous. Unlike the two previous databases, there is no information about exposure to risk (which is required to calculated mortality rates), but only population data.

Our study uses a combination of sources 1 and 2.

Sources of information

Country	Acronym used in graphs	No. of years covered	Average population size over this period	Approx. exposure in bn. life yrs	Life expectancy at birth (LE)	LE correct at year
US	USA	57	247.2	14.1	78.9	2017
Russia	RUS	50	134.9	6.7	70.9	2014
Japan	JPN	67	103.4	6.9	84.4	2018
Germany	DEU	19	81.8	1.6	80.9	2017
France	FRA	58	54.4	3.2	82.4	2017
E&W	ENW	67	50.7	3.4	81.3	2016
Ukraine	UKR	49	45.3	2.2	71.4	2013
Spain	ESP	33	42.1	1.4	83.1	2016
Poland	POL	58	33.7	2.0	77.8	2016
Czechia	CZE	68	9.7	0.7	79.0	2018
Sweden	SWE	61	8.3	0.5	82.5	2018
Norway	NOR	62	4.1	0.3	82.8	2018
Lithuania	LTU	54	2.9	0.2	75.7	2017
Latvia	LVA	54	2.1	0.1	74.8	2017
Estonia	EST	54	1.3	0.1	78.2	2017
TOTAL			**821.8**	**43.2**		
Repr. countries			**630.0**	**33.0**		

Combining the data from sources “1” and “2” enables a view of ~50 years for most countries

The graphs shown in the presentation relate to 6 “representative” countries out of the 15

Israeli data from WHO added for this presentation. Available only from 1998 to 2016.

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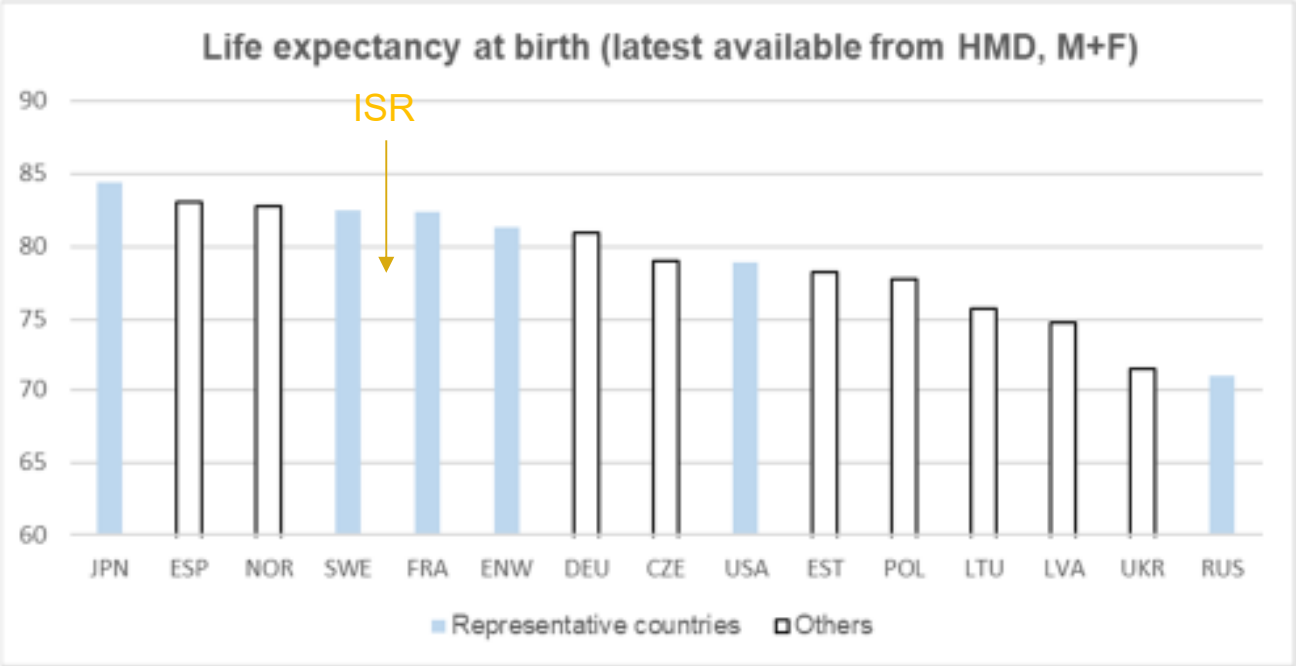
Life expectancy – countries in the study



For illustration only – LEs are for the latest year available and so are not exactly comparable.

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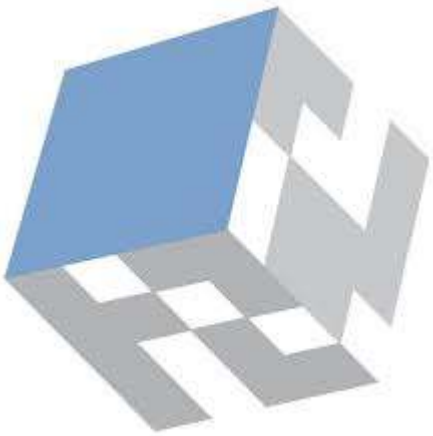
Challenges of combining sources

- Data from the two “actuarial” databases are similar but not identical
- In most cases the differences are not significant for the current study
- The two databases are independent and seek to achieve different goals
- HMD-COD: access to **unadjusted** cause-of-death data series for as many of the HMD countries as possible with periodic updates as new data become available
- HCD: a one-time to provide access to historical cause-of-death series for a limited number of countries, **adjusted** for changes in ICD.

The combined database – a 5-dimensional "data cube"



- From the HMD we have four dimensions:
  - Country (15 countries)
  - Observation year (between 19 and 68 available years, average 54)
  - Gender (M/F)
  - Age (0-1, 1-4, 5-9, 10-14, … 75-79, 80-84, 85 and up)
- We now add a 5th dimension:
  - Cause of death (4 major categories, 28 sub-categories)
- The database has ~900,000 cells for death counts, and ~30,000 cells for exposures
- An Excel spreadsheet enables "views" which freeze three dimensions and show results for the remaining two dimensions.

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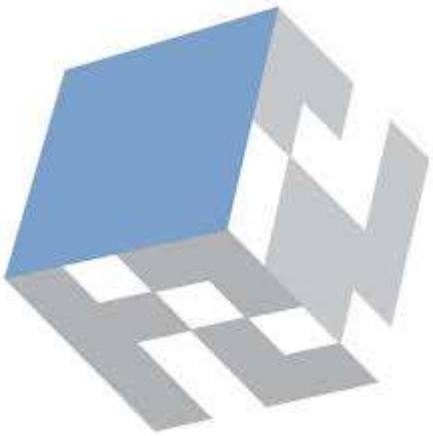
The combined database – a 5-dimensional "data cube"



- The "cube" includes the following metrics:
  - **Exposure**
  - Number of **deaths**
  - Mortality rate (**m_x** = deaths / exposure)
  - **Change in m_x** since earliest year in graph
  - Annual **mortality improvement** (moving average)

as well as a new metric "**Weighted years of life lost**" (WYLL) which is the expected number of years of life lost (relative to the maximum life expectancy – Japan F) resulting from the COD being measured, per 1000 lives. This enables a "view" of all ages together, for comparison over time or across countries.

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A brief view of the Excel model

Mortality Working Group									21/06/2020
					C:\Users\Public\Actuarial\630 Research\Cause of death\Latest\[COD analysis 2020-05-07.xlsb]Country-yr				
Mortality trends by cause of death : comparison by country and year									
Axes:	**Countries**	All							
	Years - from	1965			CLICK Formulae/Calculate Sheet TO UPDATE TABLES				
Fixed values:	**COD group:**	C lung	Cancer of trachea, bronchus and lung						3
	Ages from:	70	to	85	70-85				
	Gender:	1	*(1=M,2=F,3=both)*		M				Go to graphs
Not updated!!	***Mark up to 6 columns (1,2,3…) to be shown on graphs:***								
	1	2	3		4	5			
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Table of results								**Exposure**	
Country:	USA	RUS	JPN	DEU	FRA	ENW	ESP	UKR	POL
	15	12	7	2	6	3	4	14	11
1965	23,290,806	19,553,371	16,422,793		6,447,861	6,048,844		6,855,651	4,341,637
1966	23,472,789	19,340,201	16,514,861		6,479,863	6,121,799		6,778,391	4,354,438
1967	23,837,382	19,200,377	16,779,528		6,571,872	6,218,677		6,712,050	4,414,396
1968	24,357,757	19,010,487	17,209,961		6,685,546	6,296,446		6,630,957	4,483,491

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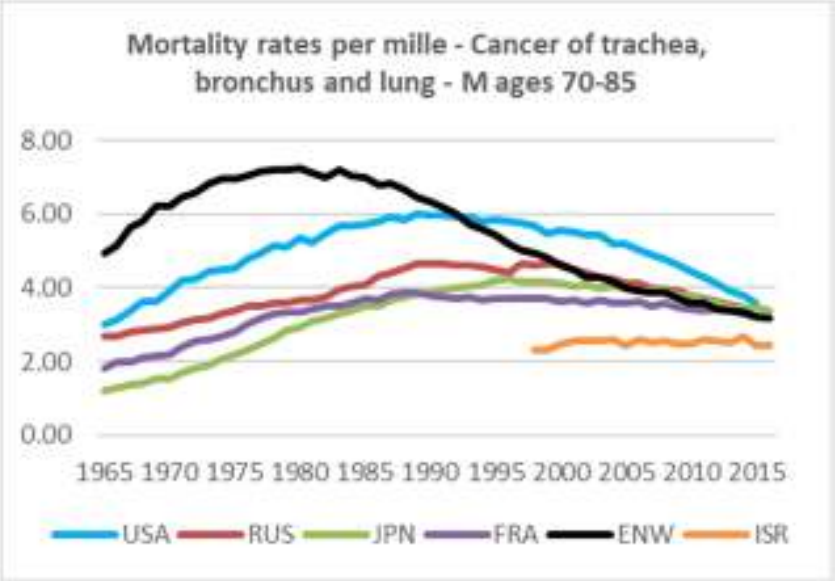
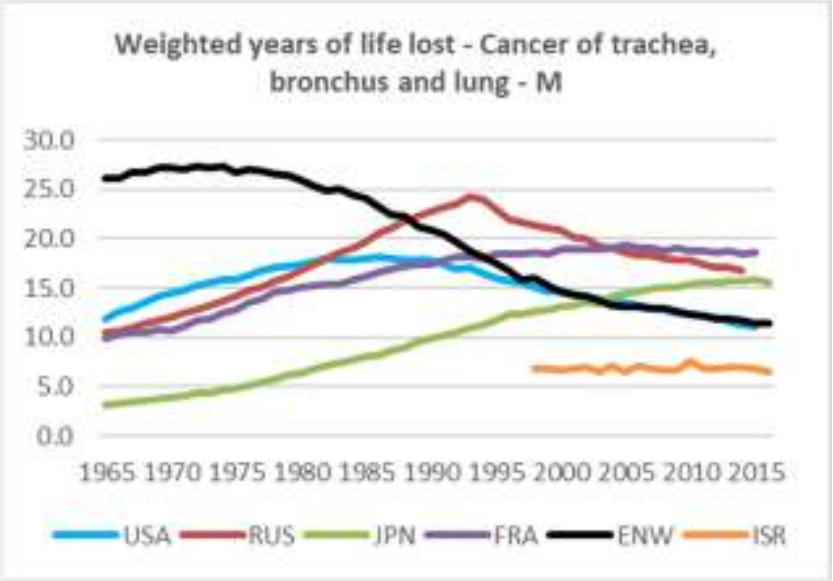
A brief view of the Excel model





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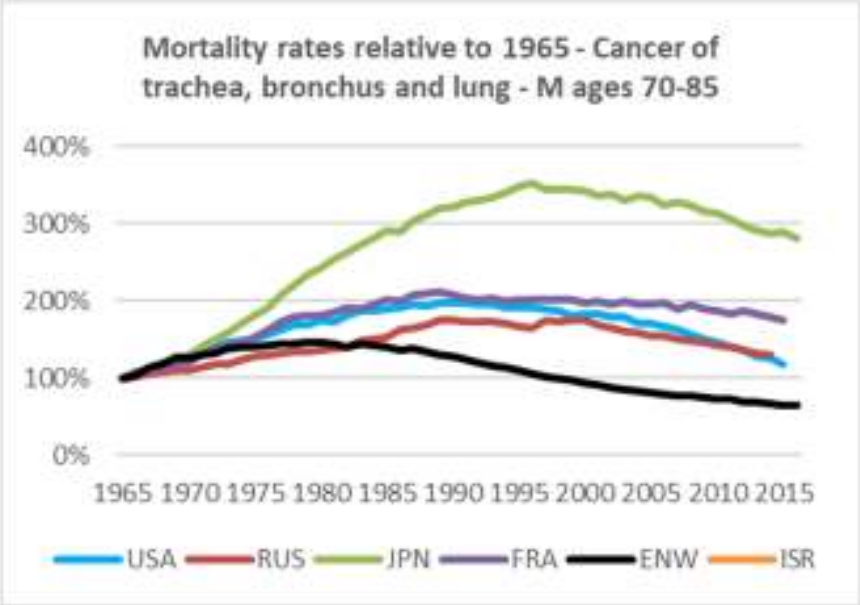

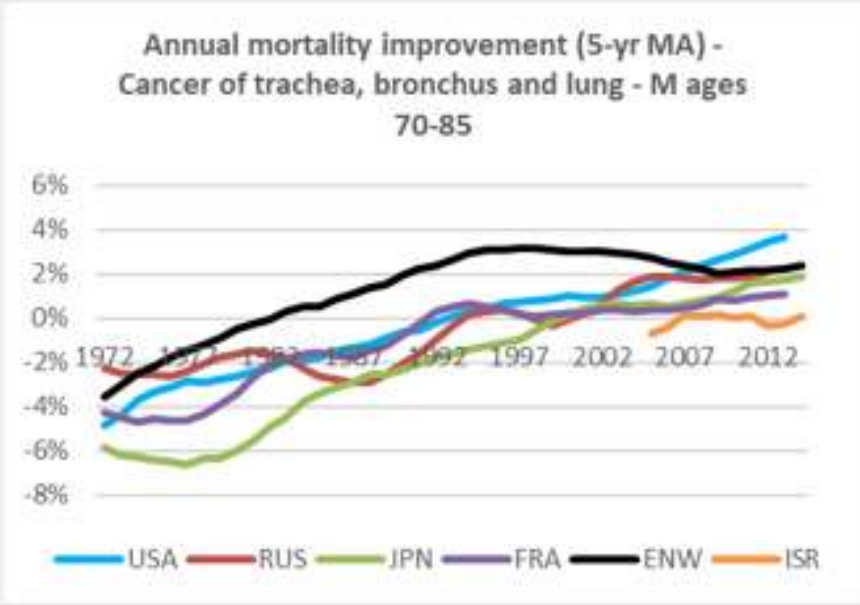

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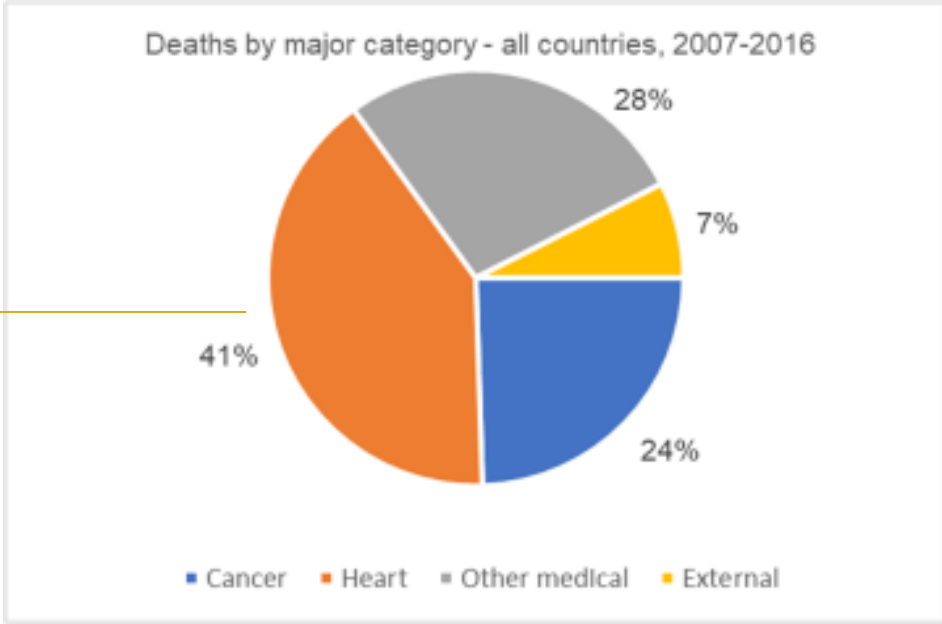
Overview of results by major categories

41% of deaths in the countries studied were from heart and circulatory diseases (down from 48% fifty years ago), but the next slide shows disparities between the countries.



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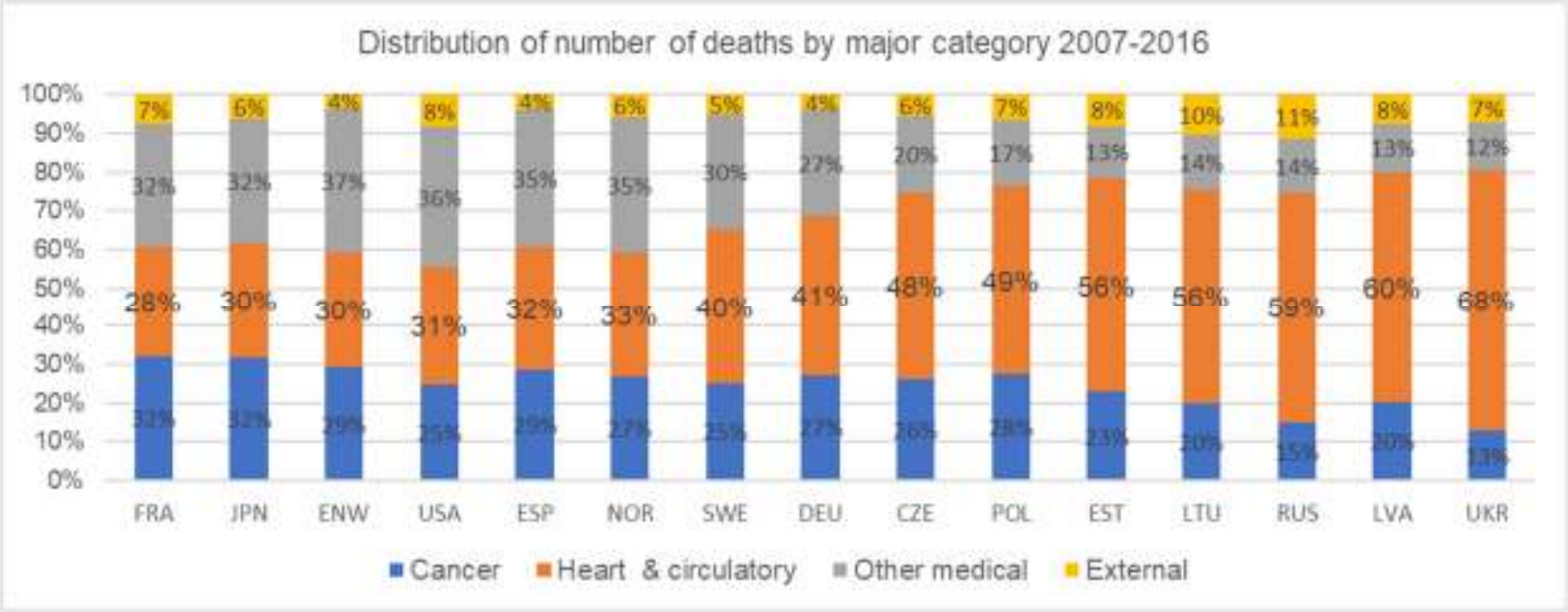
Overview of results by major categories



ISRAEL: Cancer 27%, Heart and circulatory 25%, Other medical 44%, External 5%

The proportion of deaths from heart and circulatory diseases in Eastern Europe is ~60%, in most other countries ~30%

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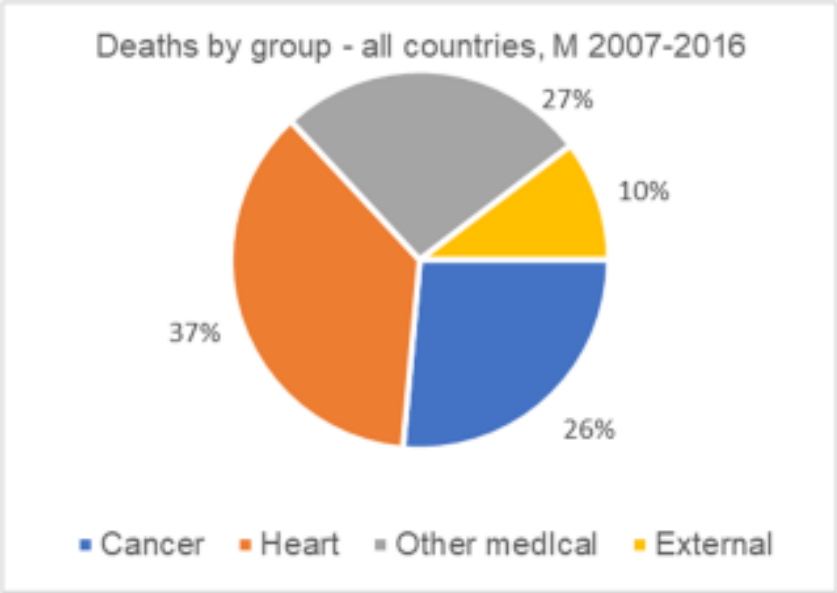
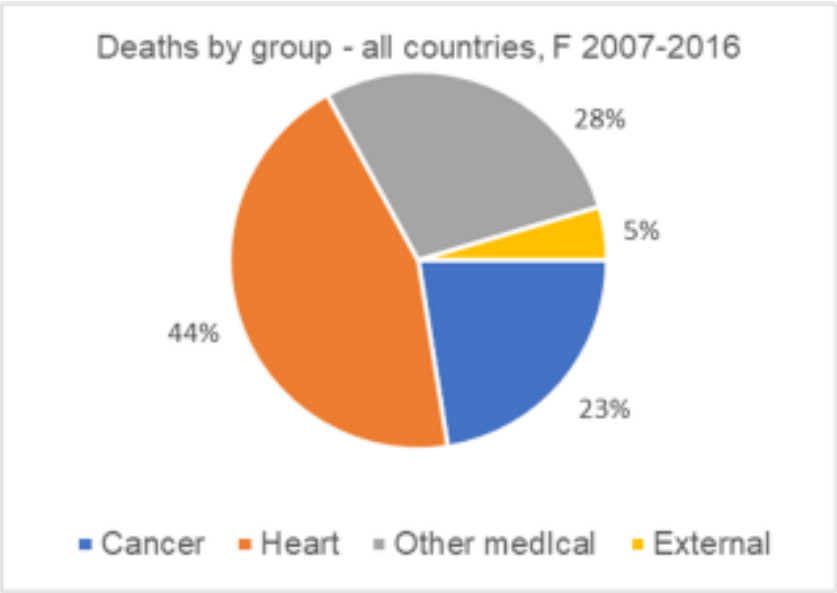
Overview of results by major categories and gender





- The higher proportion of heart disease among women is found mainly in Eastern Europe. In the US the shares are almost the same (30% for men, 31% for women)
- Deaths from external causes are much higher for men than for women.

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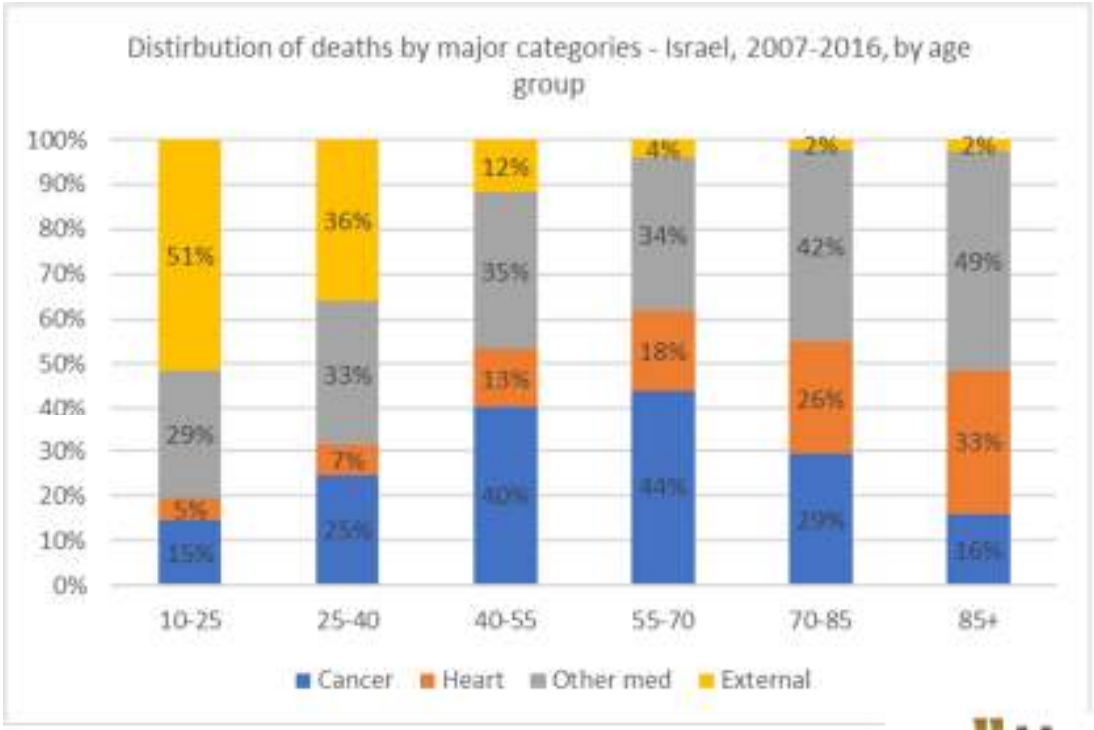
Overview of results by age group



- Cancer claims show a bell-curve peaking at 55-60

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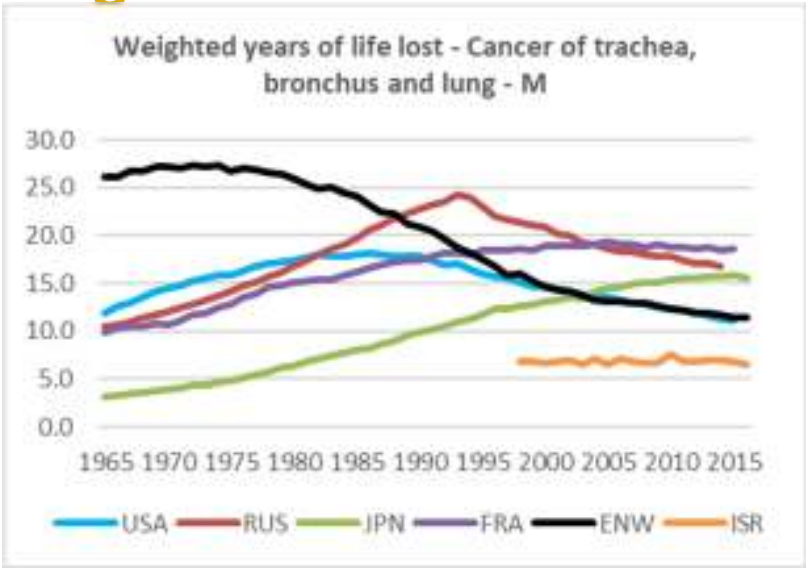
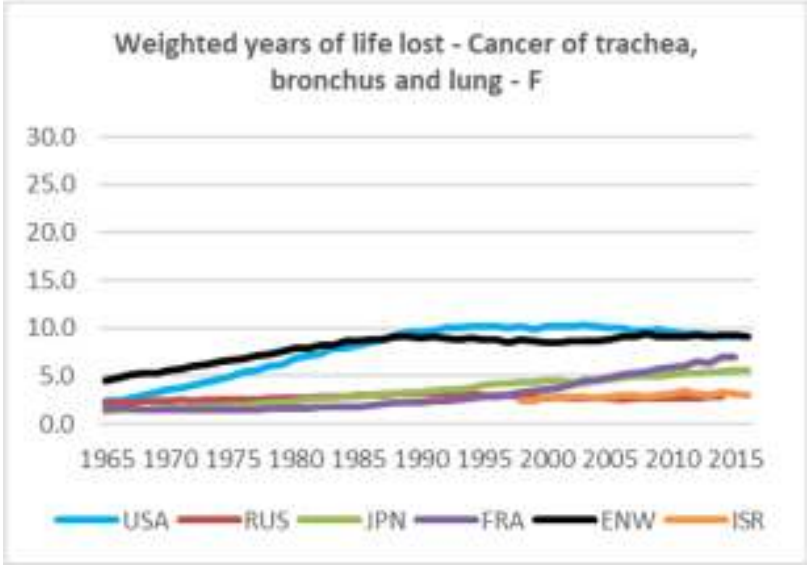
Weighted years of life lost (WYLL) by cause of death – lung cancer





- Males: Russia, US and England improving; Japan deteriorating; France and Israel static
- Females: in most countries the situation has worsened, but Russia, US and England now static.

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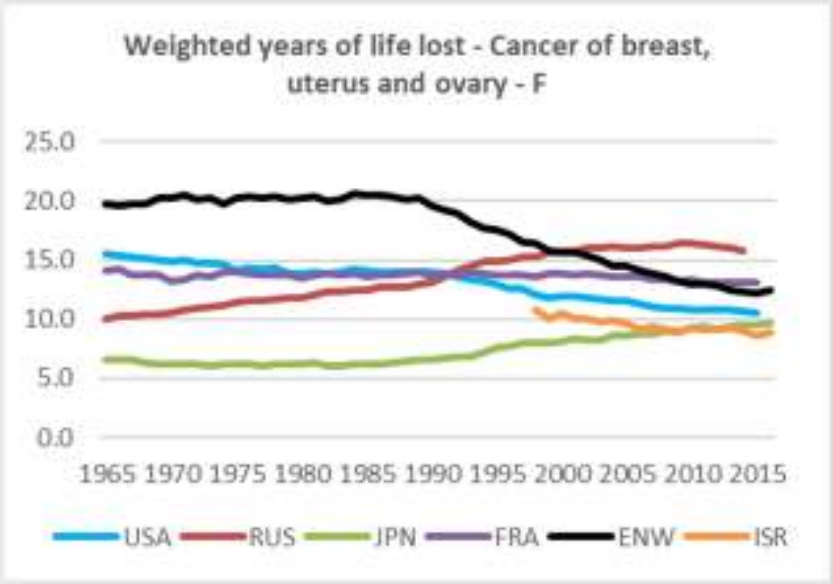
WYLL by cause of death – breast cancer



- The lowest (best) values are seen in Japan up to 2005, but with a worsening trend. Current lowest values in Israel (!)
- England and Wales - very high until 1990, since then a significant improvement.

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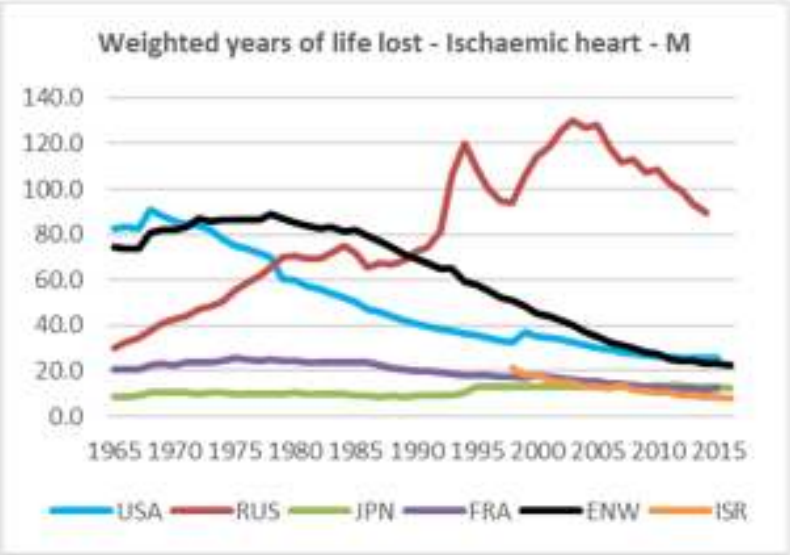
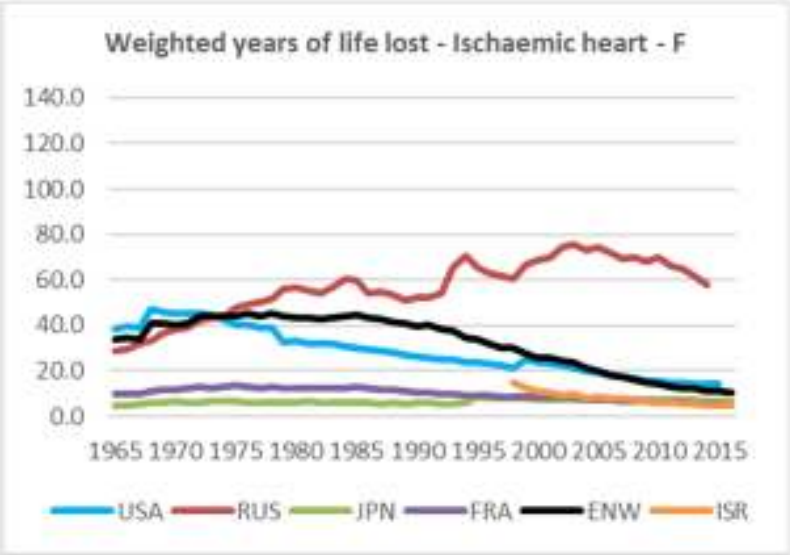
WYLL by cause of death – ischaemic heart disease





- Japan, France: low and stable
- US, England: initially high (esp. males), decrease of about two-thirds
- Russia: increasing until about 2000, some improvement since then.

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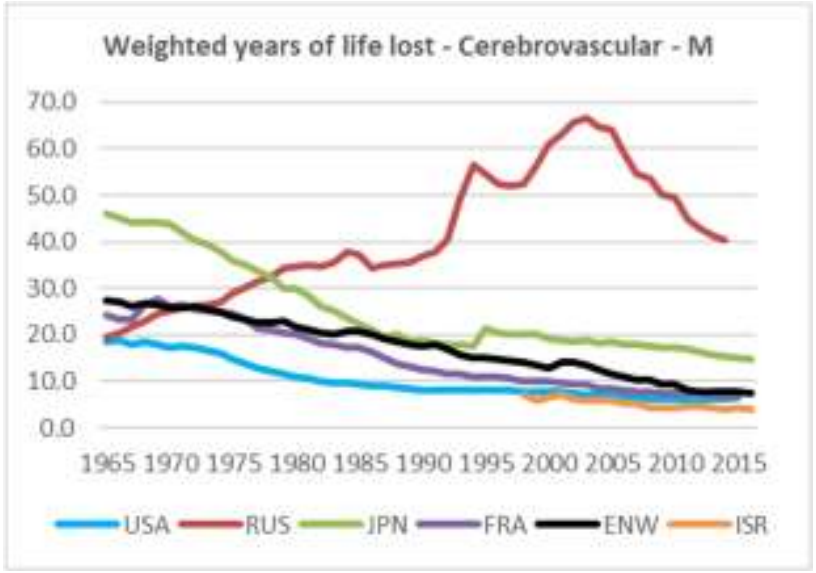
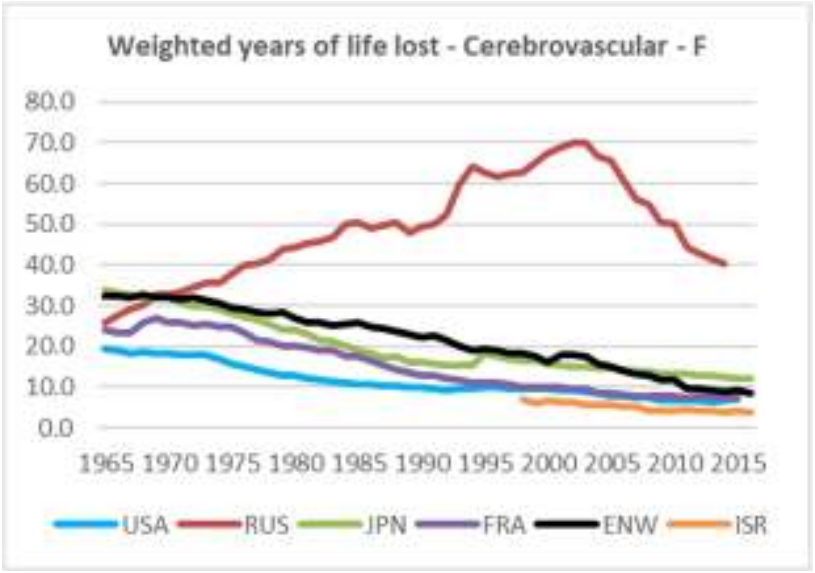
WYLL by cause of death – cerebrovascular disease





- Most countries: improvement have tapered off
- Russia: increasing until about 2000, a significant improvement since then.

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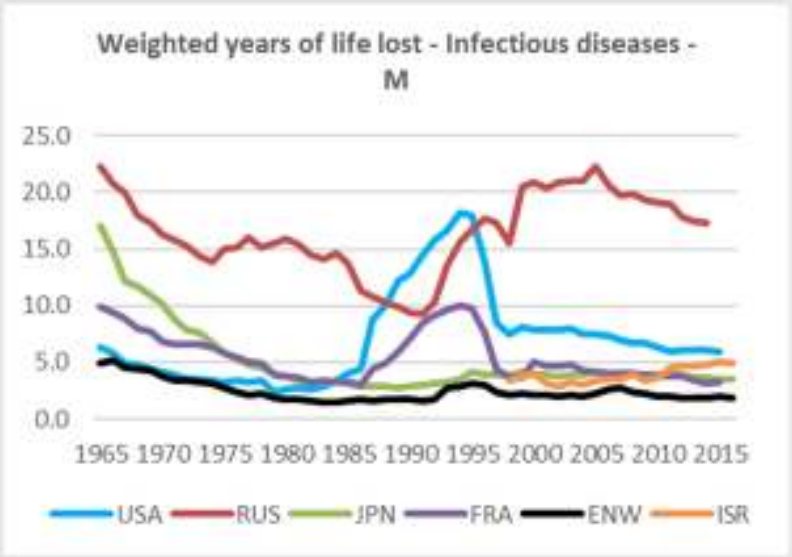
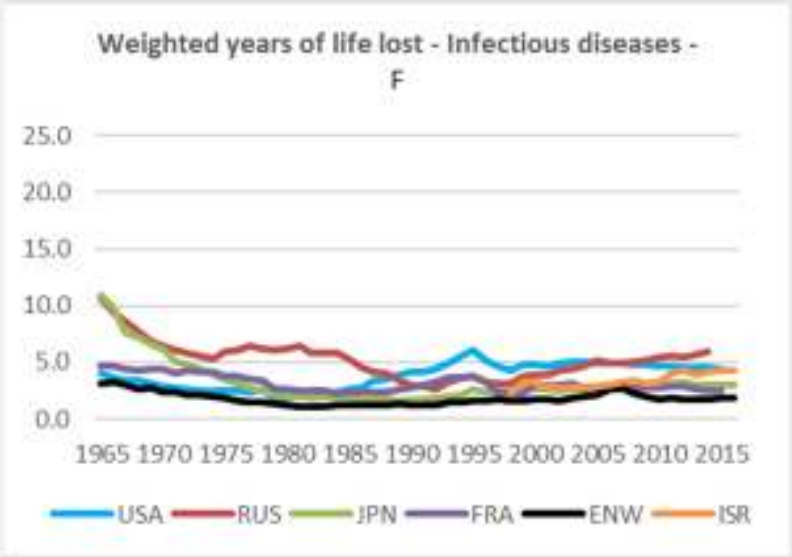
WYLL by cause of death – infectious diseases





- US and France in particular show the effect of AIDS in 1980s and 1990s
- Russia: since 2000, much higher than other countries
- Female mortality much lower, but increasing in Russia since 2000.

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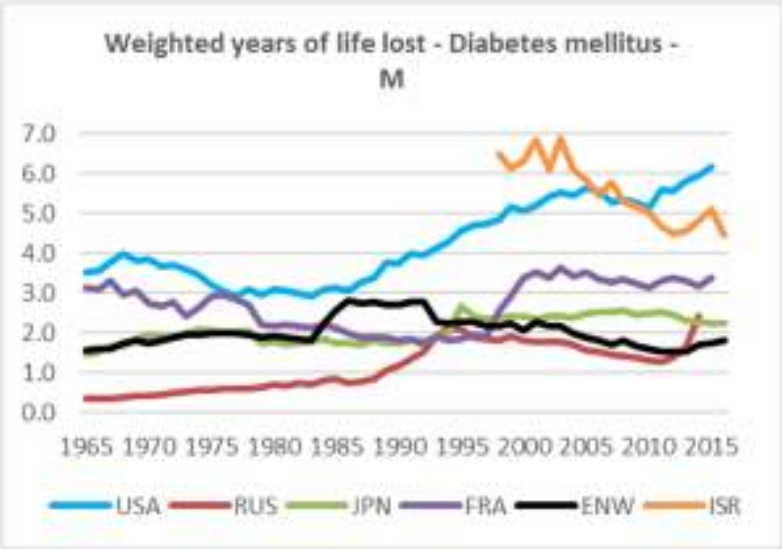
Infectious diseases (continued)

Israel 2016 - no. of deaths from:			
Age group	**Infectious diseases**	**All causes**	
10-25	7	433	2%
25-40	22	844	3%
40-55	89	2,211	4%
55-70	338	7,406	5%
70-85	962	15,465	6%
85-120	1,121	16,837	7%
TOTAL	**2,539**	**43,196**	**6%**

WYLL by cause of death – diabetes mellitus



- Israel – very high, but decreasing
- Male and females similar
- Increase for US males – does not give full expression to increase in incidence of diabetes
- Perhaps other medical complications of diabetics appear as the cause of death?

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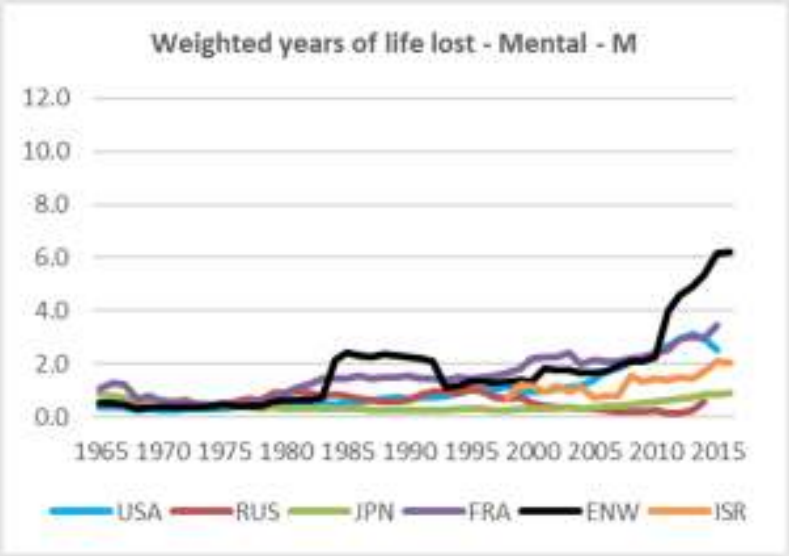
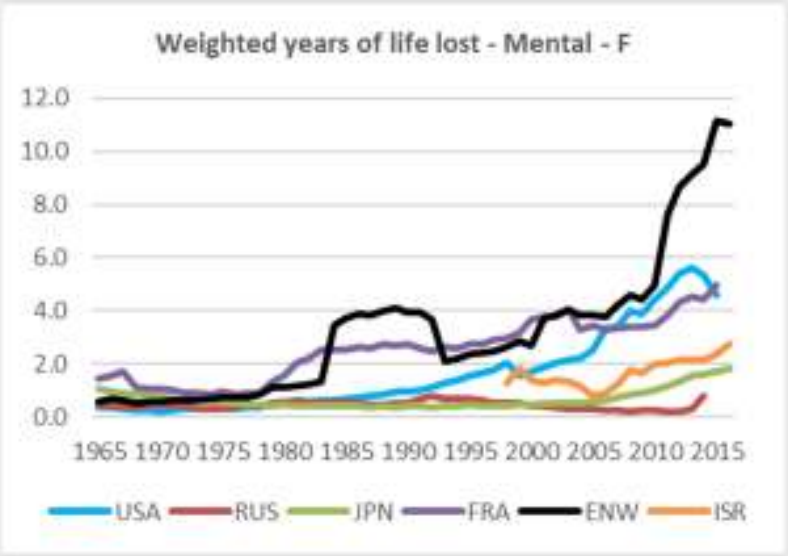
WYLL by cause of death – mental diseases (incl. dementia)





- Main contributor to the increase is dementia
- Not seen in all countries
- Higher rates for females, perhaps an indirect result of female longevity

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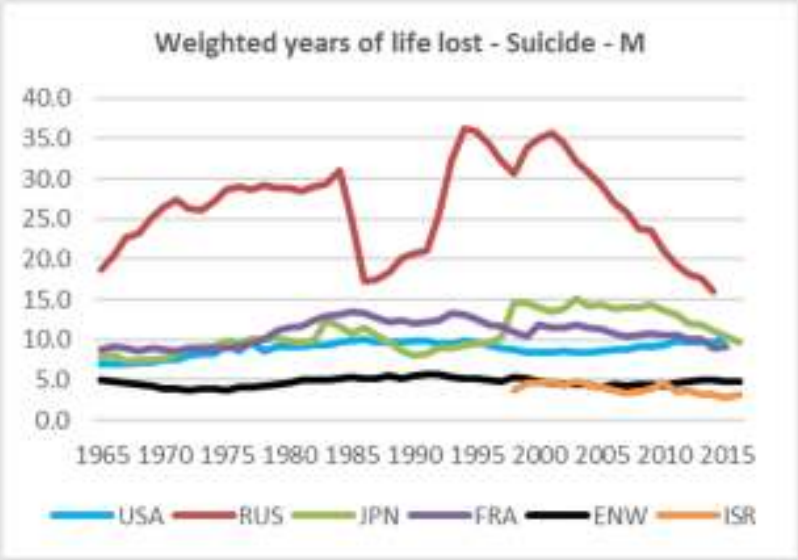
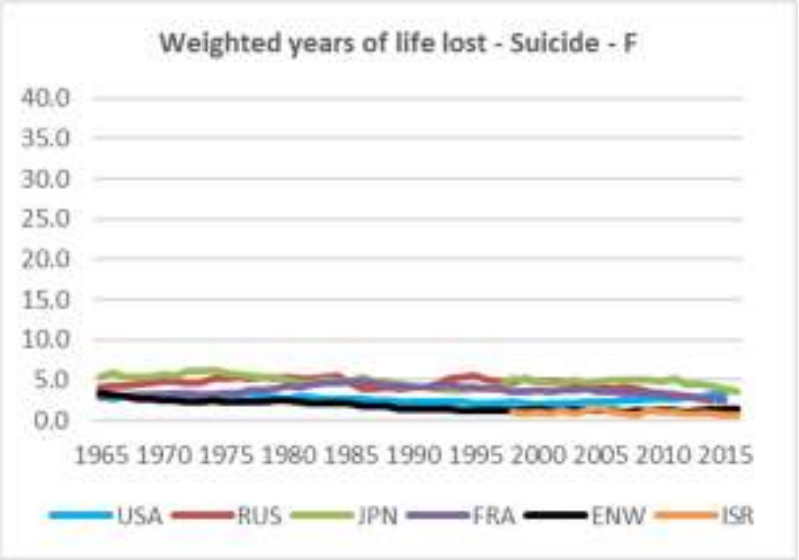
WYLL by cause of death – suicide





- Much higher for males
- Males in Russia – highest but a significant decrease since 2000
- Probably under-reported.

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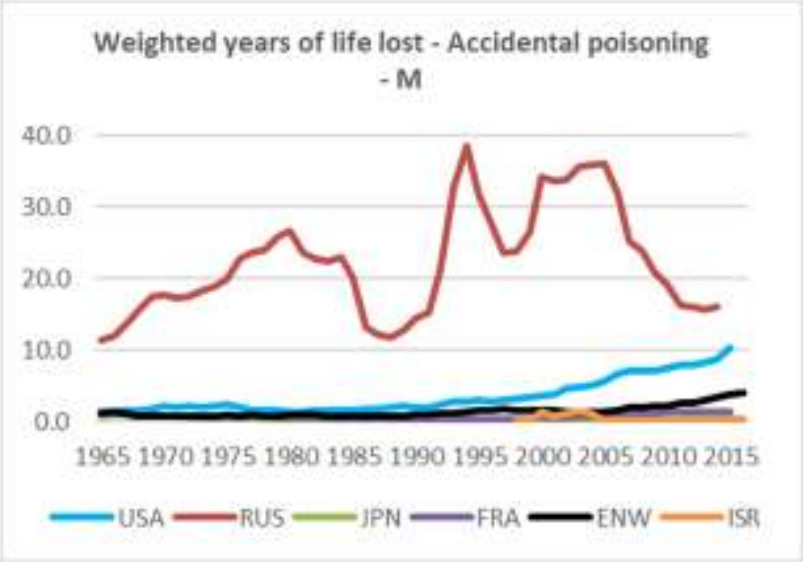
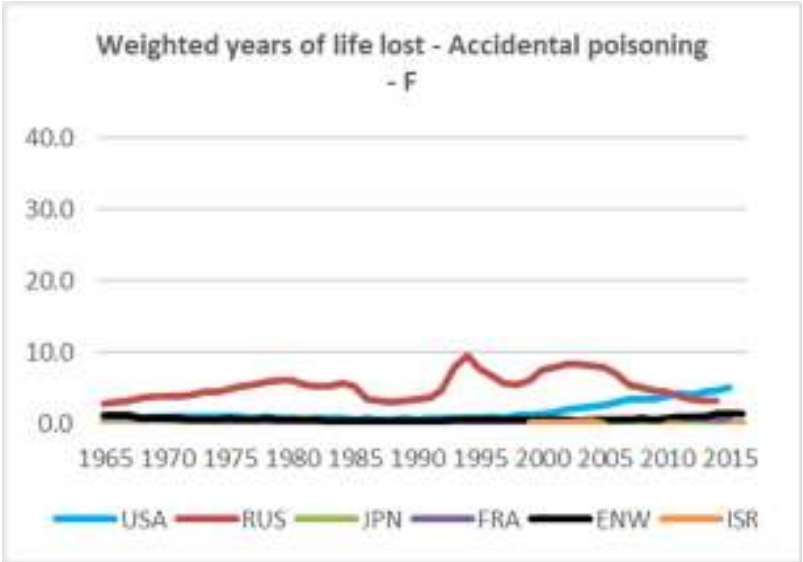
WYLL by cause of death – accidental poisoning





- Russia in the lead for both genders
- Are these really accidents?
- Dramatic increase in US in recent years.

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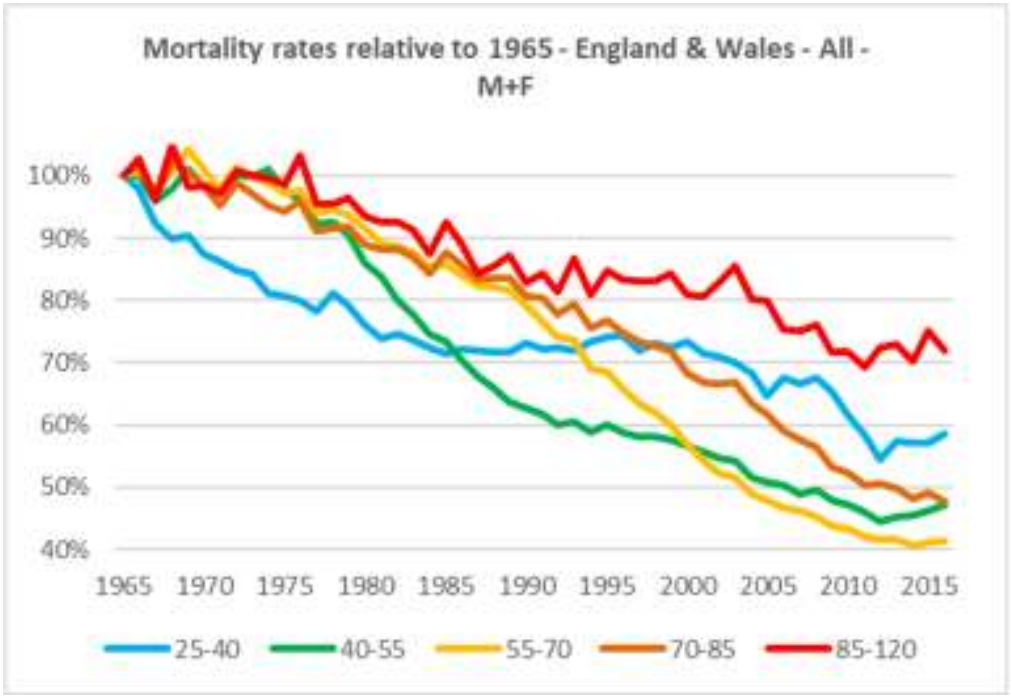
Mortality at older and younger ages



- Mortality improvements at higher (85+) and younger (25-40) ages are less than at the intermediate ages.

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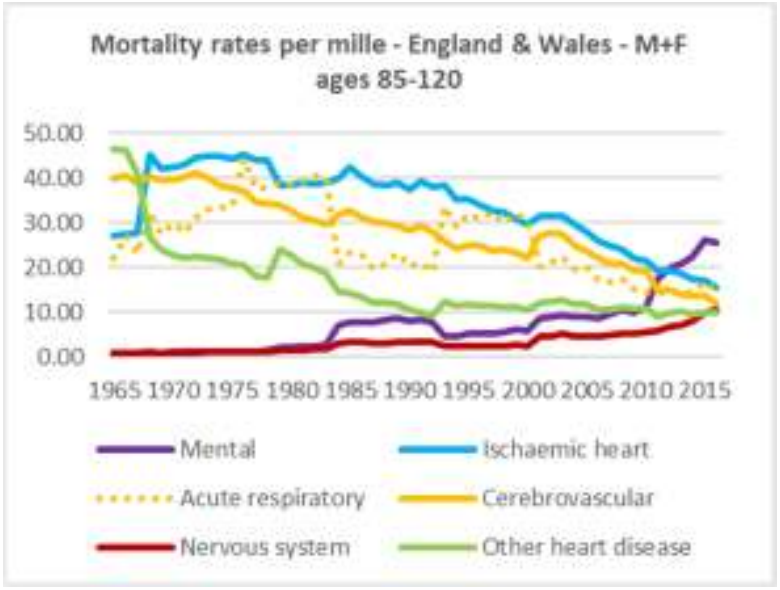
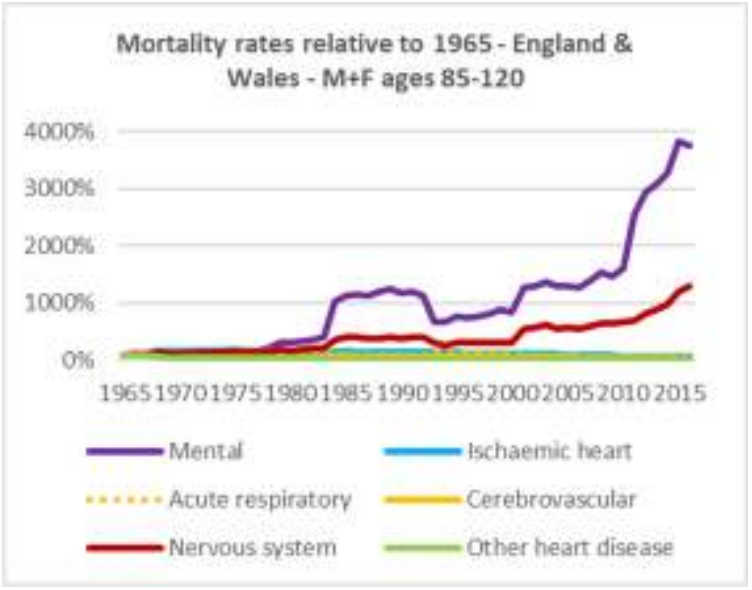
Mortality at older ages





- In the past, dominant CODs at older ages were heart, CVA and acute respiratory (pneumonia)
- This has now been overtaken by dementia – a dramatic increase
- Increasing longevity or higher awareness?

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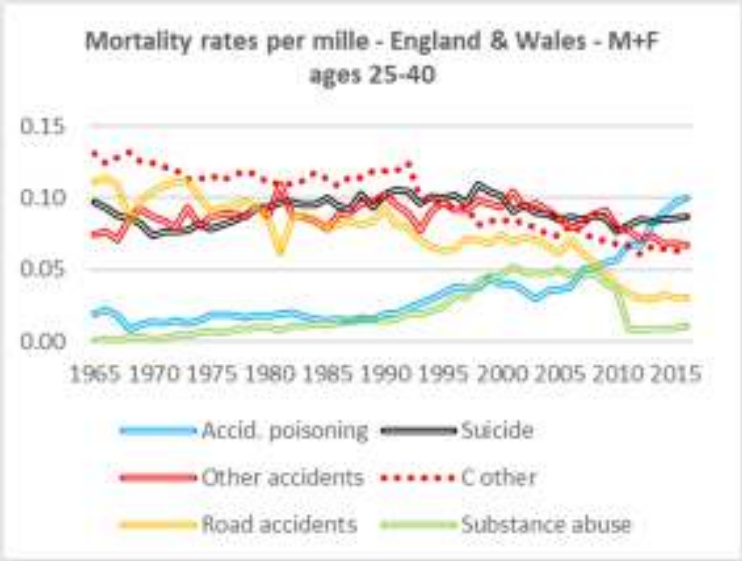
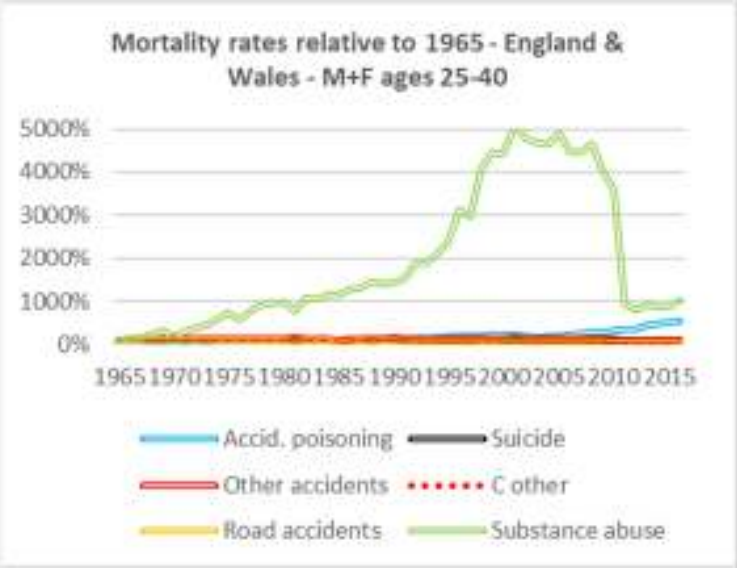
Mortality at younger ages





- Most CODs at these ages are external
- An increase in accidental poisoning
- Substance abuse: dramatic increase in the 1990s – why the sudden decrease?

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Content of the presentation

- The Mortality Working Group
- Introduction – why are causes of death important?
- Sources of information
- The Excel model
- Examples of results
- **The cohort effect**
- Data consistency and reliability
- Conclusions and summary

Measuring the cohort effect

Heat map of mortality improvements by age group and year of observation: England and Wales, males, lung cancer

Annual mortality improvement (5-yr MA relative to previous 5-yr period) - by observation year										
Age group:	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
	37	*42*	*47*	*52*	*57*	*62*	*67*	*72*	*77*	*82*
Observation years:										
1957-1961	-0.2%	0.4%	0.3%	-0.5%	-1.5%	-4.8%	-5.5%	-7.5%	-9.4%	-9.7%
1962-1966	1.0%	1.9%	1.0%	0.6%	0.1%	-1.4%	-3.8%	-4.5%	-5.4%	-8.7%
1967-1971	5.4%	1.4%	0.9%	1.4%	1.1%	0.1%	-1.2%	-4.5%	-5.6%	-5.9%
1972-1976	3.3%	4.4%	2.0%	1.4%	1.1%	1.0%	0.5%	-1.0%	-3.5%	-5.6%
1977-1981	3.1%	5.3%	4.9%	2.1%	1.9%	1.6%	1.1%	0.7%	-1.5%	-4.6%
1982-1986	3.3%	2.3%	4.0%	5.7%	2.6%	1.8%	1.8%	1.0%	1.0%	-1.1%
1987-1991	5.2%	3.3%	2.8%	4.0%	5.2%	3.0%	1.9%	2.1%	1.8%	1.1%
1992-1996	4.1%	2.2%	4.2%	2.2%	4.1%	5.8%	3.6%	2.8%	3.0%	2.7%
1997-2001	8.0%	6.7%	4.6%	5.1%	3.1%	4.2%	5.2%	3.9%	2.4%	3.1%
2002-2006	3.1%	2.7%	3.6%	2.5%	4.0%	1.7%	3.4%	4.4%	2.7%	1.8%
2007-2011	-2.7%	2.8%	4.7%	3.7%	1.4%	3.3%	1.5%	1.8%	2.8%	1.5%
2012-2016	5.2%	2.1%	1.2%	3.8%	3.7%	2.1%	3.3%	2.2%	2.3%	2.7%

- Measured by observation year, mortality changes are fairly uniform on the diagonals, but differ from one diagonal to another
- Let's rotate by 45° to show the heat map by year of birth.

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Measuring the cohort effect

Heat map of mortality improvements by age group and year of observation: England and Wales, males, lung cancer

Annual mortality improvement (5-yr MA relative to previous 5-yr period) - by approximate year of birth												
Age group:	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	Average of	Standard deviation of
YOB dose to	37	42	47	52	57	62	67	72	77	82	each row	each row
1877										-9.7%		
1882									-9.4%	-8.7%		
1887								-7.5%	-5.4%	-5.9%	-6.3%	1.1%
1892							-5.5%	-4.5%	-5.6%	-5.6%	-5.3%	0.5%
1897						-4.8%	-3.8%	-4.5%	-3.5%	-4.6%	-4.2%	0.5%
1902					-1.5%	-1.4%	-1.2%	-1.0%	-1.5%	-1.1%	-1.3%	0.2%
1907				-0.5%	0.1%	0.1%	0.5%	0.7%	1.0%	1.1%	0.4%	0.6%
1912			0.3%	0.6%	1.1%	1.0%	1.1%	1.0%	1.8%	2.7%	1.2%	0.7%
1917		0.4%	1.0%	1.4%	1.1%	1.6%	1.8%	2.1%	3.0%	3.1%	1.7%	0.9%
1922	-0.2%	1.9%	0.9%	1.4%	1.9%	1.8%	1.9%	2.8%	2.4%	1.8%	1.7%	0.8%
1927	1.0%	1.4%	2.0%	2.1%	2.6%	3.0%	3.6%	3.9%	2.7%	1.5%	2.4%	1.0%
1932	5.4%	4.4%	4.9%	5.7%	5.2%	5.8%	5.2%	4.4%	2.8%	2.7%	4.7%	1.1%
1937	3.3%	5.3%	4.0%	4.0%	4.1%	4.2%	3.4%	1.8%	2.3%		3.6%	1.1%
1942	3.1%	2.3%	2.8%	2.2%	3.1%	1.7%	1.5%	2.2%			2.4%	0.6%
1947	3.3%	3.3%	4.2%	5.1%	4.0%	3.3%	3.3%				3.8%	0.7%
1952	5.2%	2.2%	4.6%	2.5%	1.4%	2.1%					3.0%	1.5%
1957	4.1%	6.7%	3.6%	3.7%	3.7%						4.4%	1.3%
1962	8.0%	2.7%	4.7%	3.8%							4.8%	2.3%
1967	3.1%	2.8%	1.2%								2.4%	1.0%
										Standard deviation of averages:	3.4%	
										Average of standard deviations:	0.9%	
										Cohort effect index:	3.8	

The “measure of cohortness”

	For causes of death with a cohort effect	For other causes of death
Improvements for a particular year of birth across all ages	Similar	Random
Improvements at different years of birth	Different	Slight differences (often a gradual improvement)
Measure of cohortness = (SD of averages) / (Average of SD)^2	>100	<100

The “measure of cohortness”

MALES	USA	RUS	JPN	FRA	ENW	SWE	UKR	POL
All	74	11	91	214	216	147	13	66
C digestive system	77	112	163	124	73	21	61	139
C colorectal	103	220	94	96	63	27	106	111
C lung	375	131	115	182	390	73	64	137
C urinary	49	92	81	66	53	25	48	74
C other	225	136	48	135	101	76	77	67
HT/rheumatic heart	24	27	14	11	28	4	22	26
Ischaemic heart	37	16	38	78	97	46	14	46
Other heart disease	8	7	9	77	40	8	10	22
Cerebrovascular	28	10	41	38	49	36	18	31
Circulatory	28	14	37	45	30	12	11	19
Mental	15	7	20	7	3	3	5	6
Nervous system	23	8	39	23	15	13	7	39
Acute respiratory	12	5	11	7	6	5	8	15

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The “measure of cohortness”- some observations

- Cohort effects are more prominent in male mortality data
- Cohort effects are almost entirely confined to cancer
  - Most prominently lung cancer
  - Also breast and uterine cancer
  - Consistent with studies on the cohort effect
- In France and Sweden, overall mortality rates exhibit a cohort effect higher than any of the individual cohortness measures
- In Russia (males and females) there is no indication of a cohort effect for all-cause data, but cancer (especially colorectal) has a high degree of cohortness.

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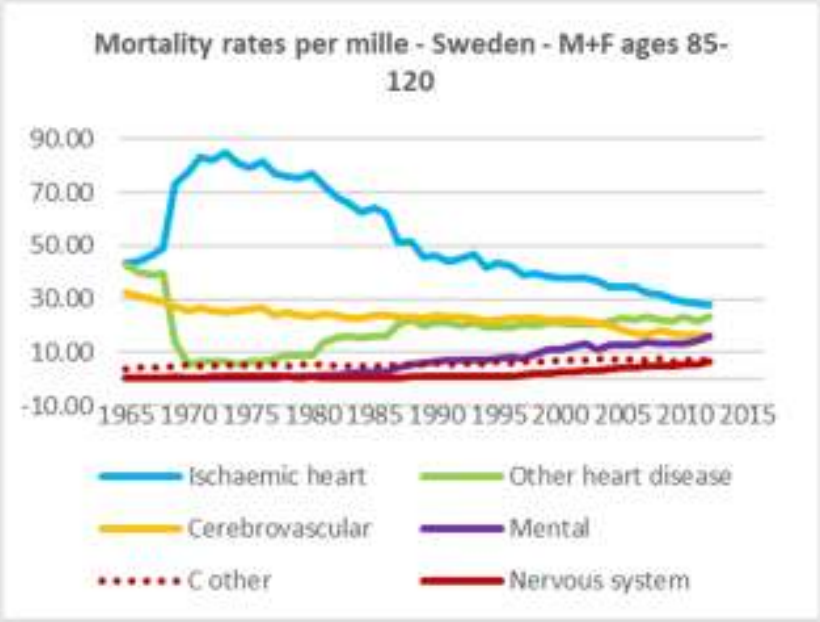
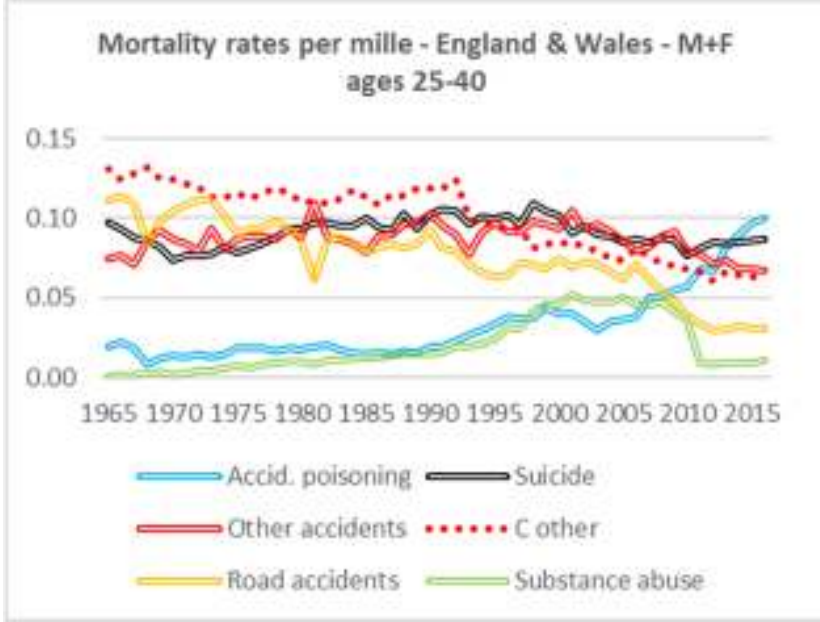
- Conclusions and summary

Data consistency and reliability

- ICD-10 “underlying cause” seems to be well defined
- But are recording practices completely uniform across countries or over time?
- Mortality attributed to mental and nervous diseases: not recognised in the past?
- A sudden death from external causes could be accident, homicide or suicide
- Changeover to ICD-10 affected the rules for determining the underlying cause of death
- Some researchers have investigated the reliability of COD recording, and advise caution
- We found some clear inconsistences in the databases, e.g. Belarus, Canada

Data consistency and reliability





Apparent “change over” from one COD to another (country-specific)

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Conclusions and summary

- We have attempted to give a comprehensive observation of mortality by COD
- Source: actuarially-based data associated with the HMD
- A new grouping: 4 major groups, 28 sub-groups of actuarial interest
- Appropriate metrics: death rate, weighted years of life lost, measure of “cohortness”
- Each cause has its own characteristics – sometimes similar across the countries studied, but often showing important differences
- The cohort effect is restricted to certain causes (mainly cancer), and not in all countries
- The studies confirm and quantify that the rapid improvements in mortality from heart disease and related conditions may well be close to the lowest mortality that medical technology can achieve.

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Conclusions and summary

- At older ages the situation is complex: reductions in heart and other diseases, but an enormous increase in deaths attributed to dementia and Alzheimer's disease
- At younger ages, medical improvements were counteracted by accidents, suicide and substance abuse
- This study did not look at dependency (reduction in mortality from a specific COD may increase mortality from other causes) – we have referenced some studies on this
- Taking into account different behaviours and trends in the mortality data based on these variables should add value to mortality projections.

Questions

Comments