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The role of lifestyle on past and future mortality in Europe



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funded by the Netherlands Organisation for Scientific Research

Importance of lifestyle factors

- Europe: > 85 % of all deaths due to NCDs (WHO 2011)
- Caused by smoking, excessive alcohol consumption, unhealthy diets, physical inactivity (WHO 2011)
- In the EU, **smoking, alcohol and obesity** are the most important preventable risk factors (WHO 2009)
- Important differences btwn countries and sexes in the importance of these lifestyle factors
- This impact is changing over time

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Changing importance of lifestyle factors

- Smoking epidemic => strong wave pattern (prevalence; mortality); Northwestern European men (Lopez et al. 1994; Thun et al. 2012)
- Obesity epidemic => prevalence tripled since 1980 (WHO 2007); wave-shaped epidemic (Xu & Lam 2018); current signs of stagnation (Rokholm et al. 2010)
- Alcohol => adult men Eastern Europe; high and fluctuating mortality (Rehm et al. 2009) ; recent declines (Trias Llimós et al. 2018)
- Importance of the birth cohort dimension for describing and explaining past trends in smoking-, alcohol- and obesity-attributable mortality (e.g. Janssen & Kunst 2005, Trias-Llimós et al. 2017; Vidra et al. 2018).

Importance for mortality forecasting

- These changes in lifestyle-attributable mortality are important for mortality forecasting (e.g. Janssen et al. 2013; Bongaarts 2014).
- Mostly by means of extrapolation (Booth & Tickle, 2008; Stoeldraijer et al. 2013)
- When past trends non-linear due to lifestyle factors, different historical period => different outcome (Janssen & Kunst, 2007; Stoeldraijer 2018)
- No non-linearity in the future

Objectives

- To estimate the impact of the smoking, alcohol and obesity 'epidemics' on current mortality levels and past trends
- To project future smoking, alcohol and obesity-attributable mortality
- To project all-cause mortality taking into account the impact of lifestyle 'epidemics'

Data

- 30 European countries, by sex and age, 1950-2016
- Age and sex-specific lifestyle-attributable mortality fractions
  - Smoking (1950-2014; 35-100 M; 40-100 F) => indirectly estimated using lung cancer mortality data from WHO (Peto et al. 1992; Janssen et al. 2013)
  - Alcohol (1990-2016; 20-100) => rates from Global Burden of Disease Study 2017 (20-64) and age pattern at highest ages using cause-specfic mortality data from WHO.
  - Obesity (1975-2016; 20-100) => PAF formula applied to prevalence data (NCD Risk Factor Collaboration study 2017) and RRs of dying from obesity (Lobstein et al. 2010).
  - Smoothing over age
  - Three lifestyle factors combined => multiplicative approach

$$PAF_{1..i} = 1 - \prod_{i=1}^{n}(1 - PAF_i)$$

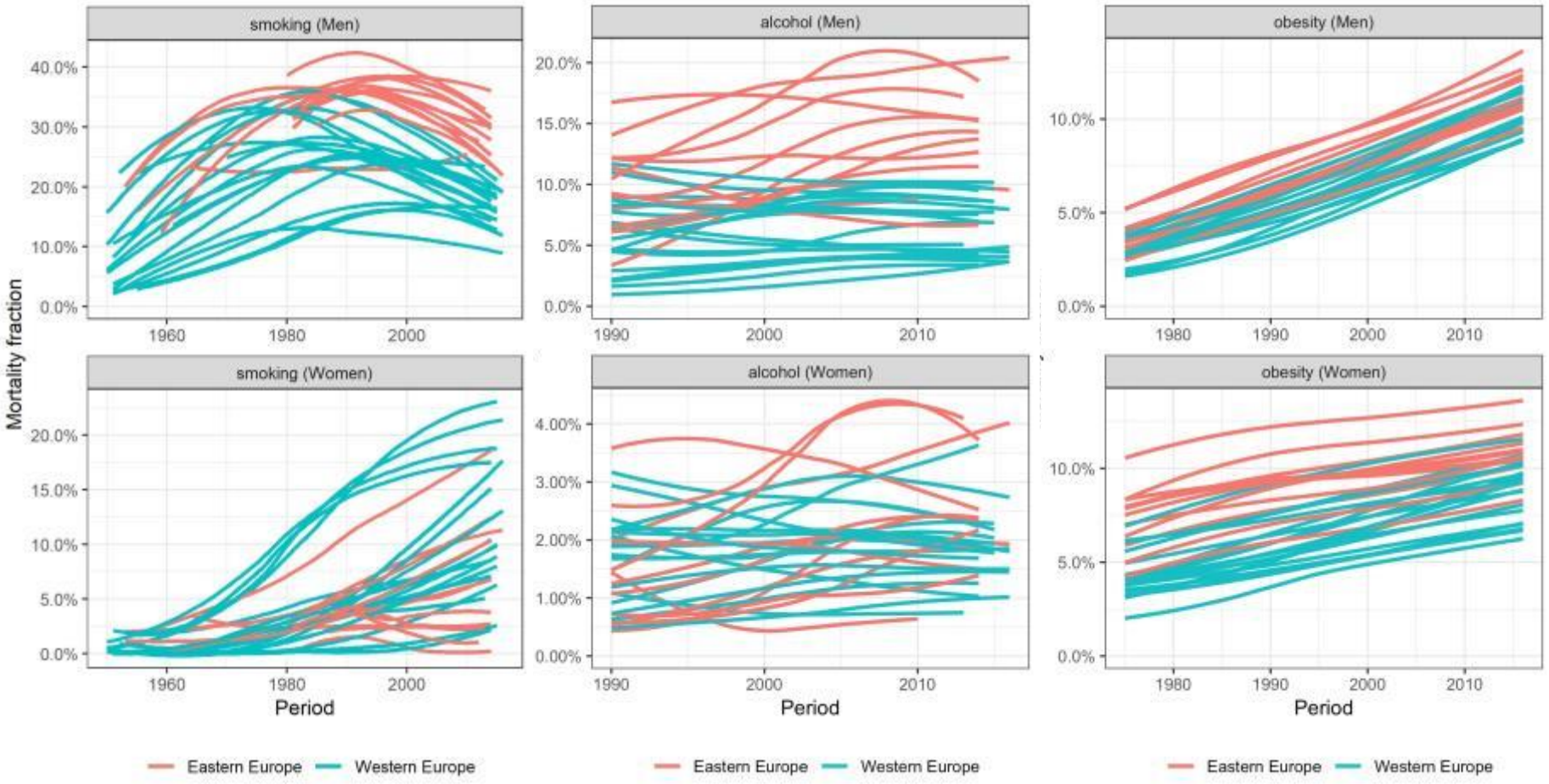
- All-cause mortality and exposure from HMD (past trends: August 27, 2018; projection: May 1, 2019)

Past impact lifestyle-attributable mortality (separately and combined)

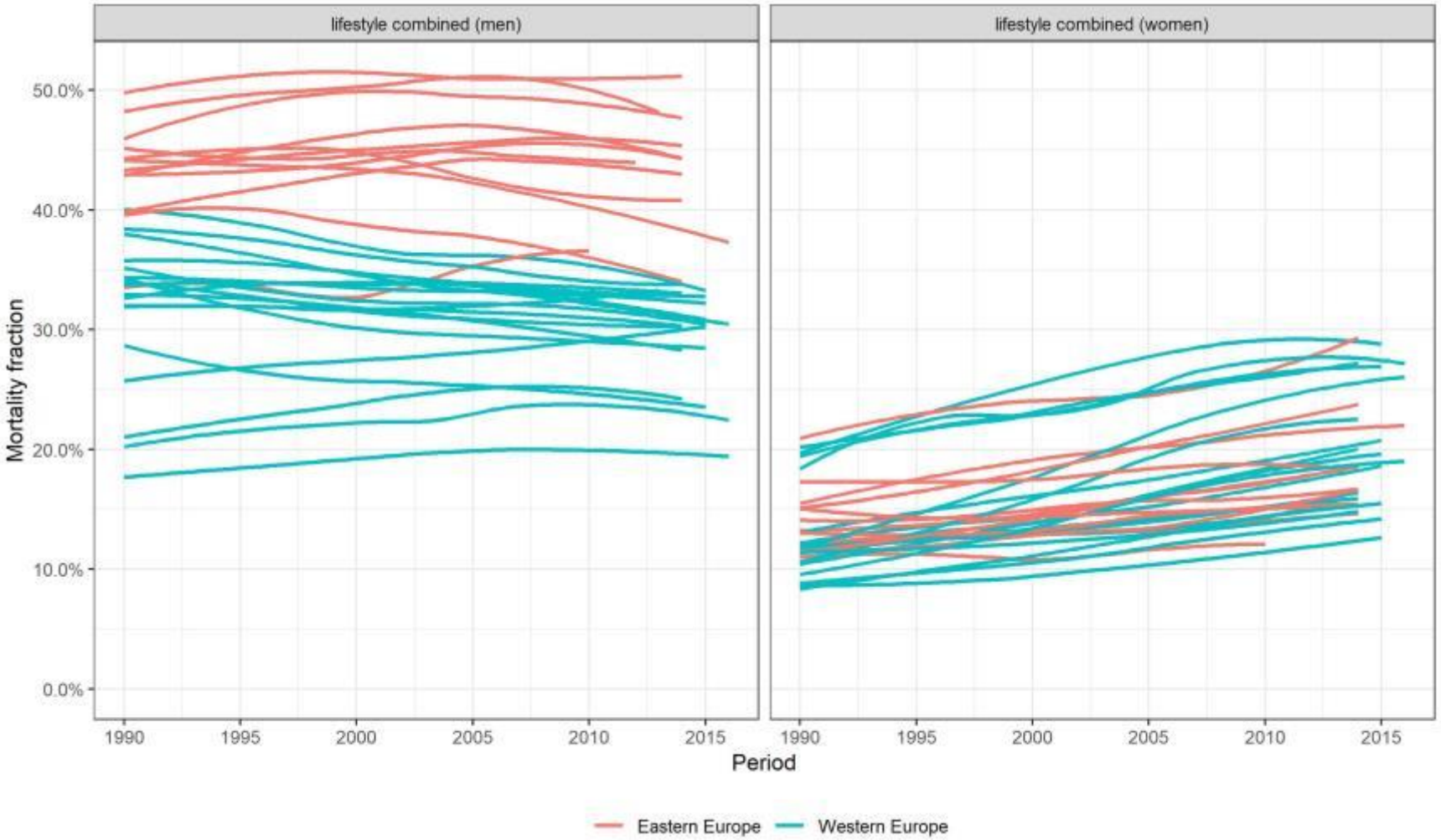
PGLE estimates, 2010

	PGLE Smoking	PGLE Alcohol	PGLE Obesity
Men			
Europe	3.76	2.27	1.28
Western Europe	2.40	1.03	1.07
Eastern Europe	4.92	3.40	1.37

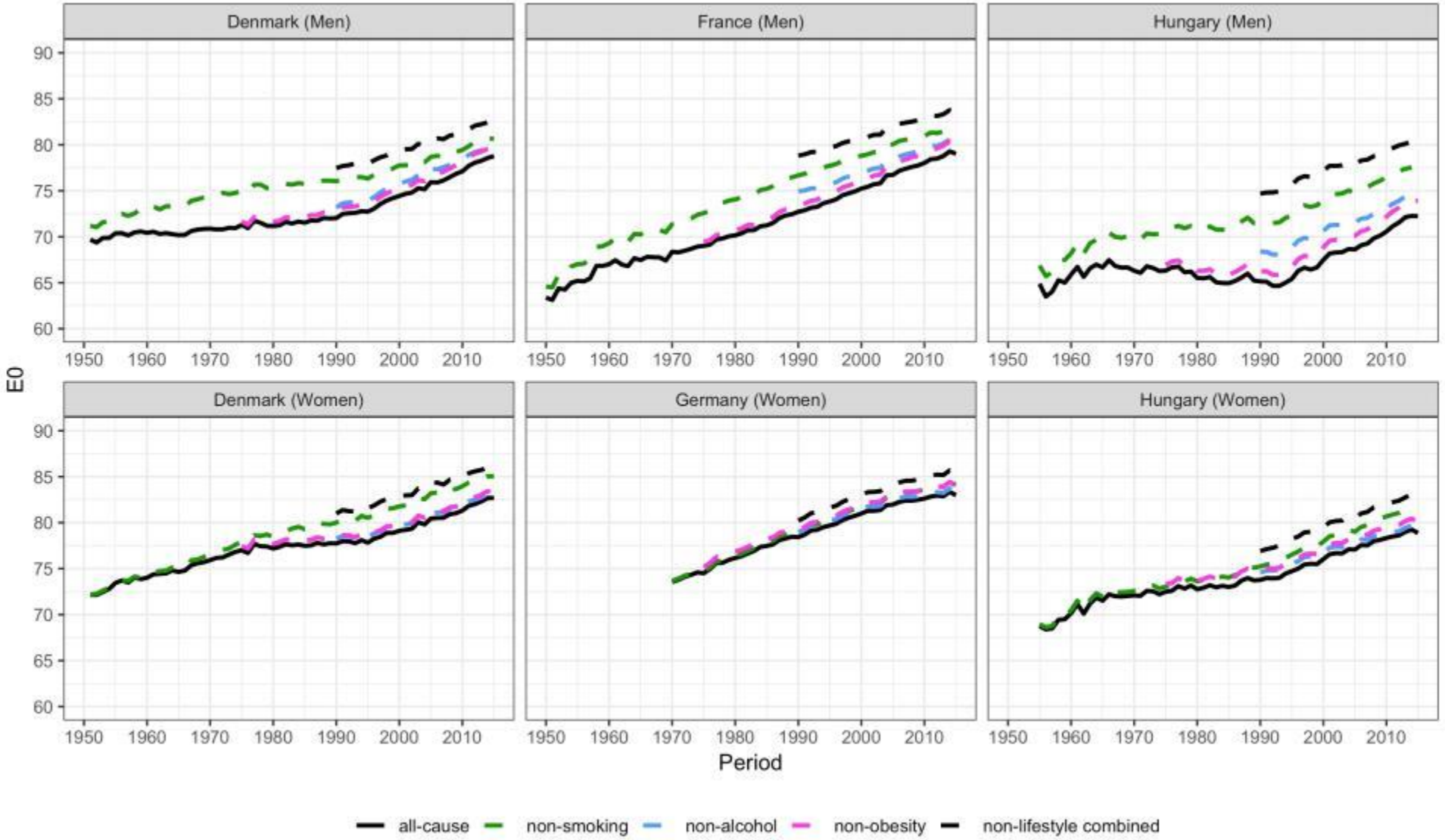
Trends age-standardised smoking, alcohol, and obesity-attributable mortality fractions



Trends age-standardised lifestyle-attributable mortality fractions, 1990-2016 (20-100)



Comparison trends e0 all-cause mortality vs trends e0 non-lifestyle attributable mortality



Future lifestyle-attributable mortality

Methods – future fractions I

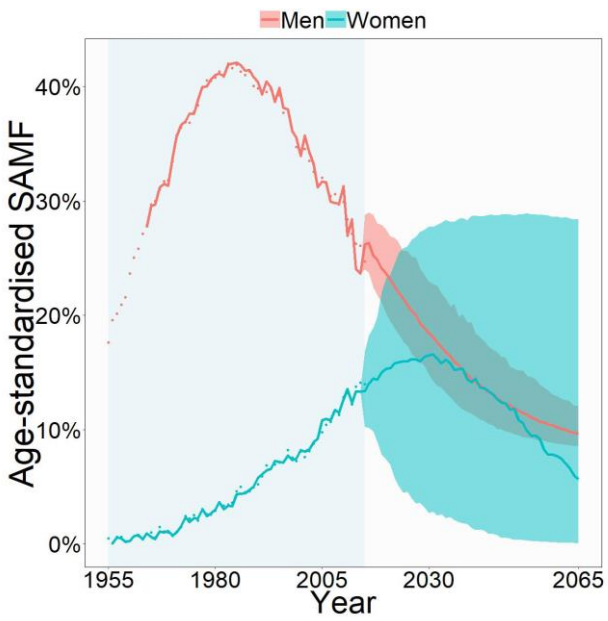
- Novel projections that take into account the wave pattern of epidemics
- Smoking & Alcohol =>
  - APC (Cairns et al. 2009) applied to attributable mortality fractions with a generalized logit link function
  - projection kt by quadratic curve with correlated errors or by decline after peak (best ARIMA)
  - projection gc by extrapolating recent trend (best ARIMA) after burning the outer cohorts
- Obesity
  - LC applied to transformed logit of prevalence
  - projection by linearly extrapolating past trend speed of change over time (1st order diff.)
  - 2000 onwards; 1985 onwards Eastern European women
- Ages up to 84

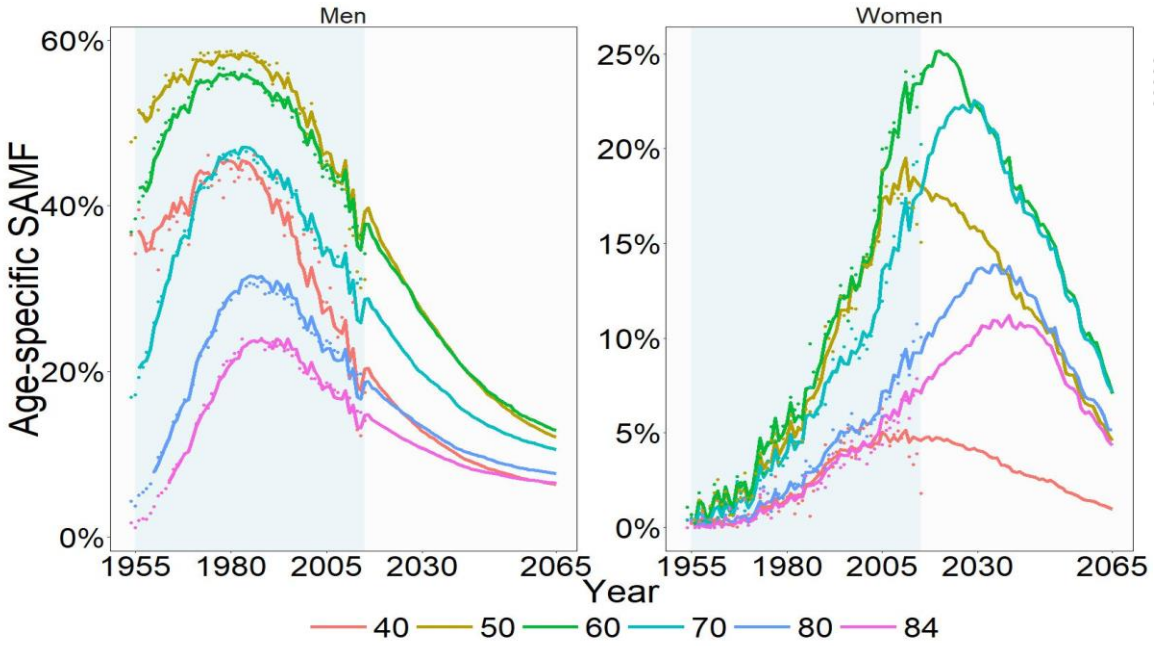
Methods – future fractions II

- Generalized / transformed => implementing bounds
  - Smoking => men LB 5% smoking prevalence; women UB max level women DK (not Hungary)
  - Alcohol => different LBs by country and sex
  - Obesity => LB age-specific prevalence 1975
- For ages 85 -100 => linear extrapolation of the logit of the fractions/prevalence for ages 75-84
- 500 simulations (for now)
- Multiplicative approach to combine the projected fractions for the three separate lifestyles

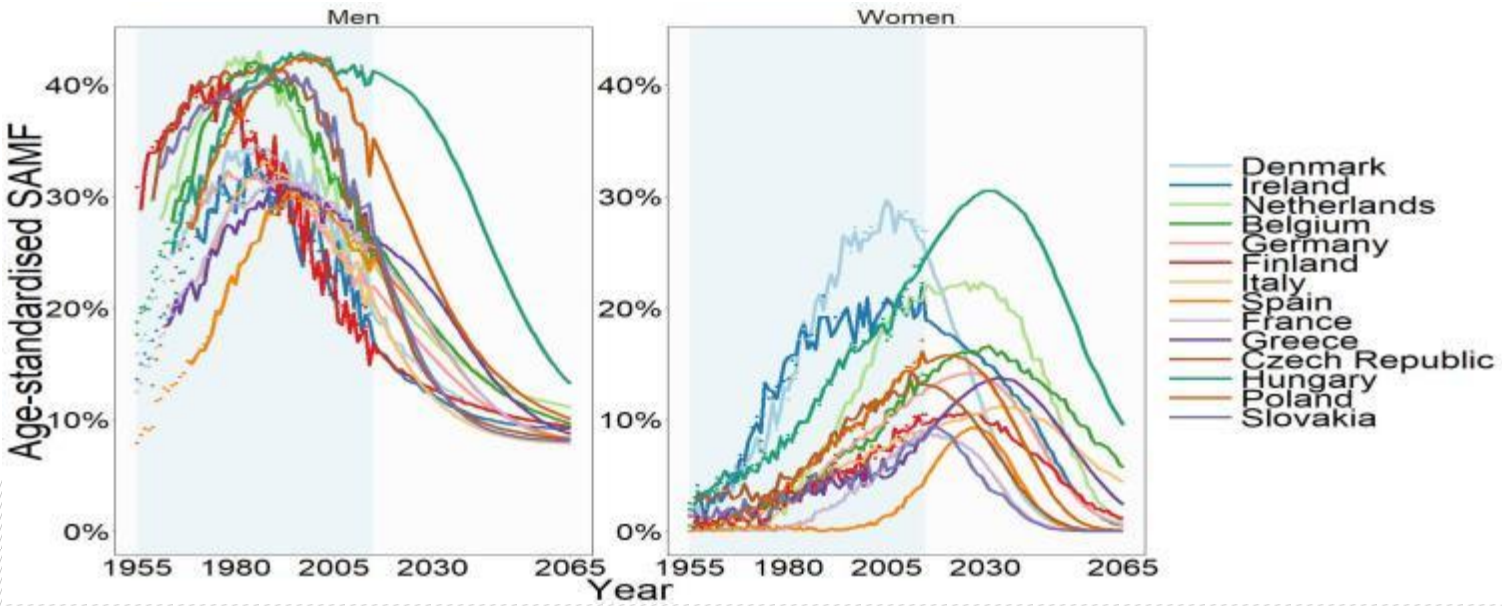
Projection smoking-attributable mortality fractions (SAMF)

Belgium



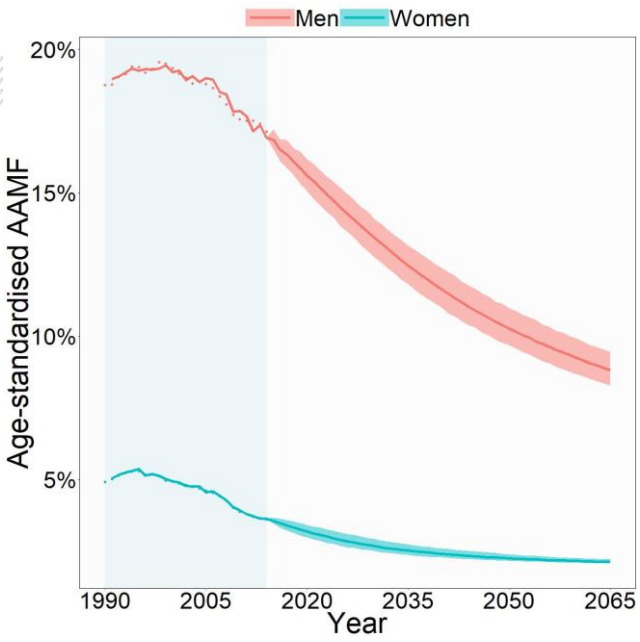


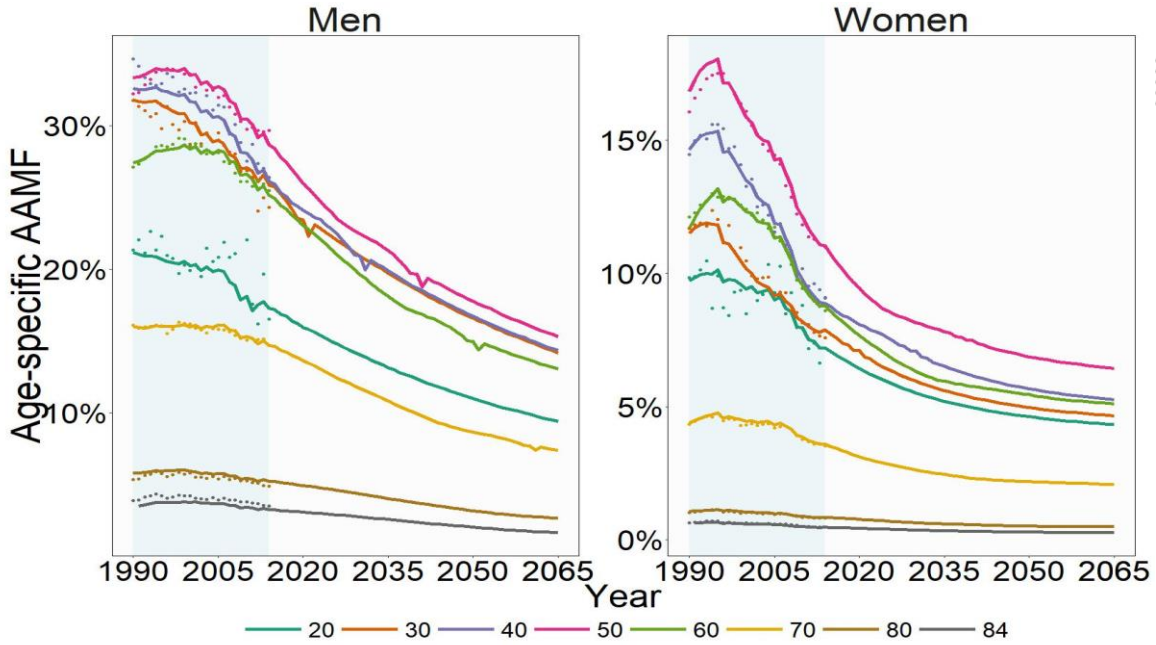
Selected countries



Projection alcohol-attributable mortality fractions (AAMF)

Hungary





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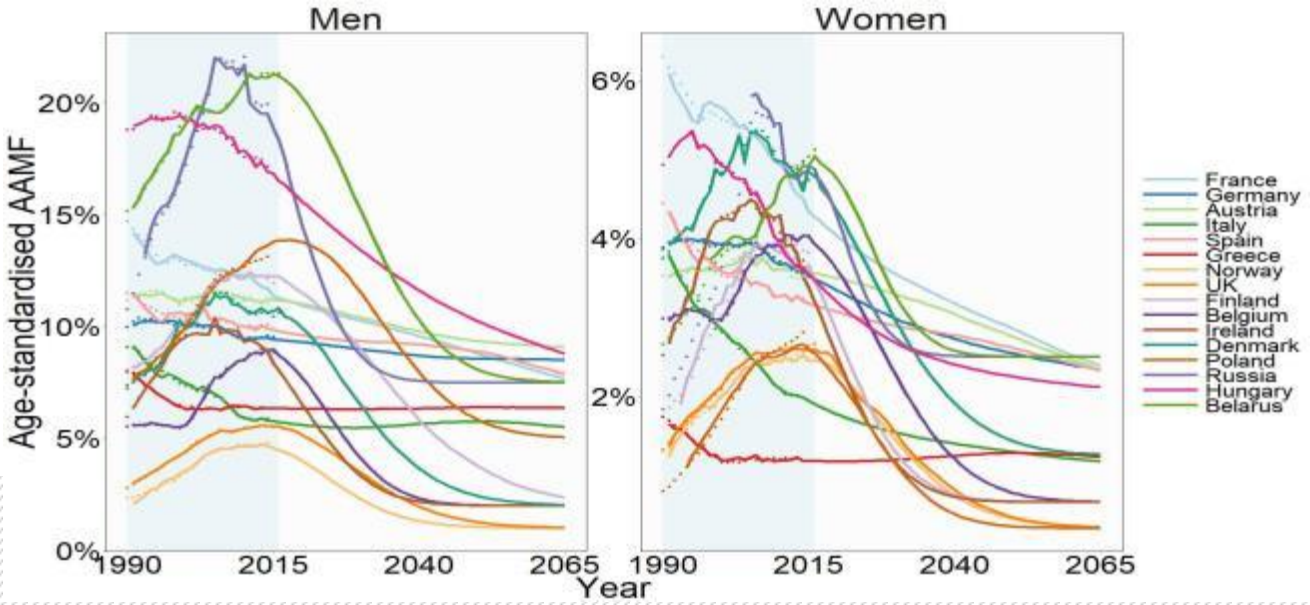
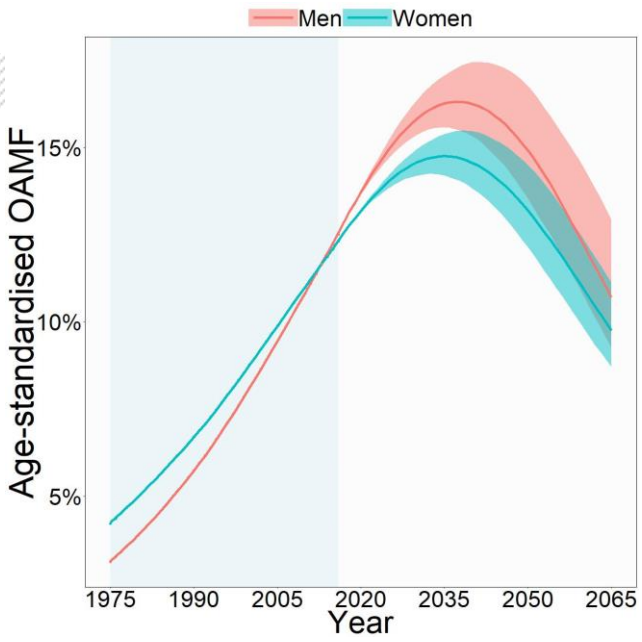
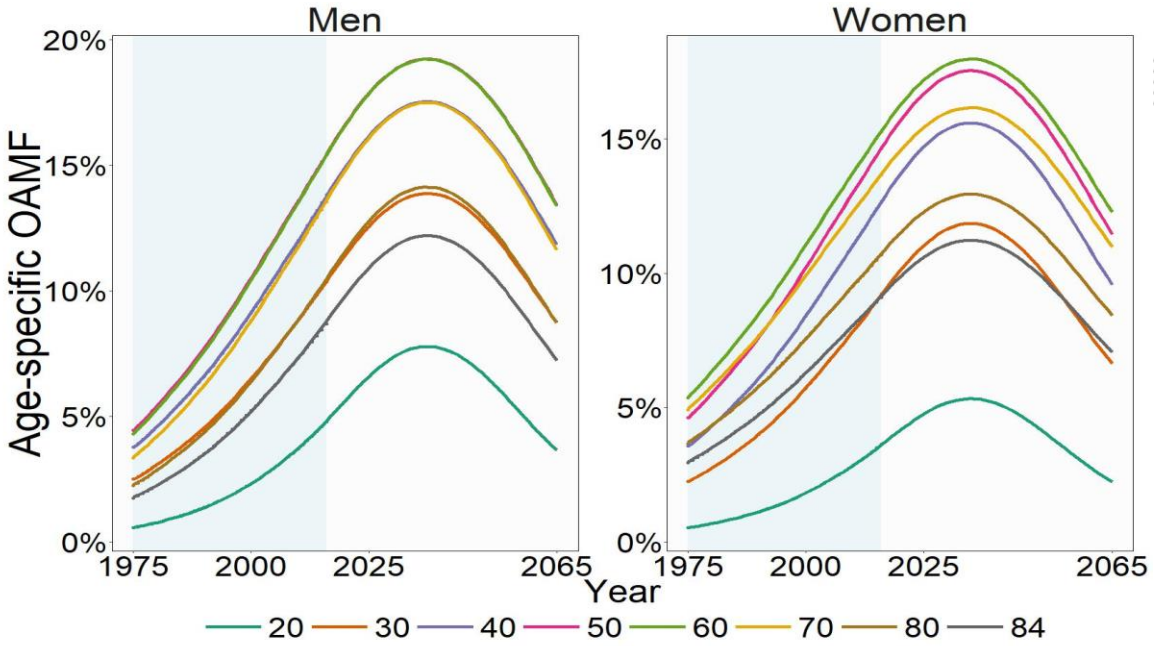


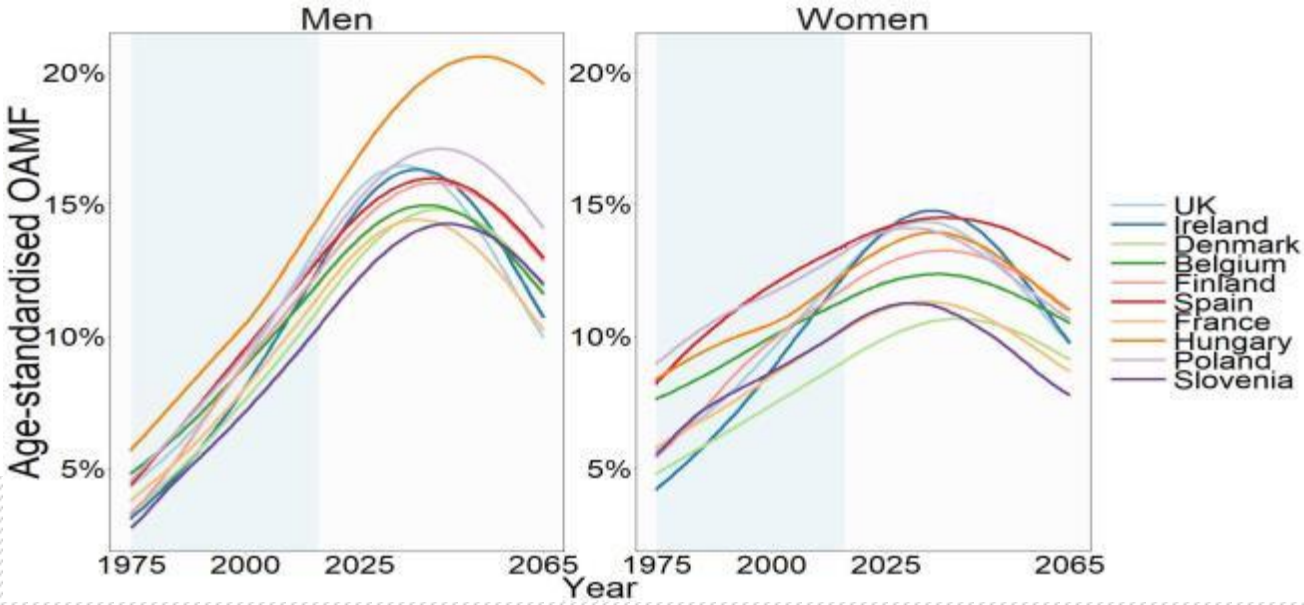
Projection obesity-attributable mortality fractions (OAMF)

Ireland

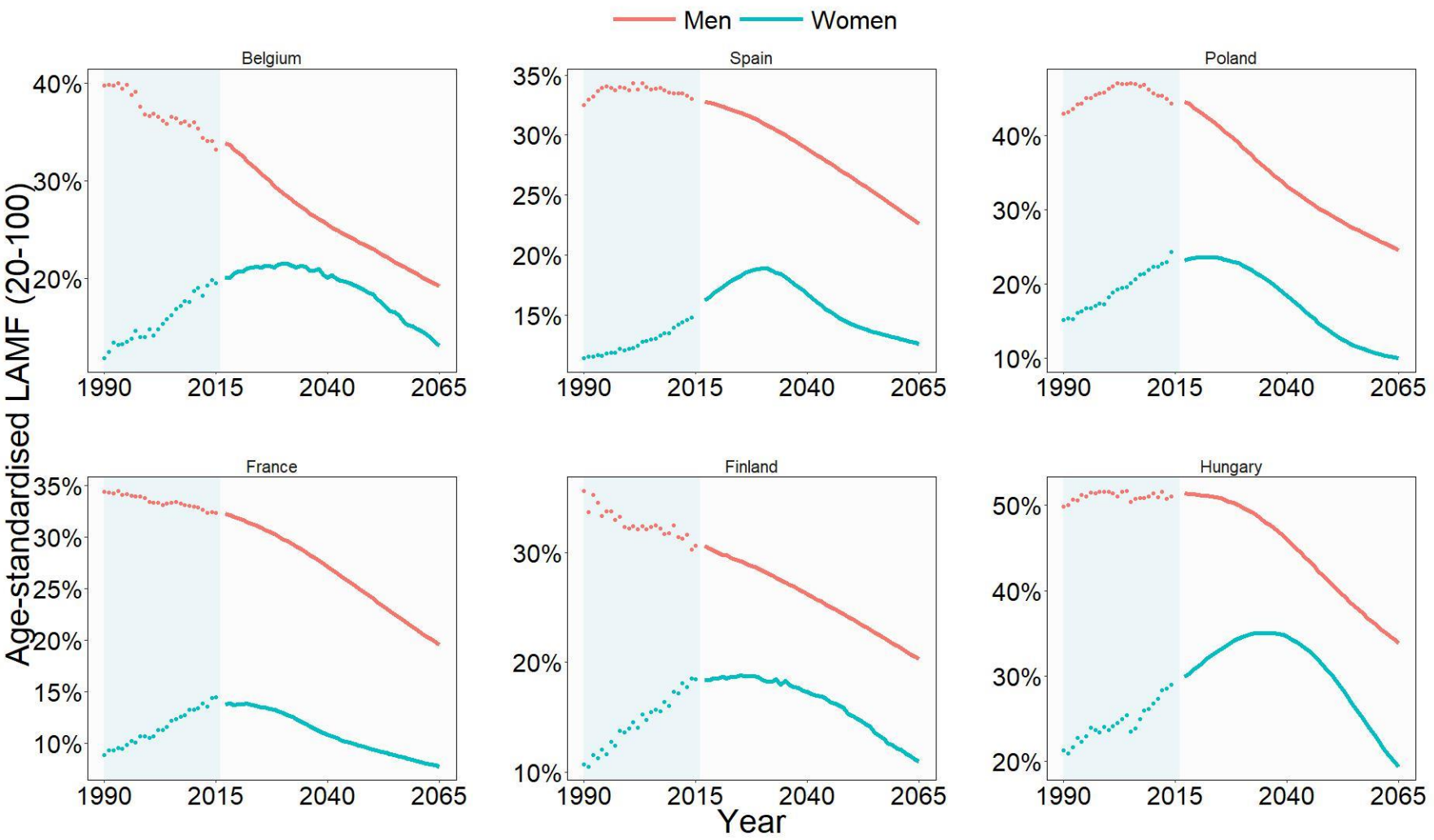




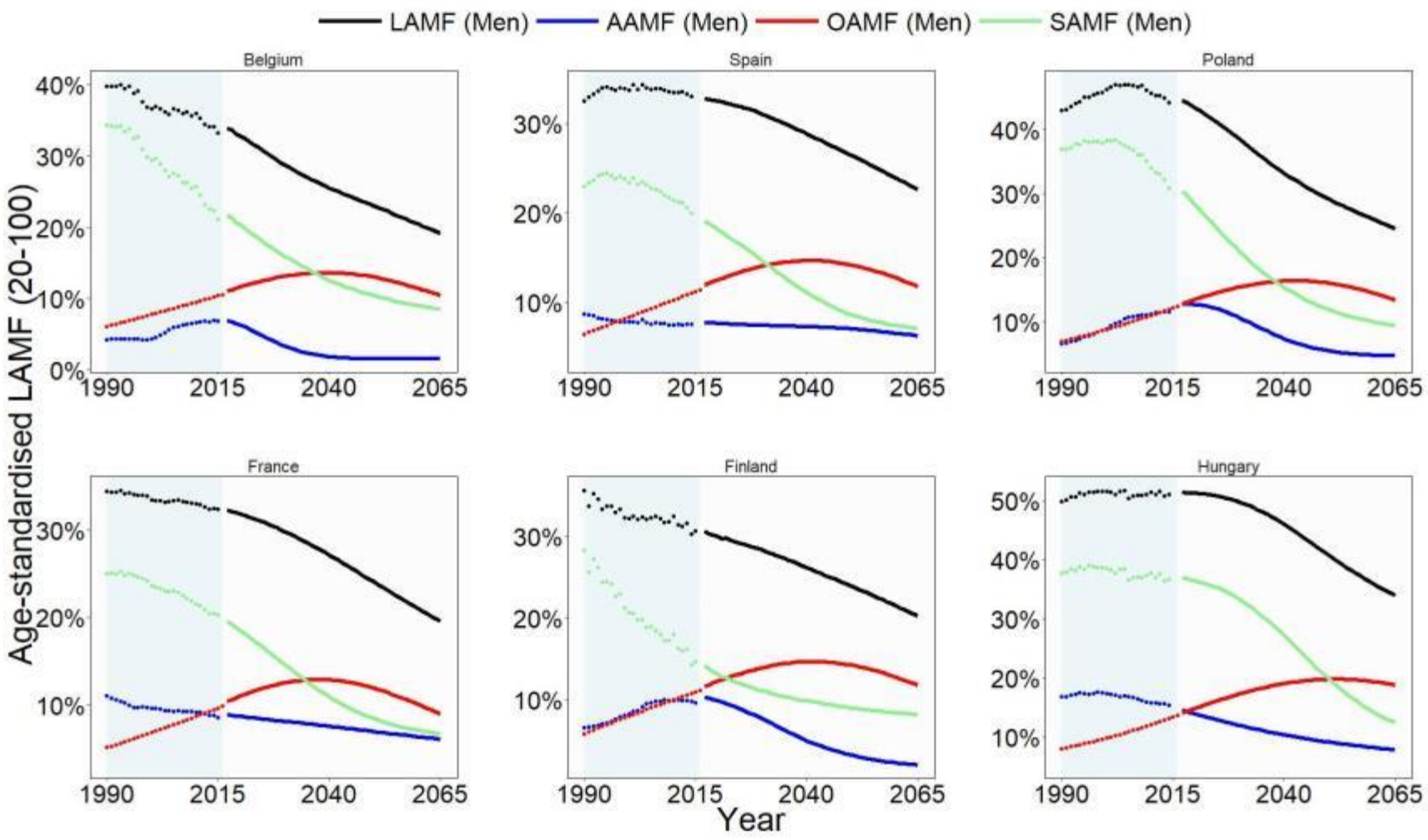
Selected countries



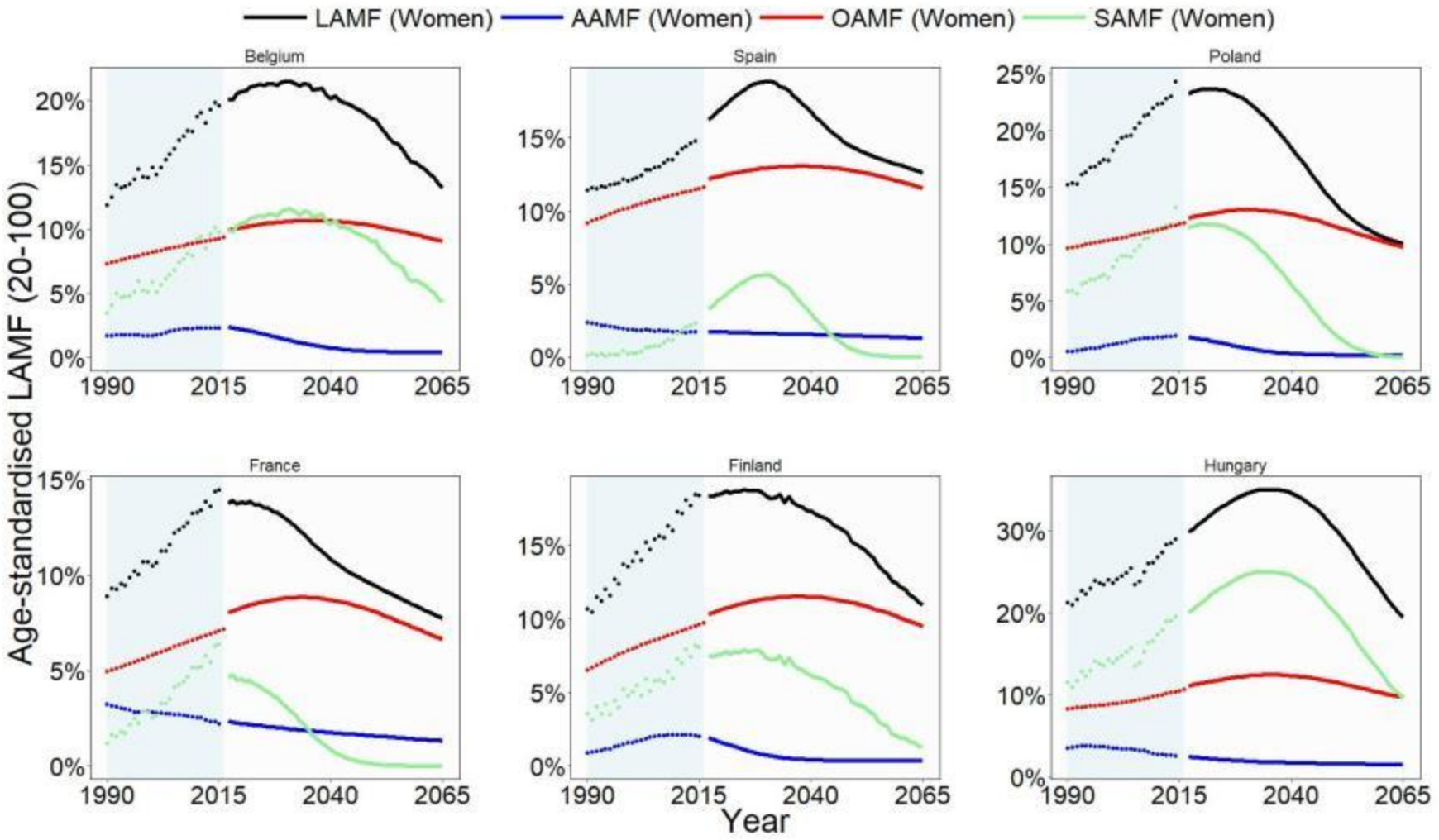
Projected lifestyle-attributable mortality fractions



Projected lifestyle-attributable mortality fractions - men



Projected lifestyle-attributable mortality fractions - women

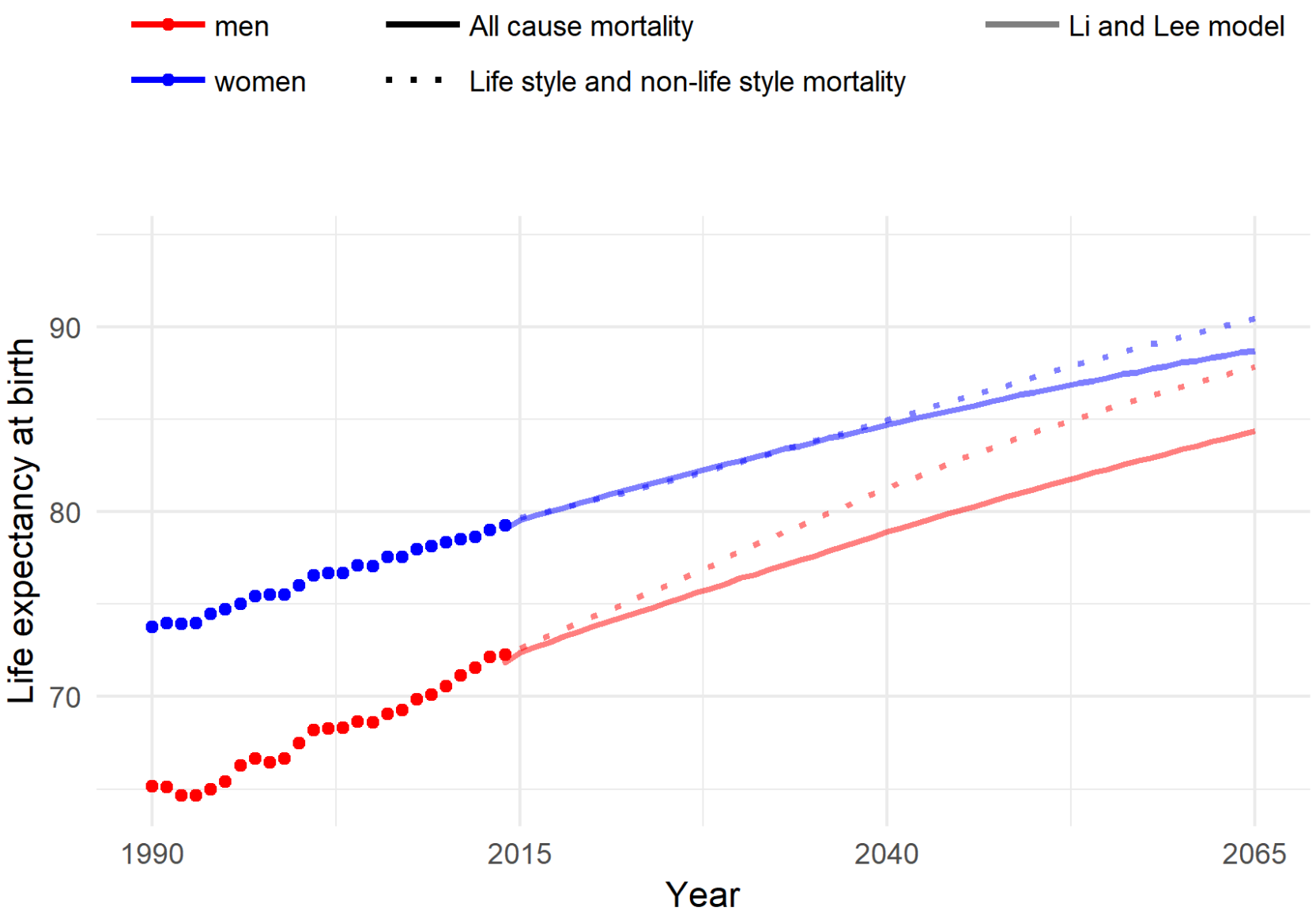


Final projection

Methods – final projection methodology

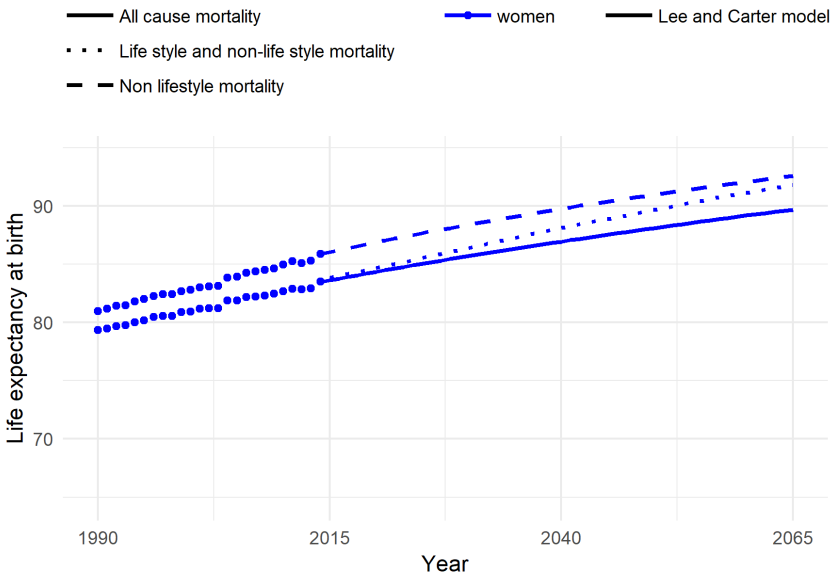
- Coherent forecast of non-lifestyle-attributable mortality rates (Li-Lee); 1990 onwards; ages 0-100. Common = women in France, Spain, Italy. kt_i => RW with no drift (non-stationary).
- Combining them:
  $m(x,t)^{allcause} = m(x,t)^{non-lifestyle} \cdot \left(\frac{1}{1-LAMF(x,t)}\right)$ (Janssen et al. 2013)
- For ages 100+ => Kannisto model of old-age mortality (Thatcher et al. 1998)
- Comparison with direct forecast of all-cause mortality (individual LC and coherent Li-Lee) and with individual LC forecast of non-lifestyle-attributable mortality

Comparisons different projections Hungary

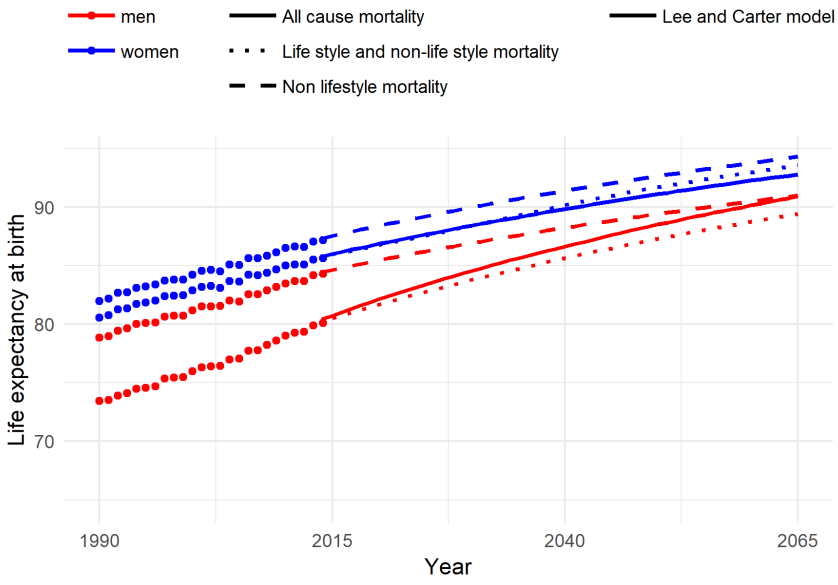


Effect lifestyle when individually forecasting mortality (LC)

Belgium women



Spain



Effect lifestyle when coherently forecasting mortality (LiLee)

	Men			Women		
		Projected e0 2065 Li and Lee			Projected e0 2065 Li and Lee	
	e0 2014	Allcause direct	Allcause indirect	e0 2014	Allcause direct	Allcause indirect
Belgium	78.6	88.6	90.6	83.5	91.4	92.7
France	79.3	89.4	91.3	85.4	93.0	94.2
Spain	80.1	89.4	91.2	85.6	92.9	93.6
Finland	78.1	88.4	90.0	83.9	91.7	92.7
Poland	73.7	85.8	89.1	81.4	90.5	92.0
Hungary	72.3	84.4	87.8	79.2	88.7	90.4

To conclude

Overall conclusion

- Smoking, alcohol and obesity have a strong effect on both past and future mortality levels and trends in Europe

- Mortality projections that take into account likely future changes in smoking, alcohol and obesity result in higher future e0 and - when projecting coherently - in larger convergence between sexes

Discussion

- Preliminary results
- Wave-shaped assumption for alcohol
- Wave-shaped epidemic does require – for obesity and alcohol - continued policy action
- Recent stagnations in life expectancy and its causes are not taken into account
- Importance of the lower bounds
- LC and Li-Lee => illustration of the effects

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Thank you

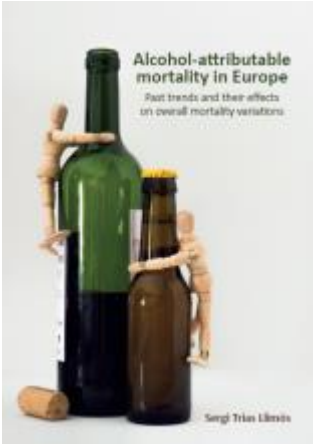
www.futuremortality.com

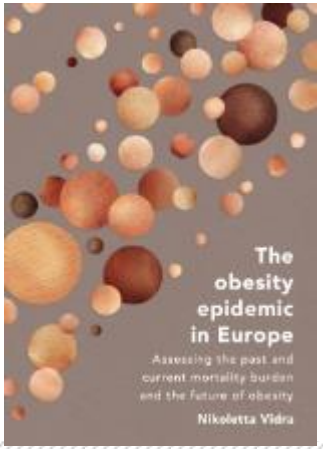
More info past trends lifestyle “epidemics”

- Trias-Llimós, S. (2018) Alcohol-attributable mortality in Europe: Past trends and their effects on overall mortality variations. PhD thesis. University of Groningen, the Netherlands. ISBN: 978-94-034-1304-4.

- Vidra, N. (2019) The obesity epidemic in Europe: Assessing the past and current mortality burden and the future of obesity. PhD thesis. University of Groningen, the Netherlands. ISBN 978-94-6380-306-9.

- Janssen, F. (submitted) Similarities and differences in the mortality impact of the smoking epidemic in low-mortality countries, 1950-2014.





See as well: www.futuremortality.com/publications

For a printed copy of one or both PhD thesises or the PDF of the smoking manuscript => f.janssen@rug.nl

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References (1)

- Booth, H., & Tickle, L. (2008). Mortality modelling and forecasting: a review of methods. *Annals of Actuarial Science*, 3(1–2), 3–43.
- Bongaarts, J. (2014). Trends in causes of death in low-mortality countries: implications for mortality projections. *Population and Development Review* 40(2), 189-212.
- Cairns, A. J., Blake, D., Dowd, K., Coughlan, G. D., Epstein, D., Ong, A., and Balevich, I. (2009). A quantitative comparison of stochastic mortality models using data from England and Wales and the United States. *North American Actuarial Journal* 13(1), 1-35.
- Janssen, F & Kunst, A. E. (2005). Cohort patterns in mortality trends among the elderly in seven European countries, 1950–99. *International Journal of Epidemiology* 34(5), 1149-1159.
- Janssen, F & Kunst, A.E. (2007). The choice among past trends as a basis for the prediction of future trends in old-age mortality. *Population Studies* 61(3): 315-326.
- Janssen, F., van Wissen, L. J., and Kunst, A. E. (2013). Including the smoking epidemic in internationally coherent mortality projections. *Demography* 50(4), 1341-1362.
- Lee, R. D., & Carter, L. R. (1992). Modeling and forecasting US mortality. *Journal of the American Statistical Association* 87(419), 659-671.
- Li, N., & Lee, R. (2005). Coherent mortality forecasts for a group of populations: An extension of the Lee-Carter method. *Demography* 42, 575–594.

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References (2)

- Lopez, A. D., Collishaw, N. E., and T. Piha (1994). A descriptive model of the cigarette epidemic in developed countries. *Tobacco Control* 3, 242–247.
- Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., and Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *The Lancet* 373(9682), 2223-2233.
- Rokholm, B., Baker, J. L., and Sørensen, T. I. A. (2010). The levelling off of the obesity epidemic since the year 1999–a review of evidence and perspectives. *Obesity Reviews* 11(12), 835-846.
- › Stoeldraijer, L., van Duin, C., van Wissen, L., & Janssen, F. (2013). Impact of different mortality forecasting methods and explicit assumptions on projected future life expectancy: the case of the Netherlands. *Demographic Research*, 29(13), 323–354.
- Thatcher, A. R., Kannisto, V., and Vaupel, J. W. (1998). The force of mortality at ages 80 to 120. *Odense Monographs on Population Aging* Vol. 5. Odense: Odense University Press.
- Thun, M., Peto, R., Boreham, J., and Lopez, A. D. (2012). Stages of the cigarette epidemic on entering its second century. *Tobacco Control* 21(2), 96-101.
- Stoeldraijer, L. (2018) Mortality forecasting in the context of non-linear past mortailty trends: an evaluation. PhD thesis. University of Groningen, the Netherlands..

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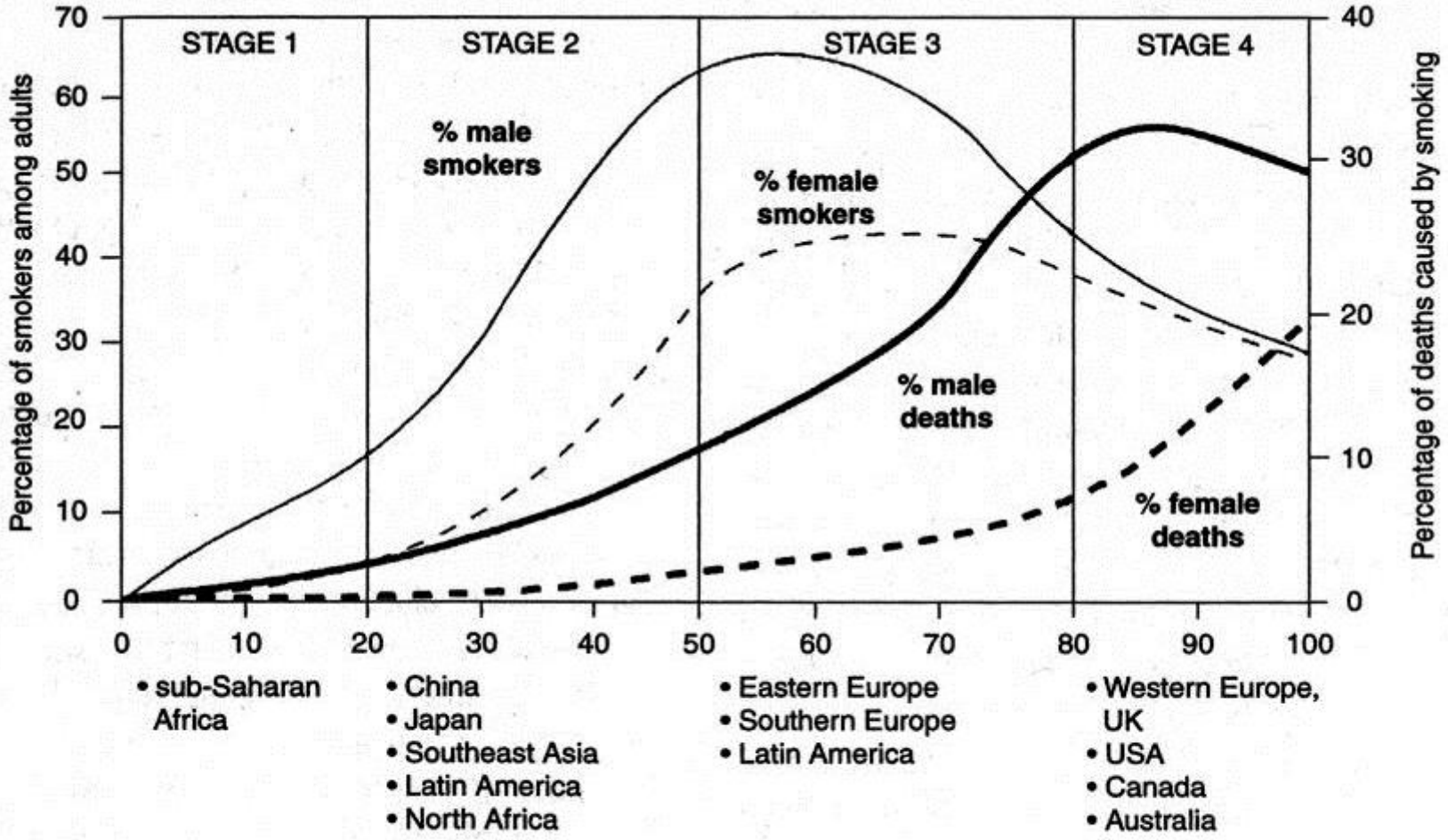
References (3)

- Trias-Llimós, S., Bijlsma, M. J., and Janssen, F. (2017). The role of birth cohorts in long-term trends in liver cirrhosis mortality across eight European countries. *Addiction* 112(2), 250-258.
- Trias-Llimós, S., Kunst, A.E., Jasilionis, D. and Janssen, F. (2018) The contribution of alcohol to the East-West life expectancy gap in Europe from 1990 onward. *International Journal of Epidemiology* 47(3), 731-739.
- Vidra, N., Bijlsma, M. J., Trias-Llimos, S., and Janssen, F. (2018). Past trends in obesity-attributable mortality in eight European countries: an application of age–period–cohort analysis. *International Journal of Public Health* 63(6), 683-692.
- WHO (2007). The challenge of Obesity in the WHO European Region and the Strategies for Response: Summary. Copenhagen: WHO Regional Office for Europe.
- WHO (2009). Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization.
- WHO (2011) Global status report on non communicable diseases 2010. Geneva: World Health Organization.
- Xu L., & Lam, T. H. (2018). Stage of obesity epidemic model: Learning from tobacco control and advocacy for a framework convention on obesity control. *Journal of Diabetes* 10(7), 564-571.

References data

- Abarca-Gómez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Acuin C, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128· 9 million children, adolescents, and adults. The Lancet 2017;390(10113):2627-2642.
- Global Burden of Disease Collaborative Network. GBD 2017 results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018. Available from http://ghdx.healthdata.org/gbd-results-tool.
- Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available from: www.mortality.org.
- Stanaway, J. D., Afshin, A., Gakidou, E., Lim, S. S., Abate, D., Abate, K. H., ... & Abdela, J. (2018). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 392(10159), 1923-1994.
- World Health Organization Statistical Information System (WHOSIS). Health statistics and health information systems. Available at: www.who.int/whosis/

Descriptive model smoking epidemic



Source: Lopez AD, Collishaw NE, Piha T. (1994). A descriptive model of the cigarette epidemic in developed countries. *Tobacco Control, 3*, 242-247.

Descriptive model obesity epidemic

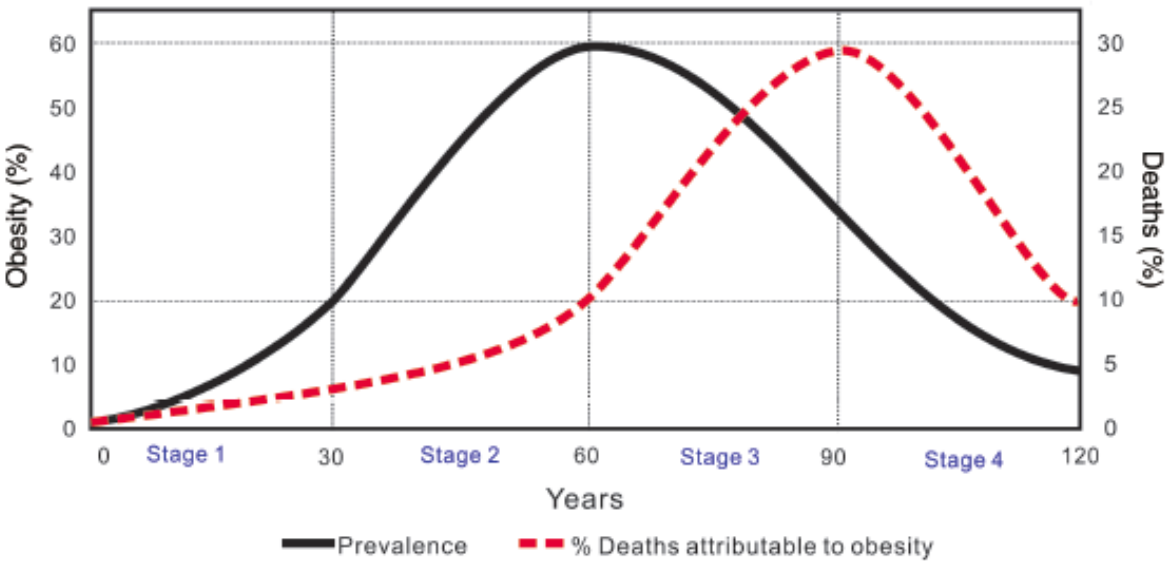
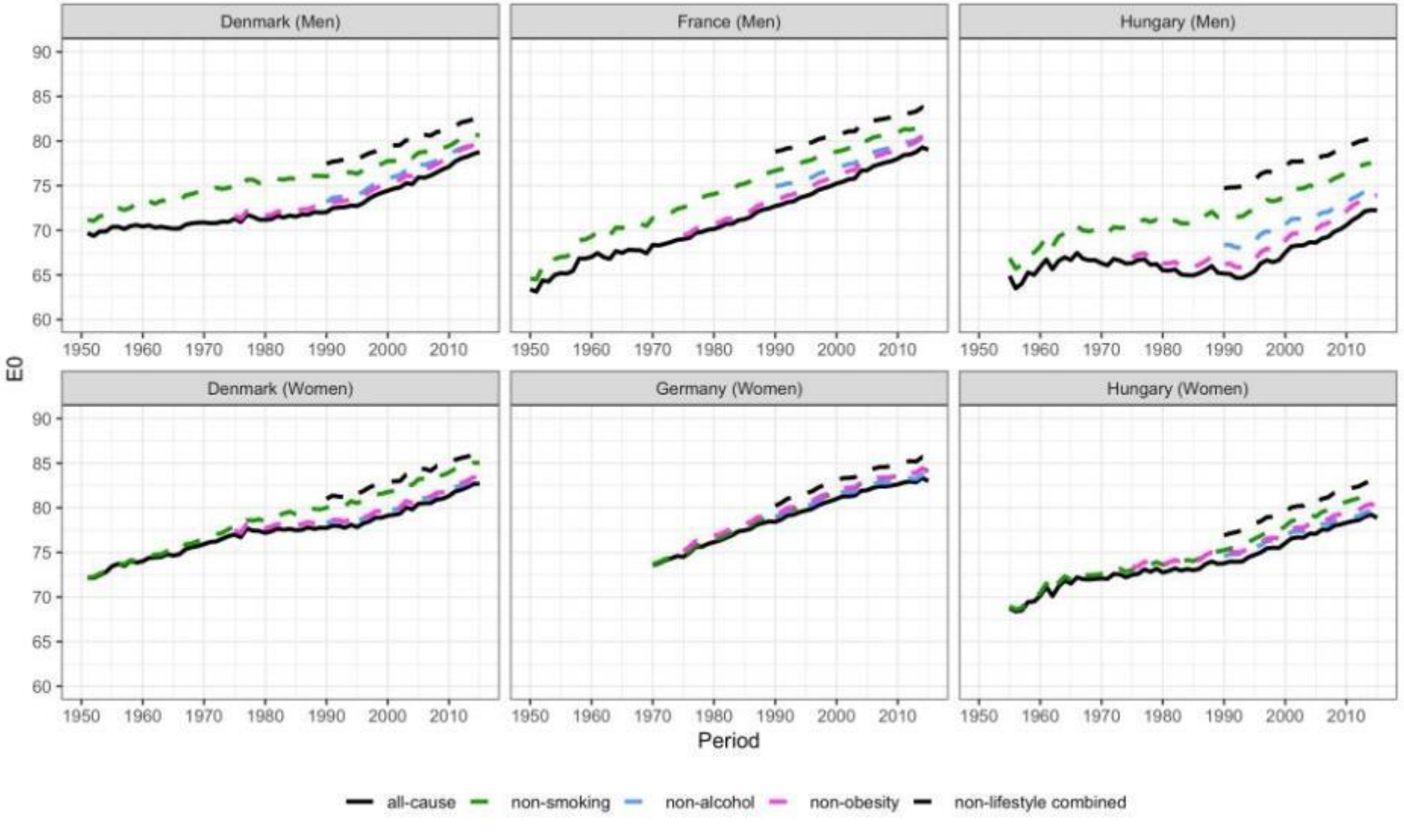


Figure 1 Model of the obesity epidemic: The criteria used to define the stages of the epidemic are based on the level of obesity prevalence and obesity-attributed mortality. Assuming 60 years between the current Stage 1 and Stage 2 to peak at a prevalence of 60%.

Xu & Lam (2018)


Denmark (Men)
France (Men)
Hungary (Men)
Denmark (Women)
Germany (Women)
Hungary (Women)
E0
Period
90
85
80
75
70
65
60
1950
1960
1970
1980
1990
2000
2010
all-cause
non-smoking
non-alcohol
non-obesity
non-lifestyle combined

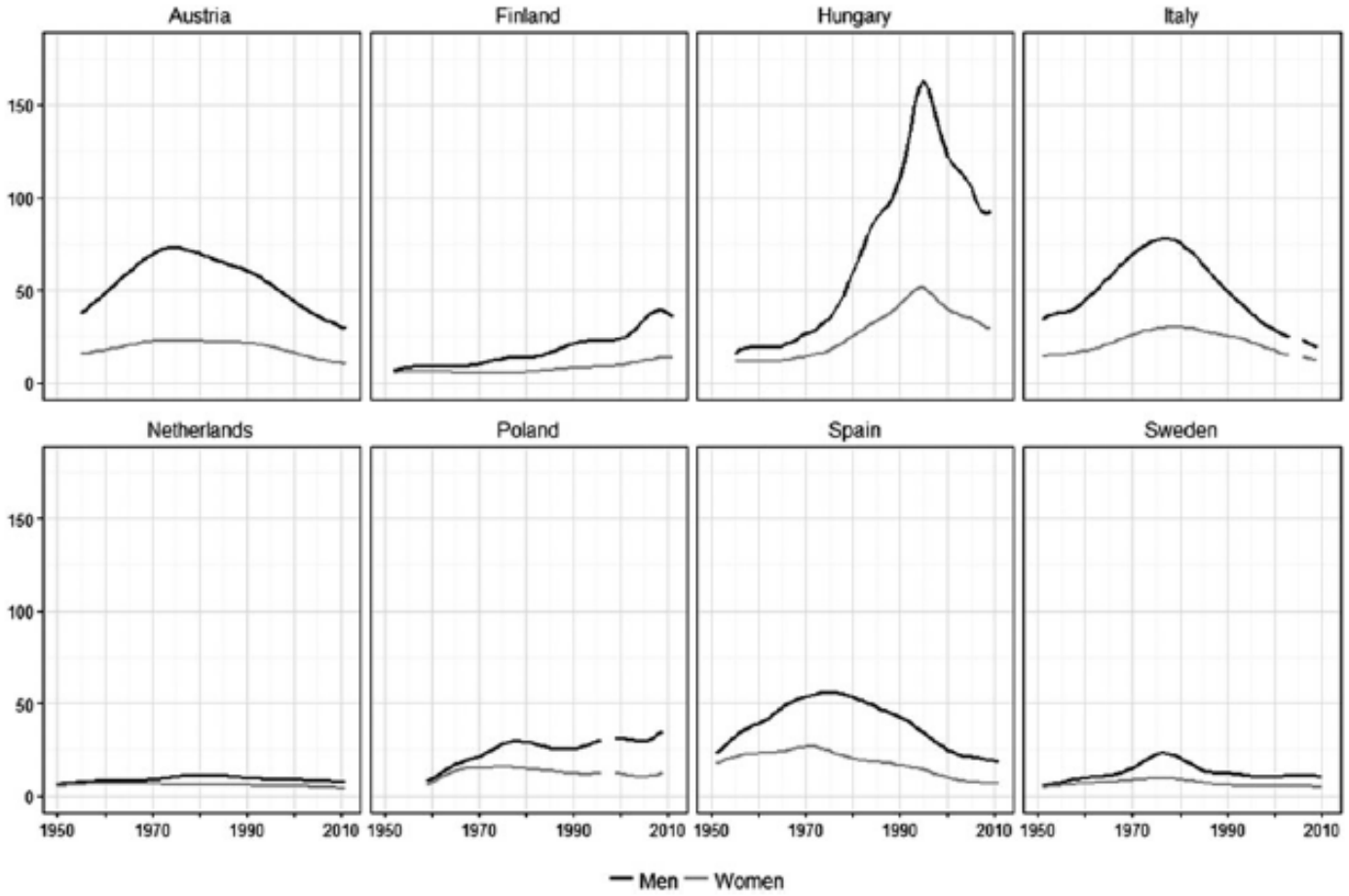
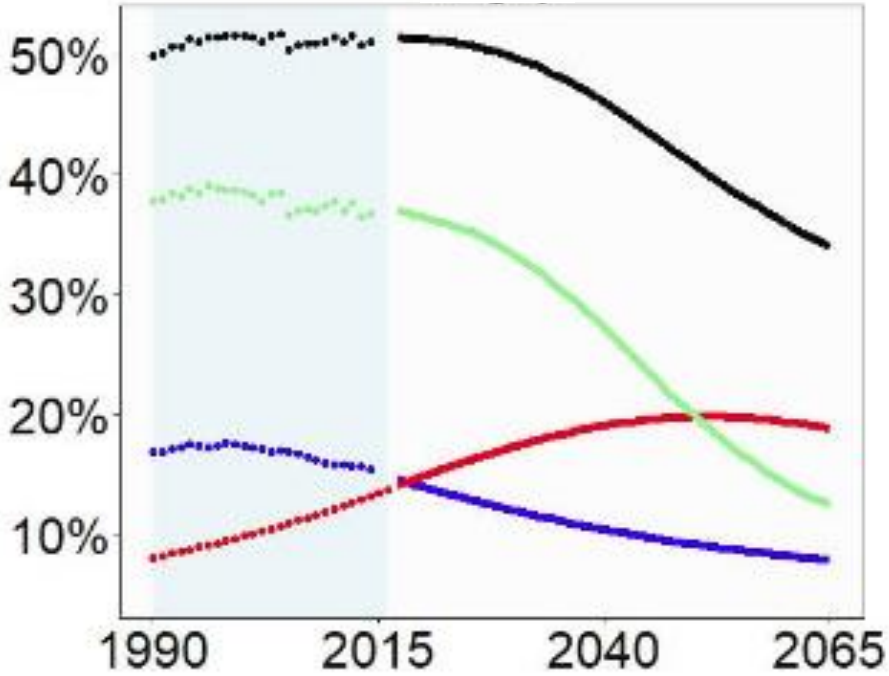


Figure 1 Age-standardized liver cirrhosis mortality rate in eight European countries, aged 15–94 years, 1950–2011, by sex

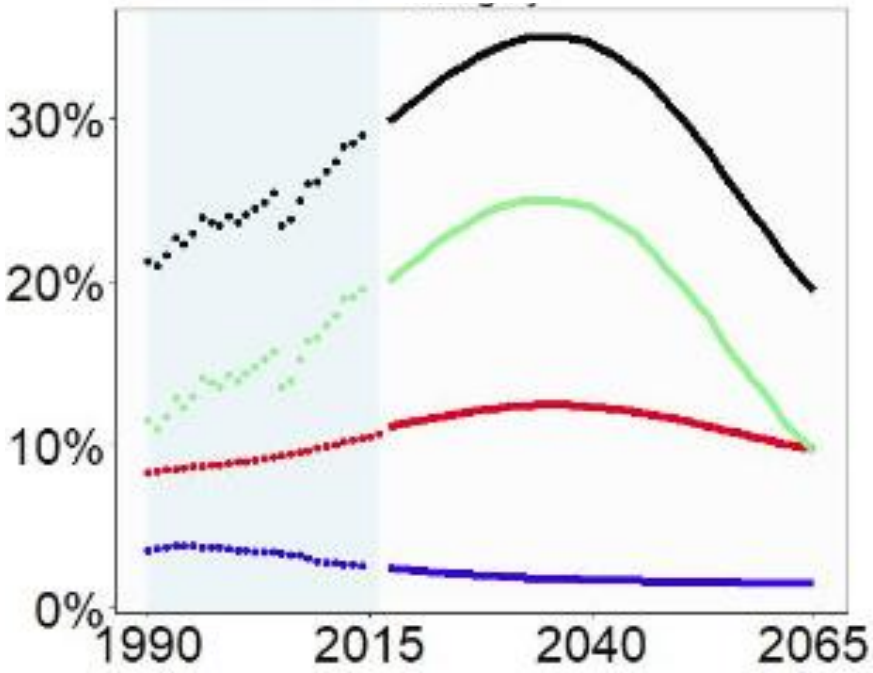
Trias-Llimós et al. 2017

Hungary – observed & projected fractions

men

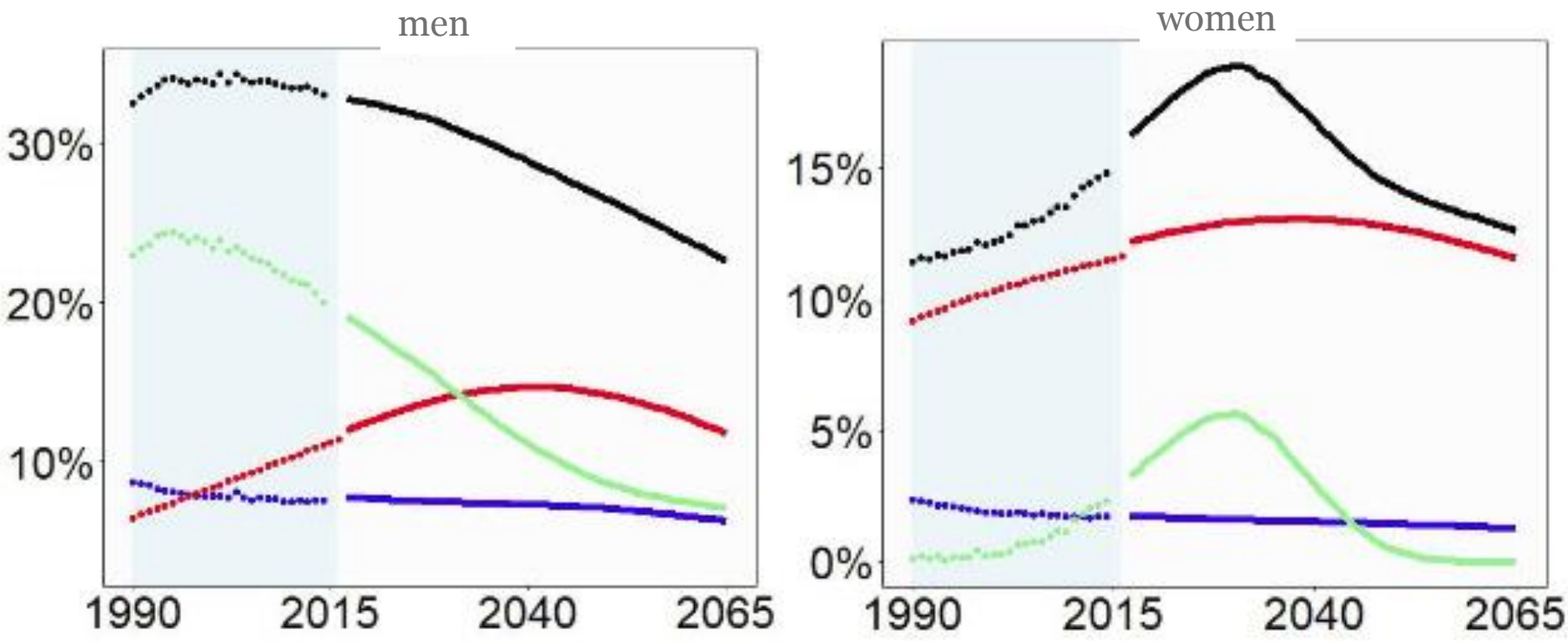


women

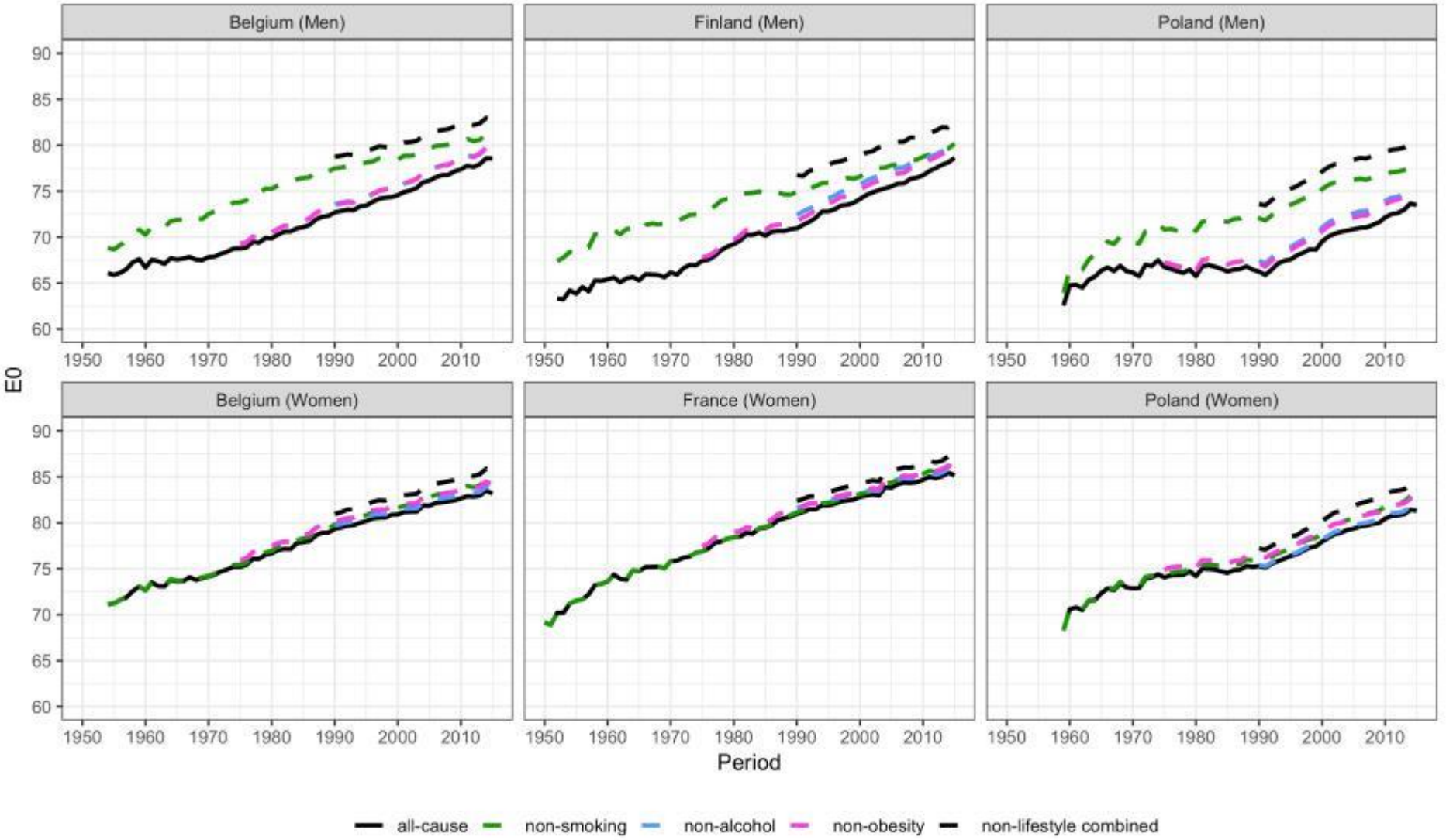


Age-standardised fractions (20-100)

Spain – observed & projected fractions



Age-standardised fractions (20-100)


Belgium (Men)
Finland (Men)
Poland (Men)
Belgium (Women)
France (Women)
Poland (Women)
E0
Period
90
85
80
75
70
65
60
1950
1960
1970
1980
1990
2000
2010
all-cause
non-smoking
non-alcohol
non-obesity
non-lifestyle combined

Next steps

- Finetuning (smoothing; HCD data for alcohol CEE)
- If possible extend the timeseries for alcohol => longer timeseries non-lifestyle attributable mortality
- Smoking: implement lower bound among women
- Different age pattern of the lower bounds
- Numerous sensitivity analyses, e.g. different estimation of lifestyle-attributable mortality combined; different assumption projection alcohol-attributable mortality.
- Examine the effect of the separate lifestyle factors on future e0
- Take into account past trends in mortality compression and delay into the final mortality forecast