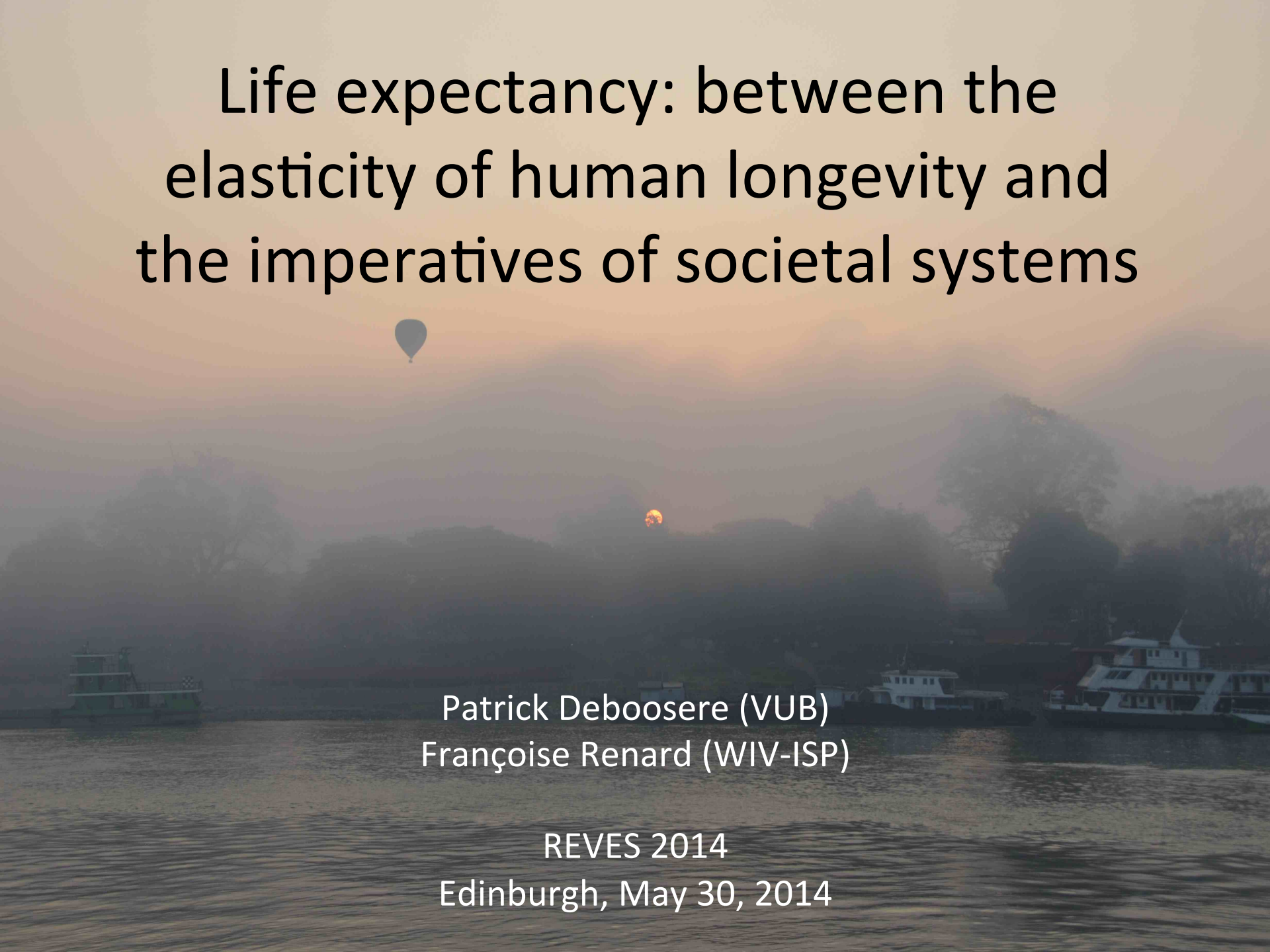
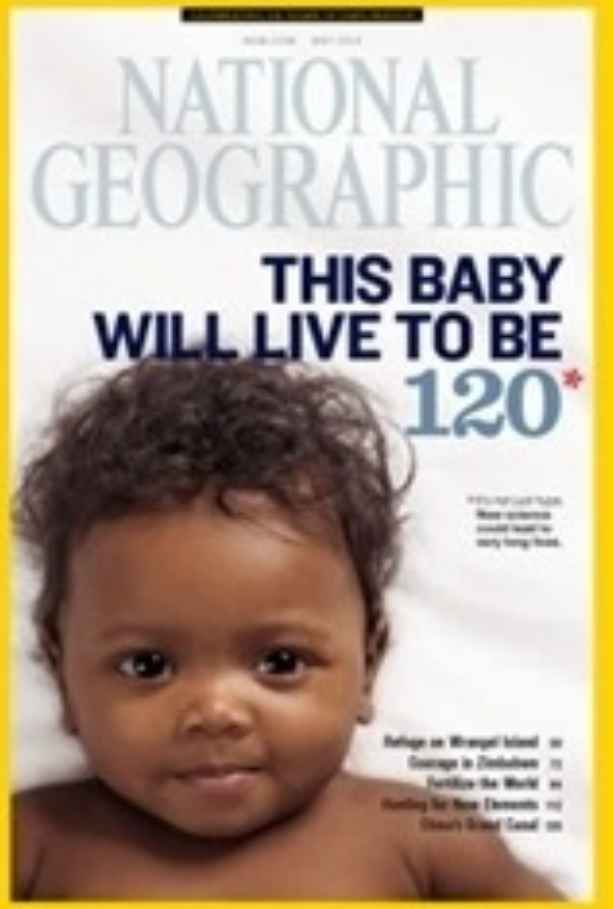
Life expectancy: between the elasticity of human longevity and the imperatives of societal systems



Patrick Deboosere (VUB)
Françoise Renard (WIV-ISP)

REVES 2014
Edinburgh, May 30, 2014



National Geographic, May 2013
Magic number 120

Google's project Calico: the search giant looks for an answer to ageing

Larry Page announces mysterious and ambitious new project that will "focus on health and well-being"

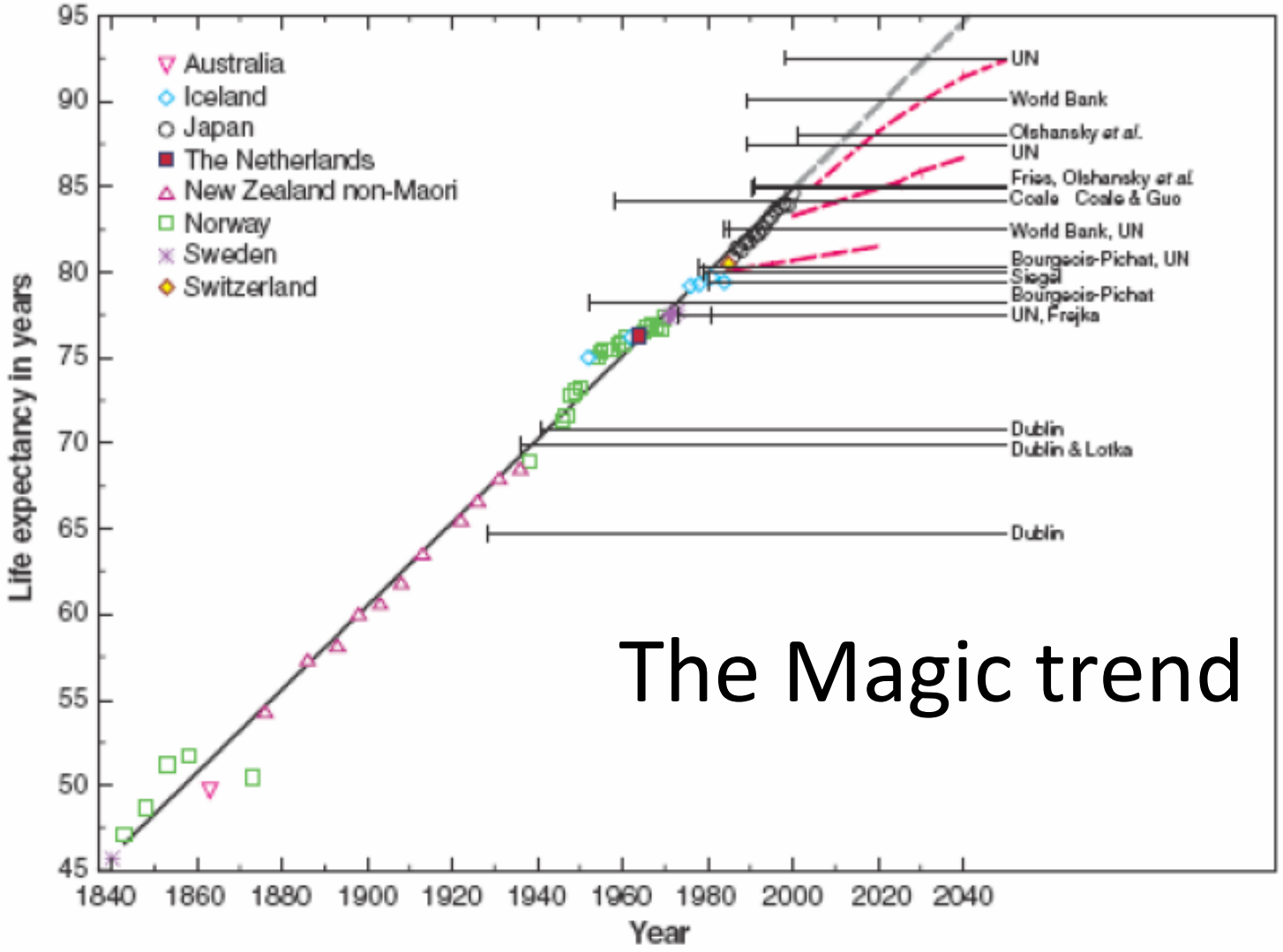
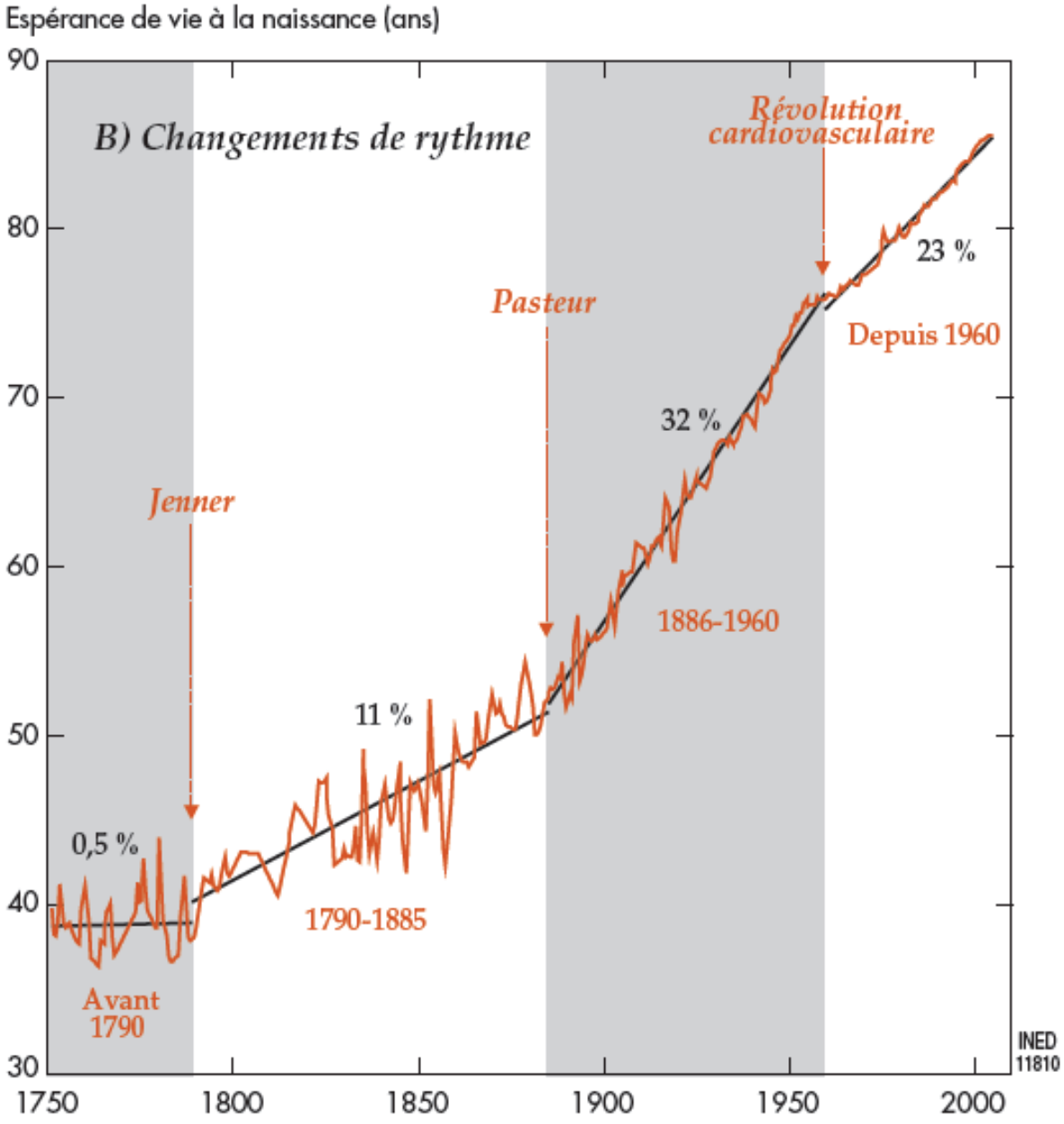


Fig. 1. Record female life expectancy from 1840 to the present [suppl. table 2 (*1*)]. The linear-regression trend is depicted by a bold black line (slope = 0.243) and the extrapolated trend by a dashed gray line. The horizontal black lines show asserted ceilings on life expectancy, with a short vertical line indicating the year of publication (suppl. table 1). The dashed red lines denote projections of female life expectancy in Japan published by the United Nations in 1986, 1999, and 2001 (*1*): It is encouraging that the U.N. altered its projection so radically between 1999 and 2001.

Conclusion of the Oeppen & Vaupel article

Three Findings

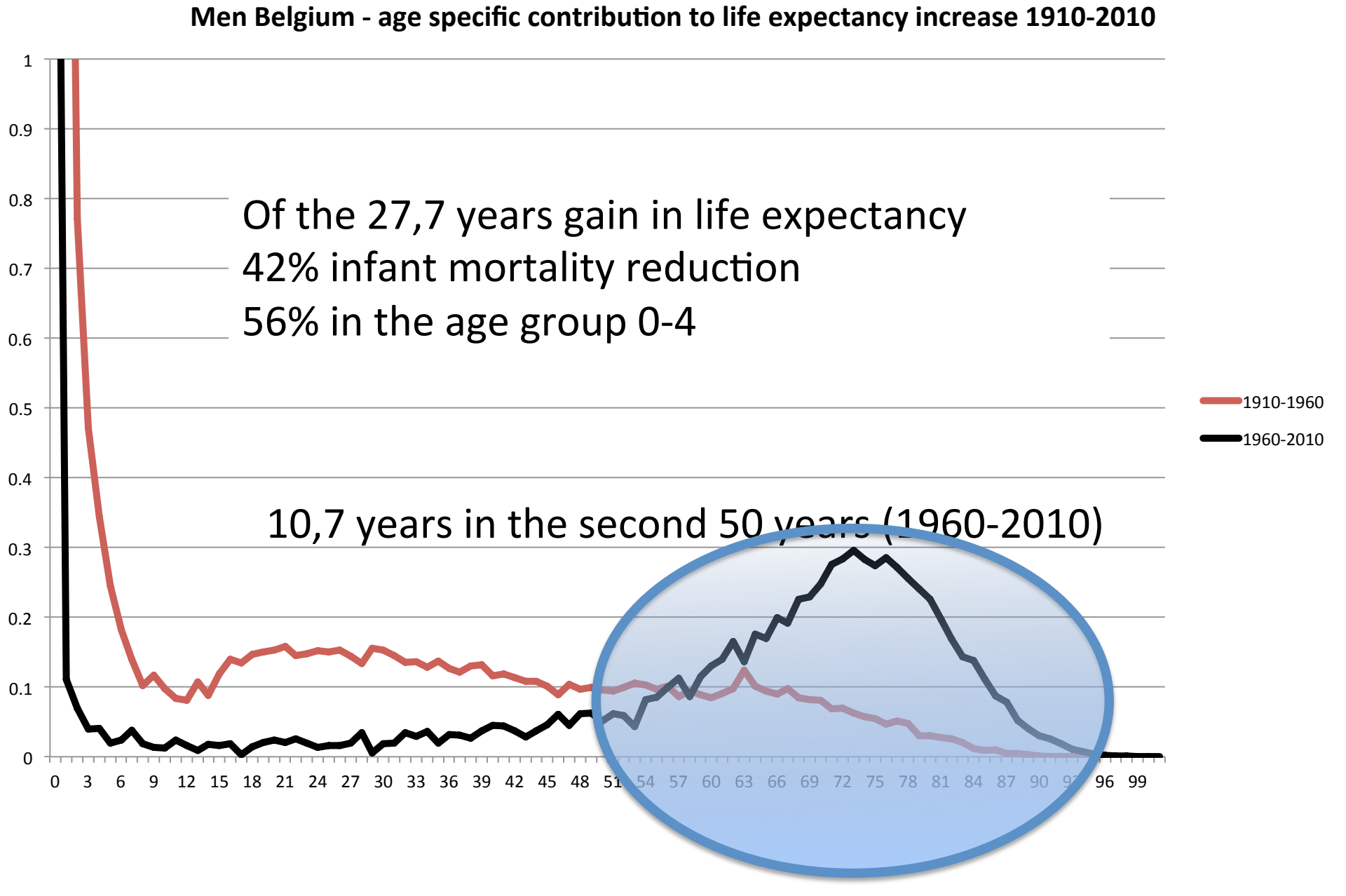
- "This mortality research has exposed the empirical misconceptions and specious theories that underlie the pernicious belief that the expectation of life cannot rise much further. Nonetheless, faith in proximate longevity limits endures, sustained by ex cathedra pronouncement and mutual citation. In this article we add three further lines of cogent evidence.
- First, experts have repeatedly asserted that life expectancy is approaching a ceiling: these experts have repeatedly been proven wrong.
- Second, the apparent leveling off of life expectancy in various countries is an artifact of laggards catching up and leaders falling behind.
- Third, if life expectancy were close to a maximum, then the increase in the record expectation of life should be slowing. It is not. For 160 years, best-performance life expectancy has steadily increased by a quarter of a year per year, an extraordinary constancy of human achievement."

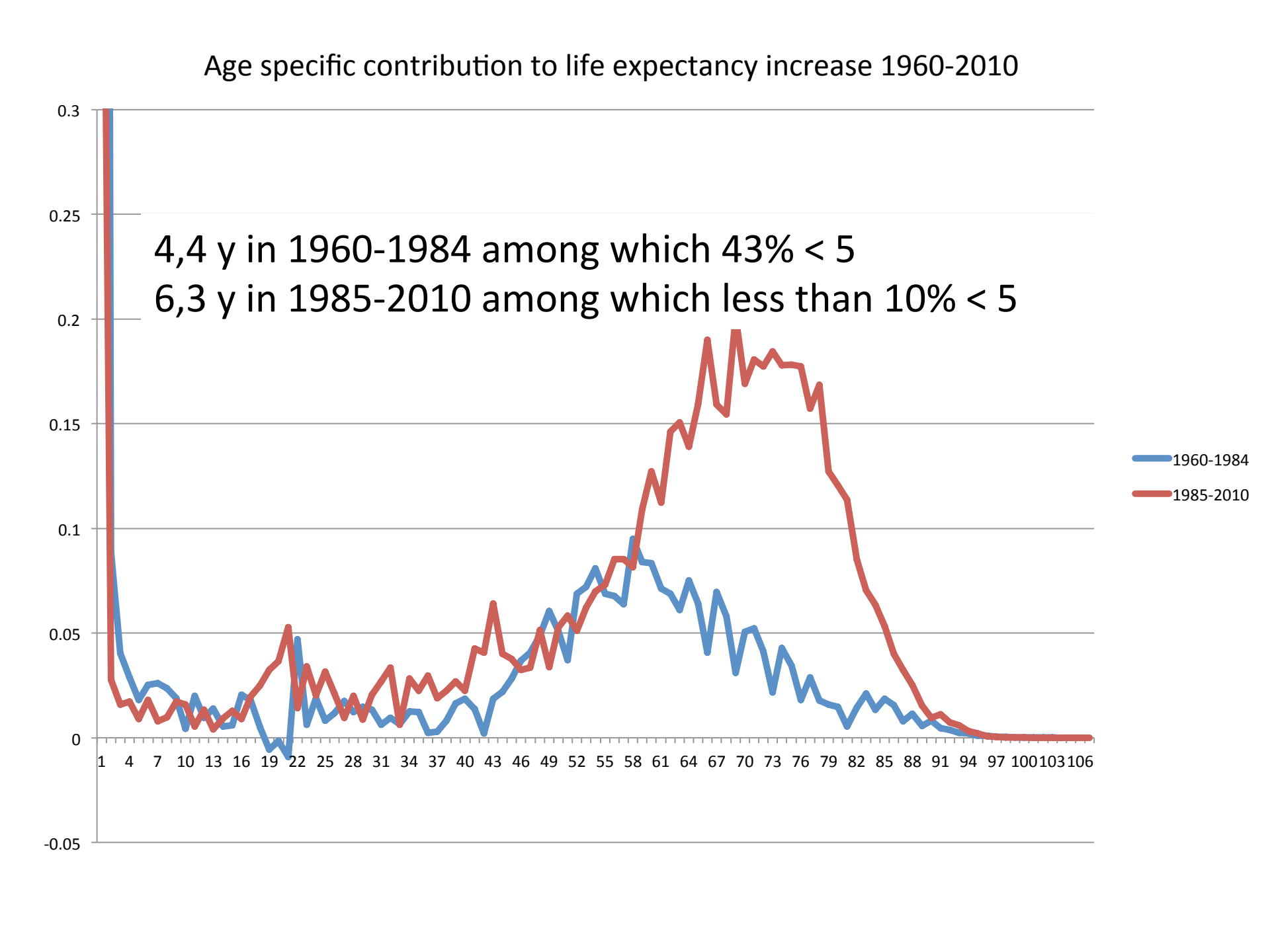


Vallin & Meslé, 2010

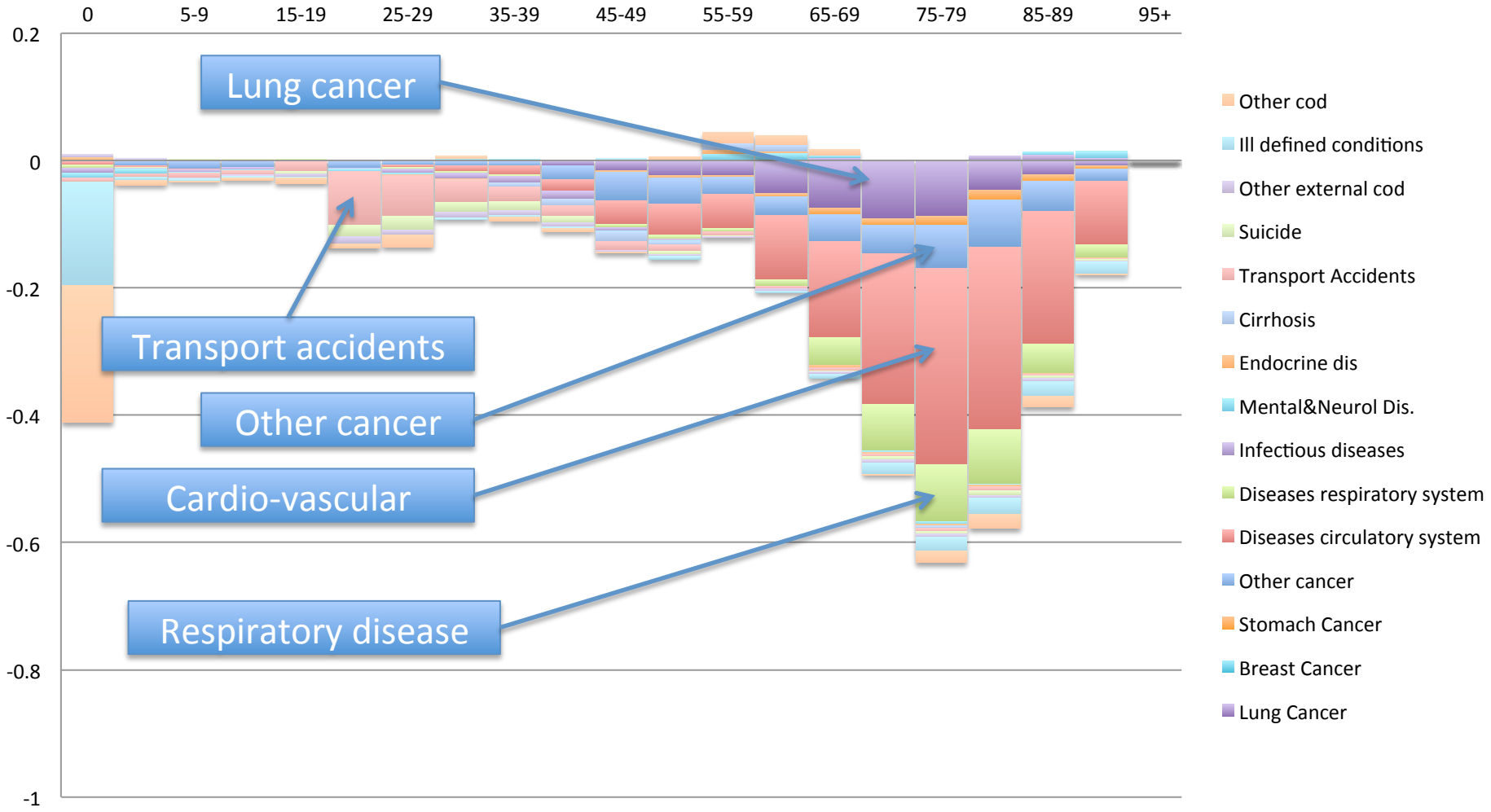
Data & methods

- Data:
  - Human Mortality Database
  - Belgian register data
  - cause specific mortality registers
- Methods
  - decomposition of life expectancy by age and by cause of mortality (Arriaga, 1984)
  - PYLL

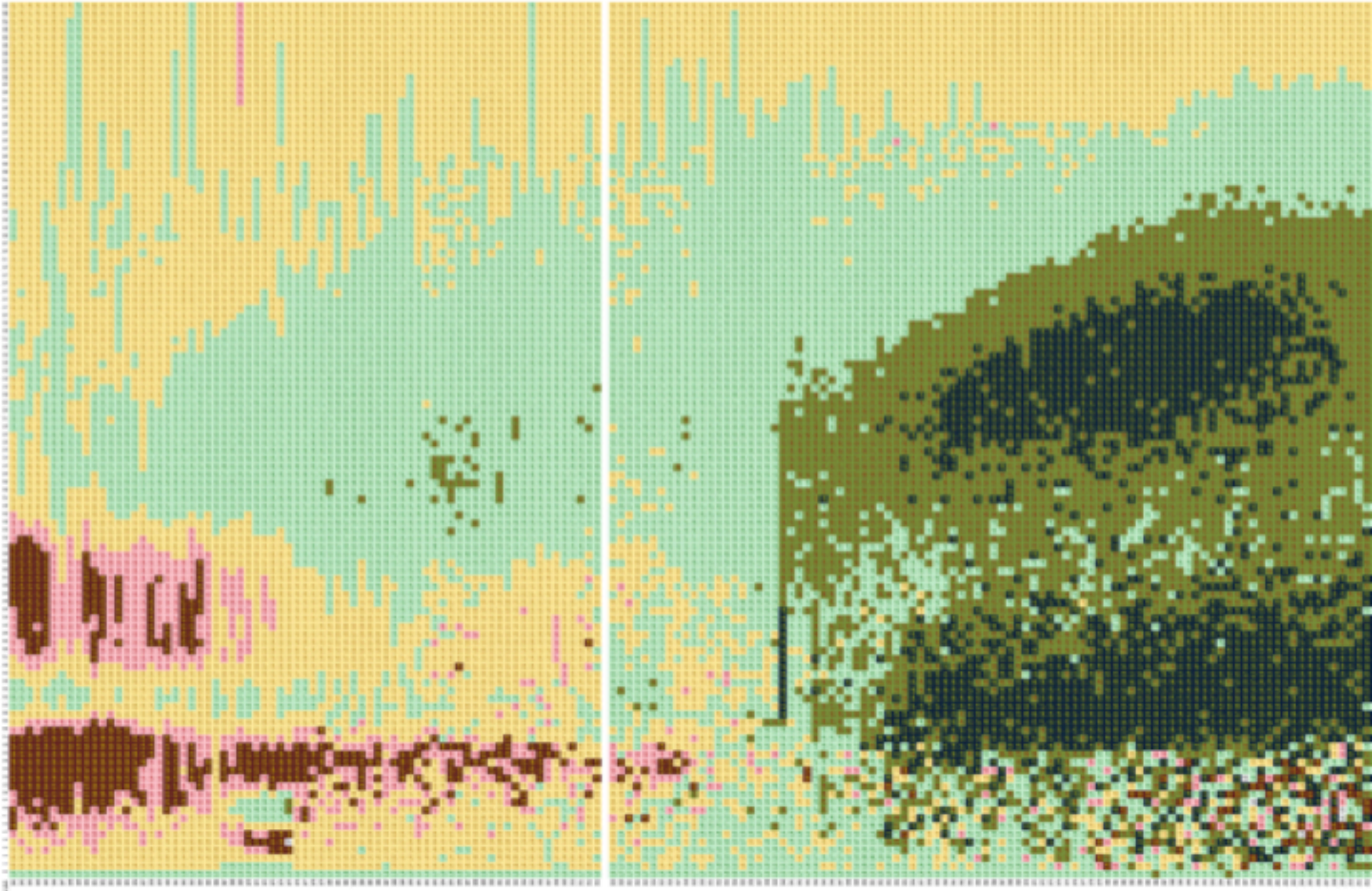

Men Belgium - age specific contribution to life expectancy increase 1910-2010
Of the 27,7 years gain in life expectancy
42% infant mortality reduction
56% in the age group 0-4
10,7 years in the second 50 years (1960-2010)
1910-1960
1960-2010
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 96 99


Age specific contribution to life expectancy increase 1960-2010
4,4 y in 1960-1984 among which 43% < 5
6,3 y in 1985-2010 among which less than 10% < 5
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106
1960-1984
1985-2010

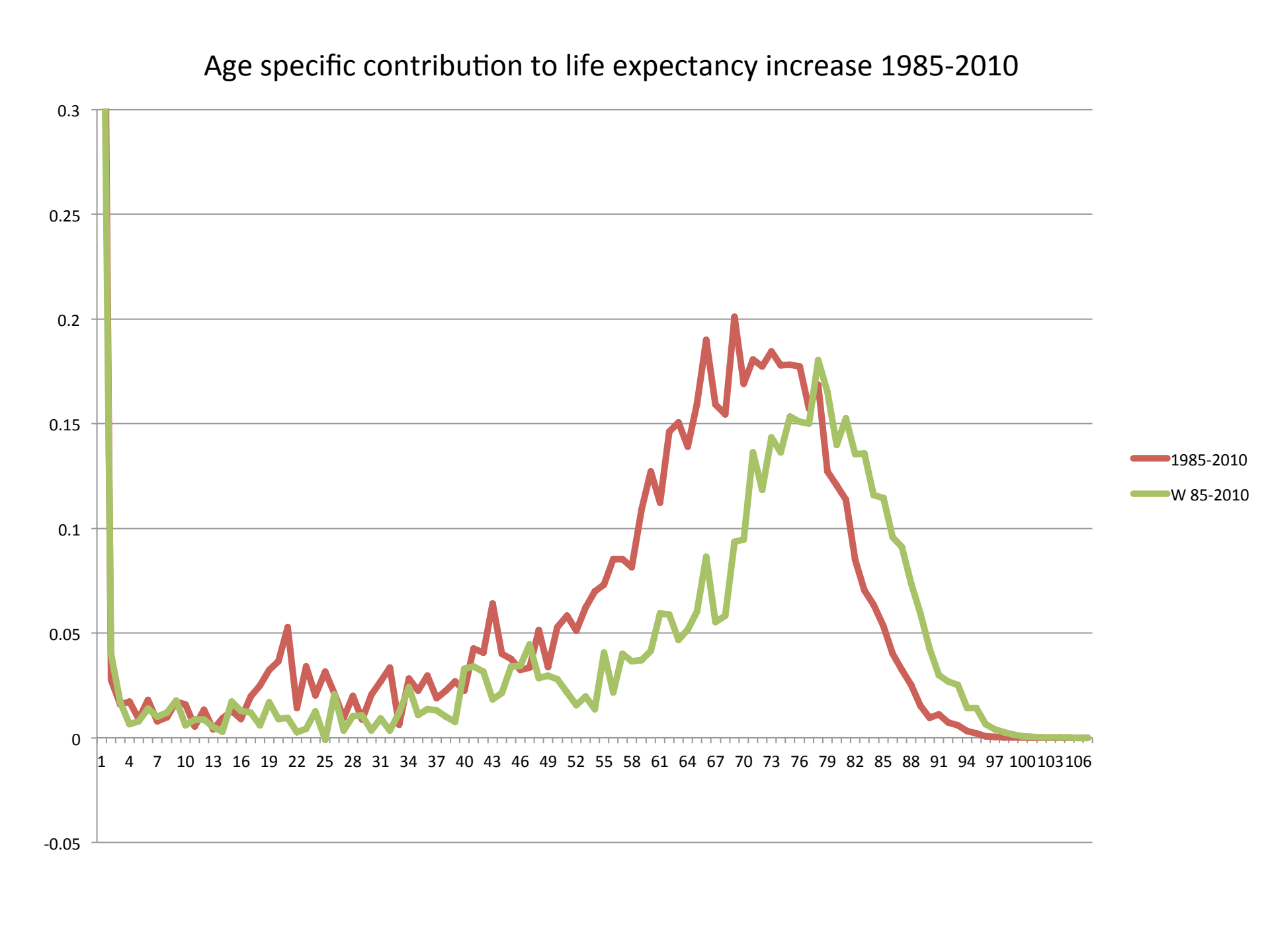
Age- and cause-specific contribution to evolution in life expectancy
Belgium, men 1993-2009

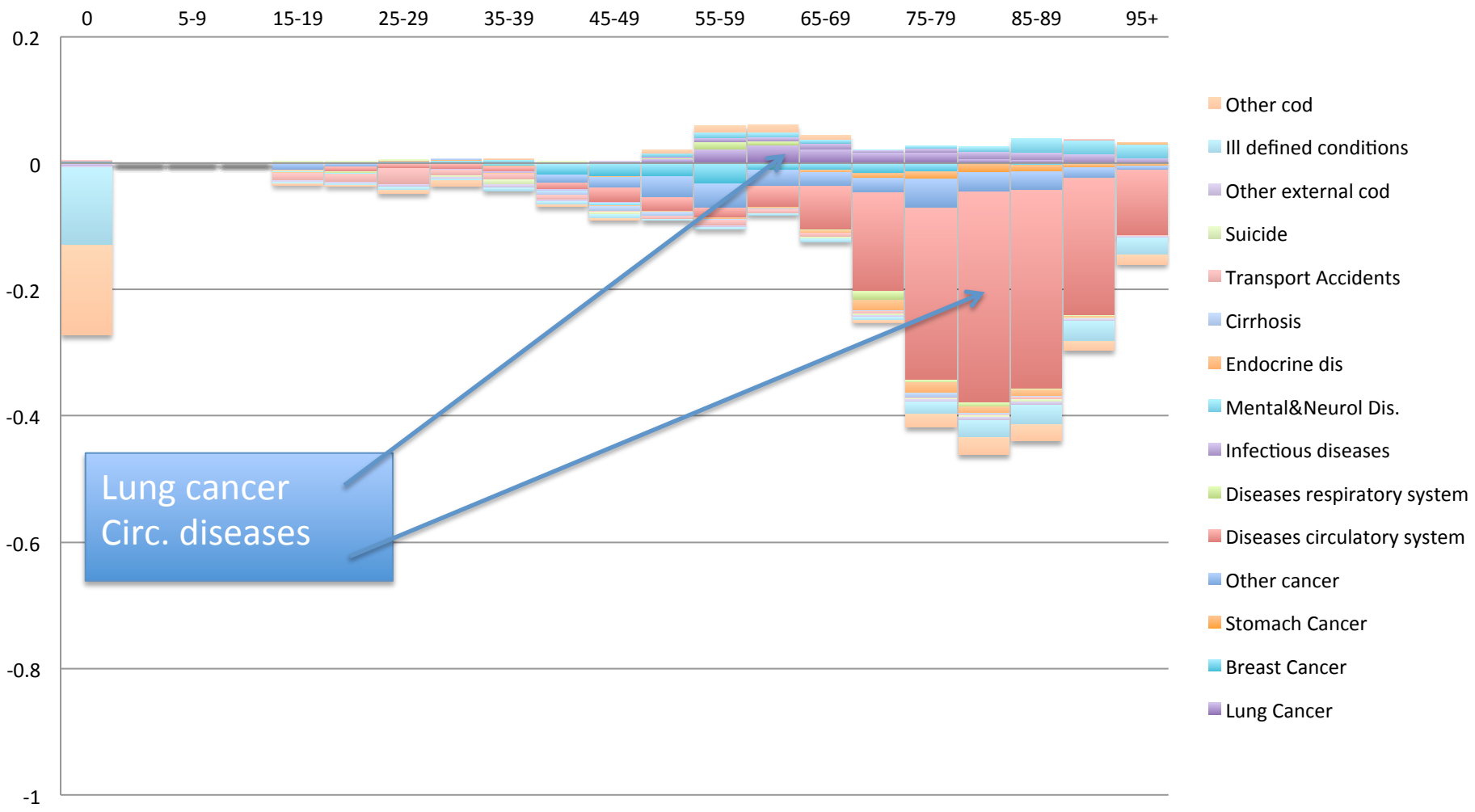


Lexis diagram Belgium 1841-2012 (x-axis) ratio age specific mortality men/women (y-axis 0-110)
red = female excess mortality, green = male excess mortality



- Progress in life expectancy at older ages in men largely related to the decreasing smoking epidemic and improving work conditions
- There is still plenty of room for progress when we consider the impact of the smoking epidemic
- But what about women?


Age specific contribution to life expectancy increase 1985-2010
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106
1985-2010
W 85-2010


Age- and cause-specific contribution to increase in life expectancy
Belgium, women 1993 - 2009
0
5-9
15-19
25-29
35-39
45-49
55-59
65-69
75-79
85-89
95+
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Lung cancer
Circ. diseases
Other cod
Ill defined conditions
Other external cod
Suicide
Transport Accidents
Cirrhosis
Endocrine dis
Mental&Neurol Dis.
Infectious diseases
Diseases respiratory system
Diseases circulatory system
Other cancer
Stomach Cancer
Breast Cancer
Lung Cancer

Chronic exposure to PM contributes to the risk of developing cardiovascular and respiratory diseases, as well as lung cancer. In the European Union, average life expectancy is estimated to be 8.6 months lower due to exposure to $PM_{2.5}$ resulting from human activities.(WHO, 2006b).

Bell, M.L. and D.L. Davis, Reassessment of the lethal London fog of 1952: novel indicators of acute and chronic consequences of acute exposure to air pollution. Environ Health Perspect, 2001. **109 Suppl 3**: p. 389-94.

Annual mean, ug/m3, WHO Ambient air pollution in cities, 2014

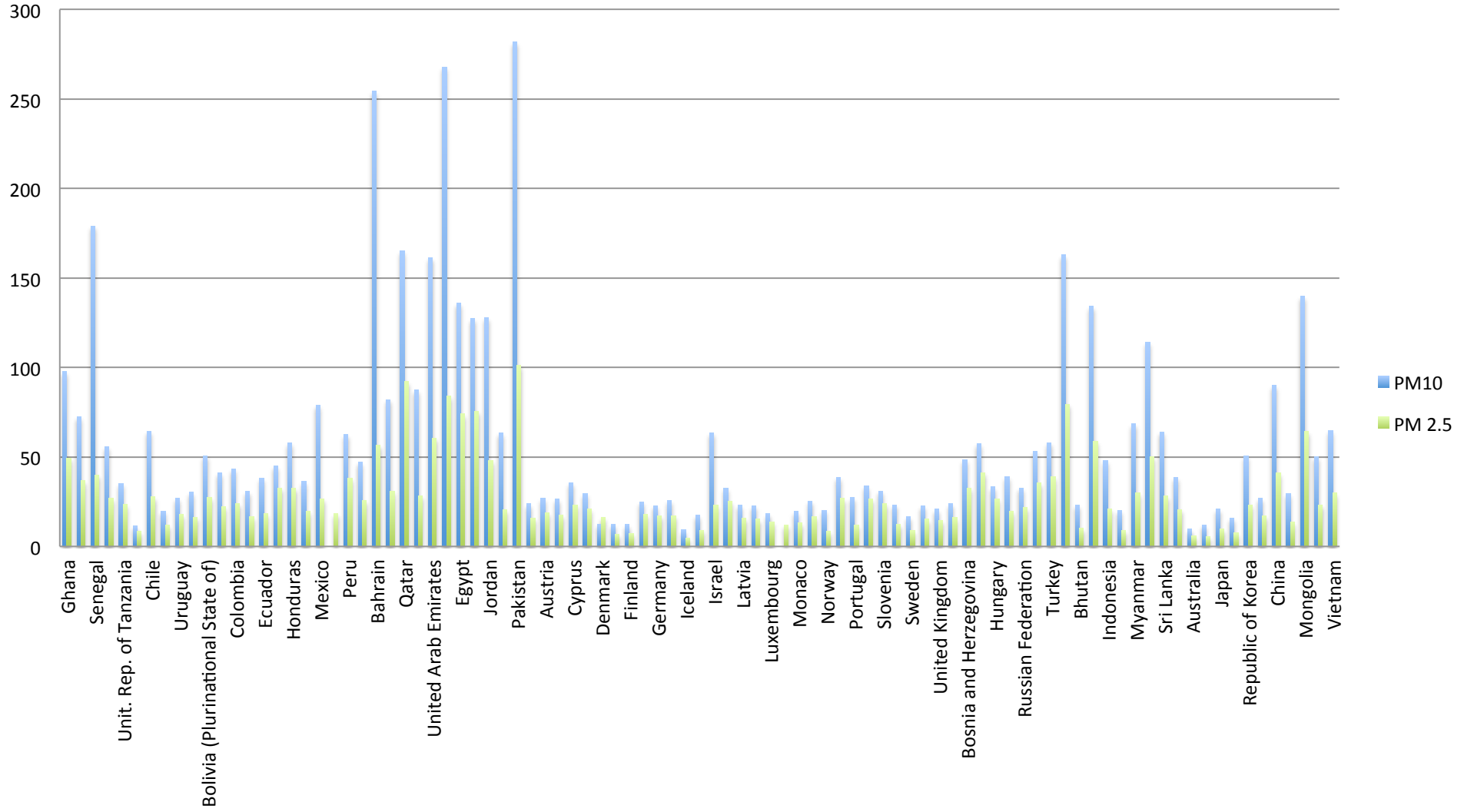
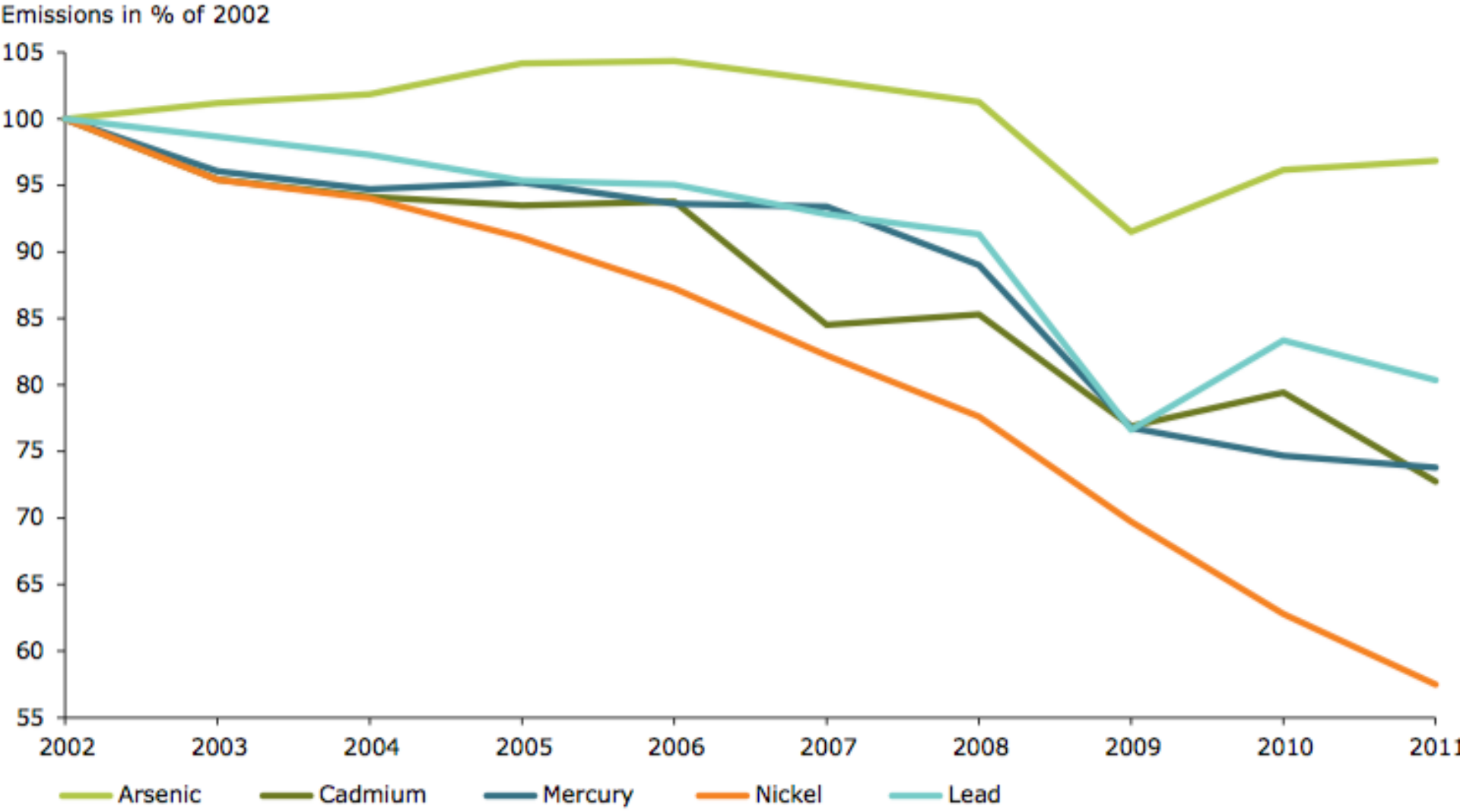


Figure 7.1 **EU emissions of As, Cd, Hg, Ni and Pb, 2002–2011, as a percentage of 2002 emissions**



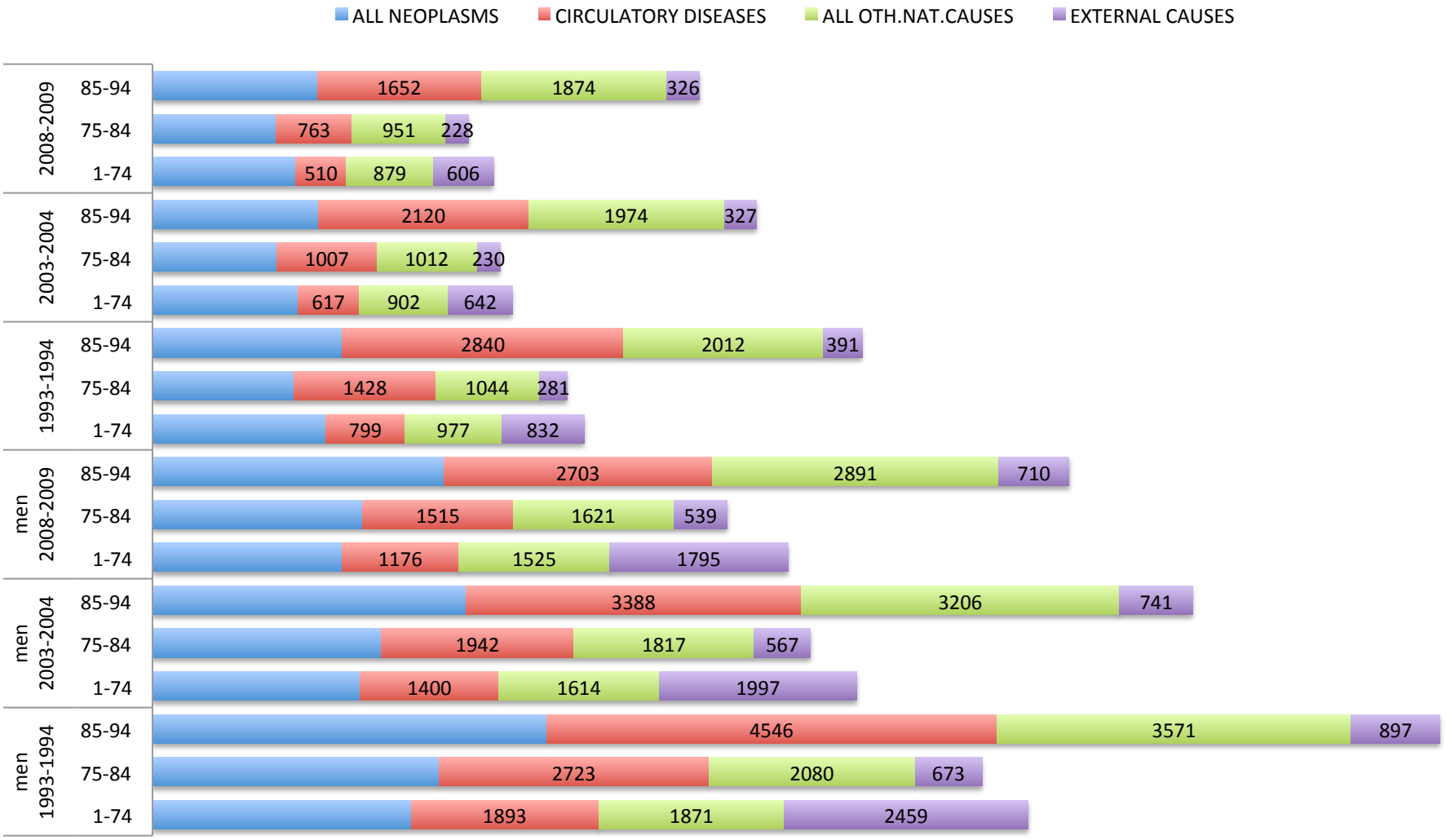
Source: EEA.

Evolution of mortality (1-75 year) in Women by main causes in Belgium, across the 1993-2009 period

age-adjusted PYLL rates per 100.000

Cause of death	*PYLL 1993-1994*	*PYLL 2003-2004*	*PYLL 2008-2009*	*15 years change PYLL*
ALL CAUSES	4358	3630	3440	**-21,10%**
NATURAL CAUSES	3525	2988	2834	**-19,60%**
ALL NEOPLASMS	1749	1468	1445	**-17,40%**
Head,Neck & oesoph.Ca	53	55	46	**-13,20%**
Stomach Ca	38	27	30	**-21,60%**
Colorectal Ca	146	106	107	**-27,10%**
Liver Ca	25	24	23	**-5,80%**
Pancreas Ca	57	50	57	**0,60%**
Lung Ca	175	210	248	**41,90%**
Breast Ca	517	411	364	**-29,50%**
Female genital org.ca	232	172	171	**-26,30%**
CNS Ca	103	70	76	**-26,10%**
Hematol.Ca	144	105	99	**-31,00%**
Other Neoplasms	260	237	223	**-14,20%**
CIRCULATORY DISEASES	799	617	510	**-36,20%**
ALL OTH.NAT.CAUSES	977	902	879	**-10,00%**
Chron.Obs.Pulm.Dis.	101	92	89	**-11,70%**
Chronic Liver Dis.	134	107	103	**-23,00%**
Remaining Other Natural Causes	657	601	601	**-8,50%**
EXTERNAL CAUSES	832	642	606	**-27,20%**
Road Accident	282	174	133	**-52,60%**
Non transp.acc.(Poison/fall/envir.)	152	118	130	**-14,50%**
Suicide	287	280	266	**-7,50%**
Event of Undet.Intent	38	20	37	**-3,30%**
Miscell.oth.Ext.causes	73	51	39	**-45,70%**

PYLL Belgium 1993-2009



How much progress in 1993-2009?

	men			women		
	1-74	75-84	85-94	1-74	75-84	85-94
ALL NEOPLASMS	27%	27%	26%	17%	13%	13%
CIRCULATORY DISEASES	38%	44%	41%	36%	47%	42%
ALL OTHER NATURAL CAUSES	18%	22%	19%	10%	9%	7%
EXTERNAL CAUSES	27%	20%	21%	27%	19%	17%

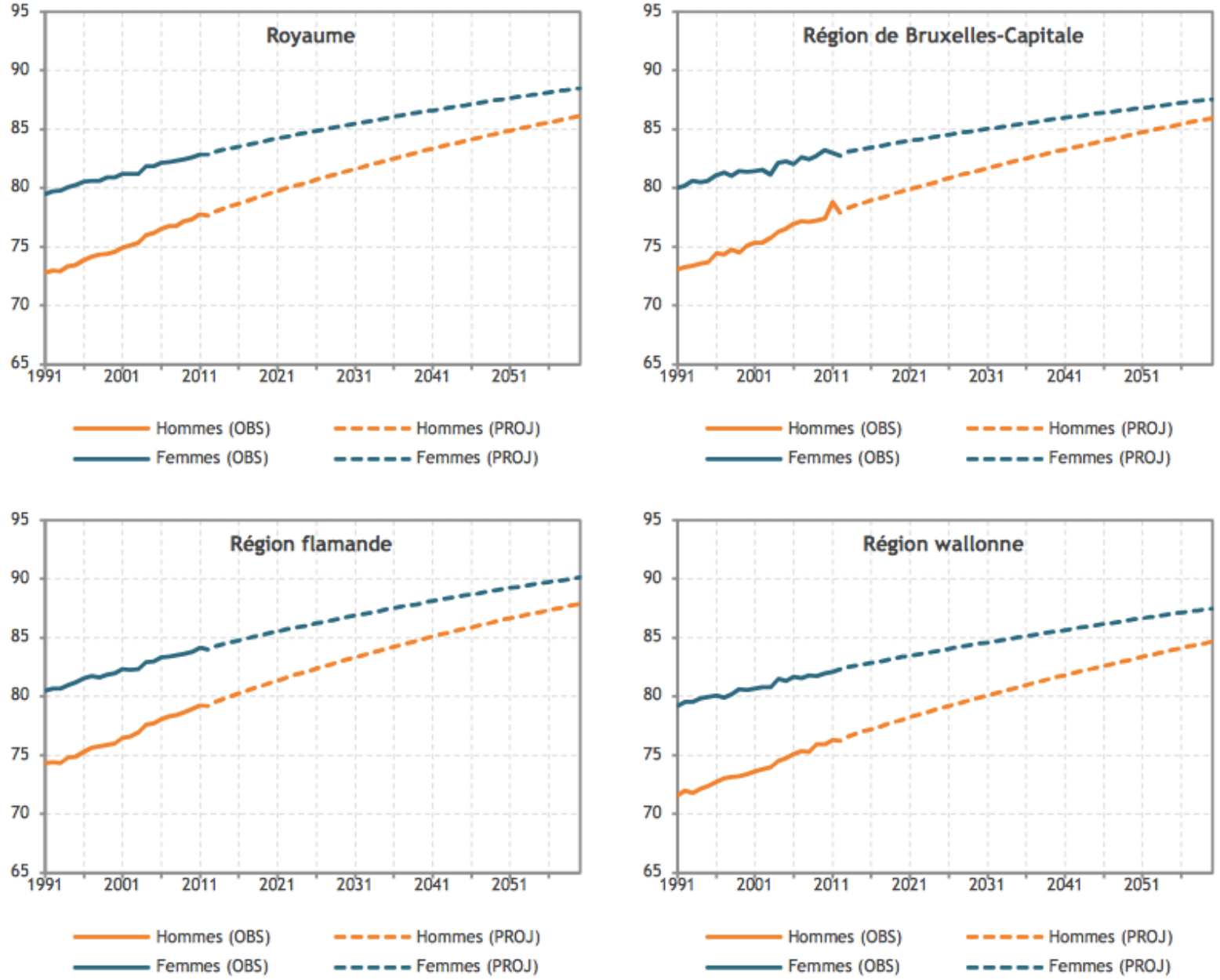
Massive improvement in reduction of potential years of life lost for CV in all age groups
Relative improvement similar for men and women, but men start from more lost years

Neoplasms & other causes: tempo of improvement among women is slowing down

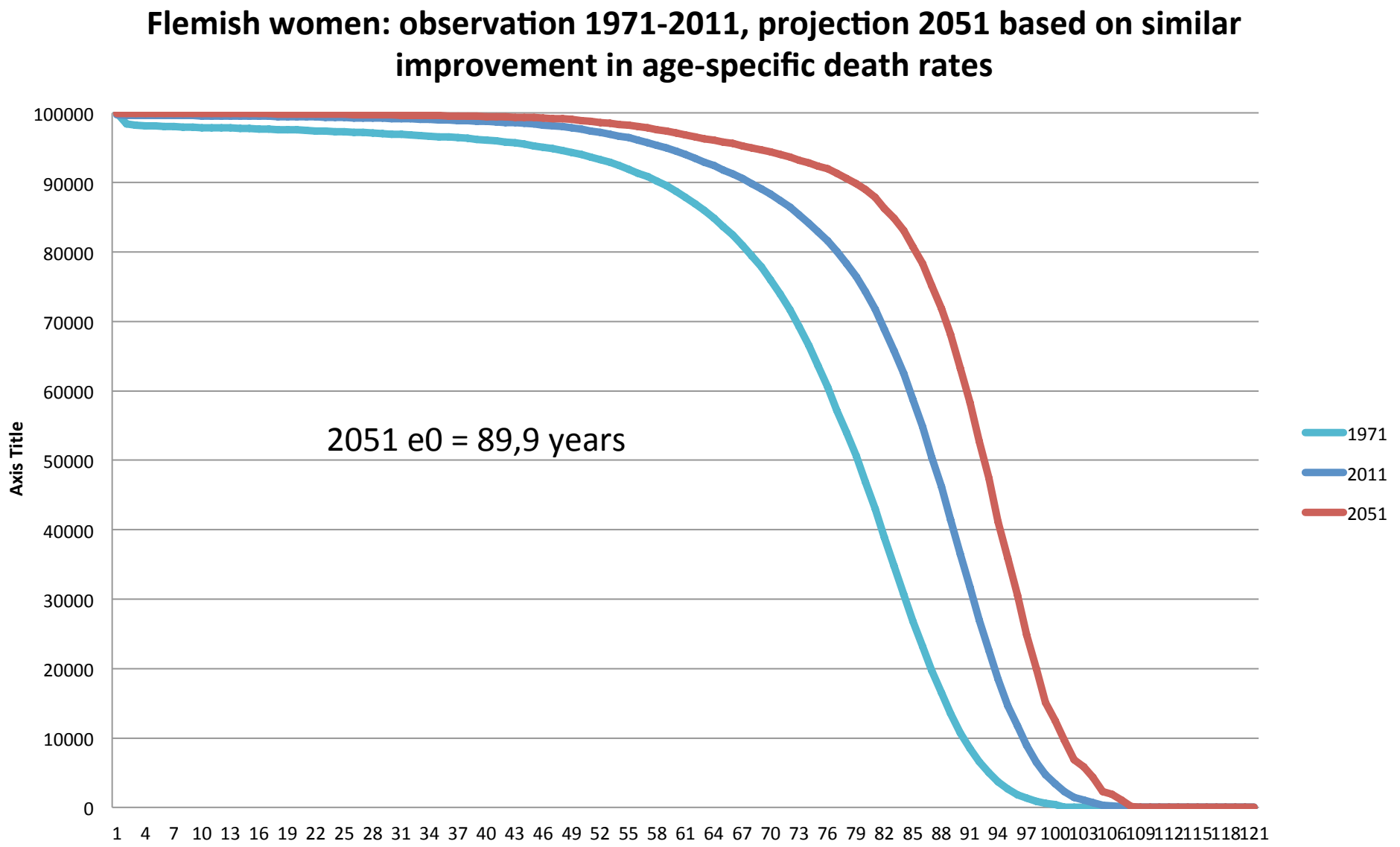
What are the implications for the future?

- "Officials charged with forecasting trends in life expectancy over future decades should base their calculations on the empirical record of mortality improvements over corresponding spans of the past. Because best-practice life expectancy has increased by 2.5 years per decade for a century and a half, ***one reasonable scenario would be that this trend will continue in coming decades. If so, record life expectancy will reach 100 in about six decades.***"
- "An alternative method for forecasting life expectancy is to ***analyze the rapidity of improvement in age-specific death rates over many decades and then to use this information to project death rates over coming decades***. The official Japanese forecast, issued in 1997, of life expectancy (for males and females combined) in 2050 is 82.95. Projections based on the decline in death rates in Japan since 1950 result in a life expectancy some 8 years longer, 90.91"

Graphique 9 Espérances de vie à la naissance pour le Royaume et par Région

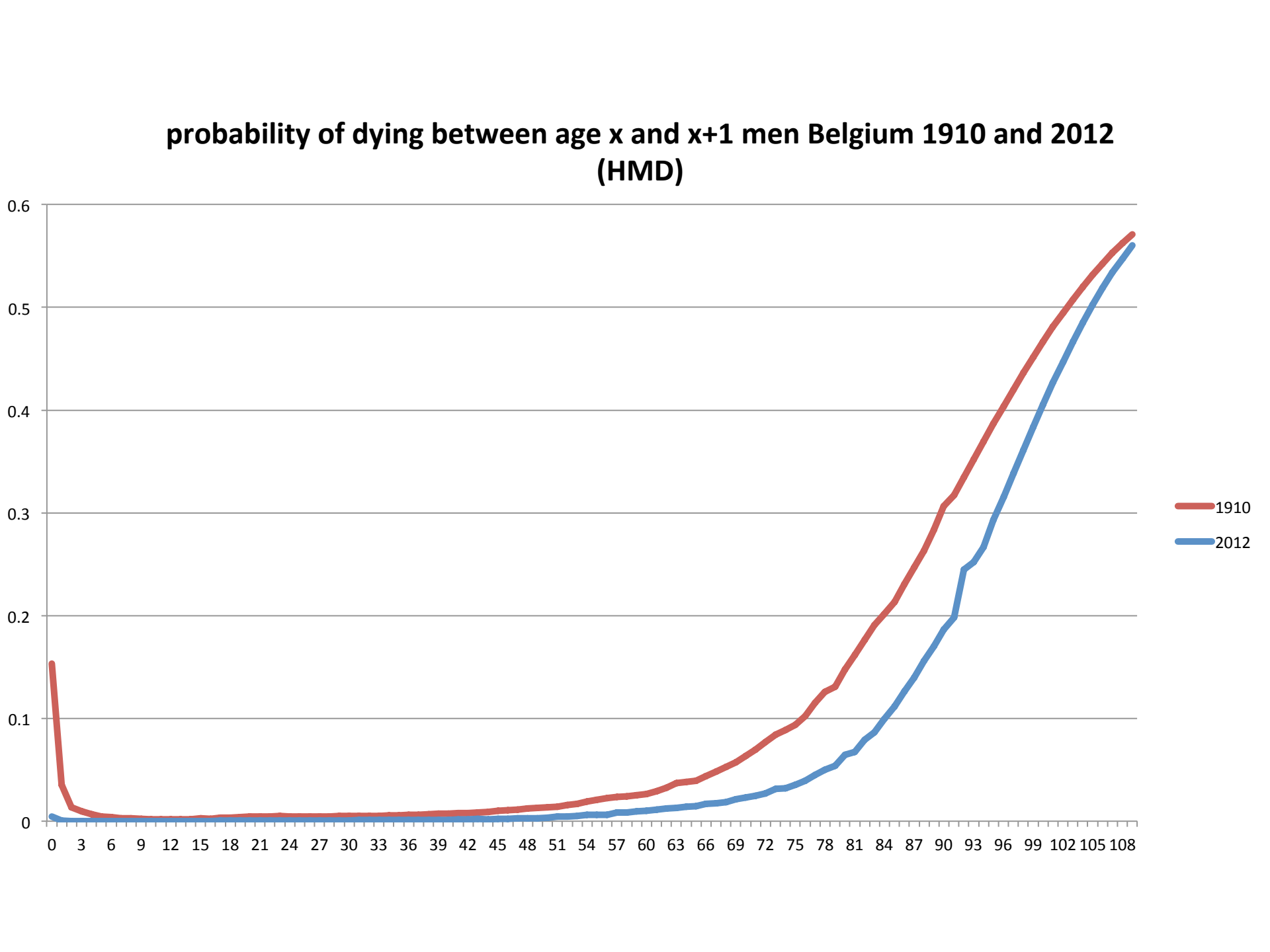


Sources : 1991-2012 : RN-DGSIE et calculs BFP ; 2013-2060 : Perspectives démographiques 2013-2060, BFP-DGSIE


Flemish women: observation 1971-2011, projection 2051 based on similar improvement in age-specific death rates
Axis Title
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106 109 112 115 118 121
2051 e0 = 89,9 years
1971
2011
2051

Future gains in life expectancy?

- There is no reason to impose an upper limit to life expectancy, as centenarians and super-centenarians empirically prove that there is plenty of room to progress: life expectancy is after all a collective process
- At the other hand a simple extrapolation of past increases in life expectancy by 2.5 years per decade is not very realistic as extending survival time in old age becomes increasingly more difficult because of the simple laws of nature
- If we assume that **mortality by age** improves at the same rate as in the past 100 years the increase in life expectancy will be about 0.1 year per annum over the next 100 years


probability of dying between age x and x+1 men Belgium 1910 and 2012 (HMD)
0.6
0.5
0.4
0.3
0.2
0.1
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99 102 105 108
1910
2012

Ray Kurzweil — Immortality by 2045

Director of Engineering at Google

Concluding reflections

- Where you live and how you live, both dimensions of the society we belong to, are shaping the outcome of life expectancy
- Life expectancy of "vanguard" populations (by gender, educational level or social class) inside a country demonstrates the potential for improvement under the current conditions of life and knowledge
- But it also points to the very fact that life expectancy is a collective endeavor and that the ultimate improvement is depending as much of how we are organizing our societies as from the progress we realize in molecular biology as has recently been illustrated by diverging trends in life expectancy among the East European countries.
- The expansion of poverty in many European countries and the widening of inequalities are as much a threat to the improvement of life expectancy as the unsolved challenges of cellular ageing or Alzheimer disease
- Today, with the lingering crisis of 2008 and the enduring high levels of unemployment, we need to avoid the risk that the Mediterranean financial regime will neutralize the Mediterranean diet


Thanks for your attention