

Online Appendix

The Sensitivity of the Healthy Life Years Indicator: Approaches for Dealing with Age-Specific Prevalence Data

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* This Online Appendix contains additional information regarding the article:
<http://www.comparativepopulationstudies.de/index.php/CPoS/article/view/476/373>



Fig. A1: Age-specific prevalence by different smoothing methods, by sex and selected European countries, 2017

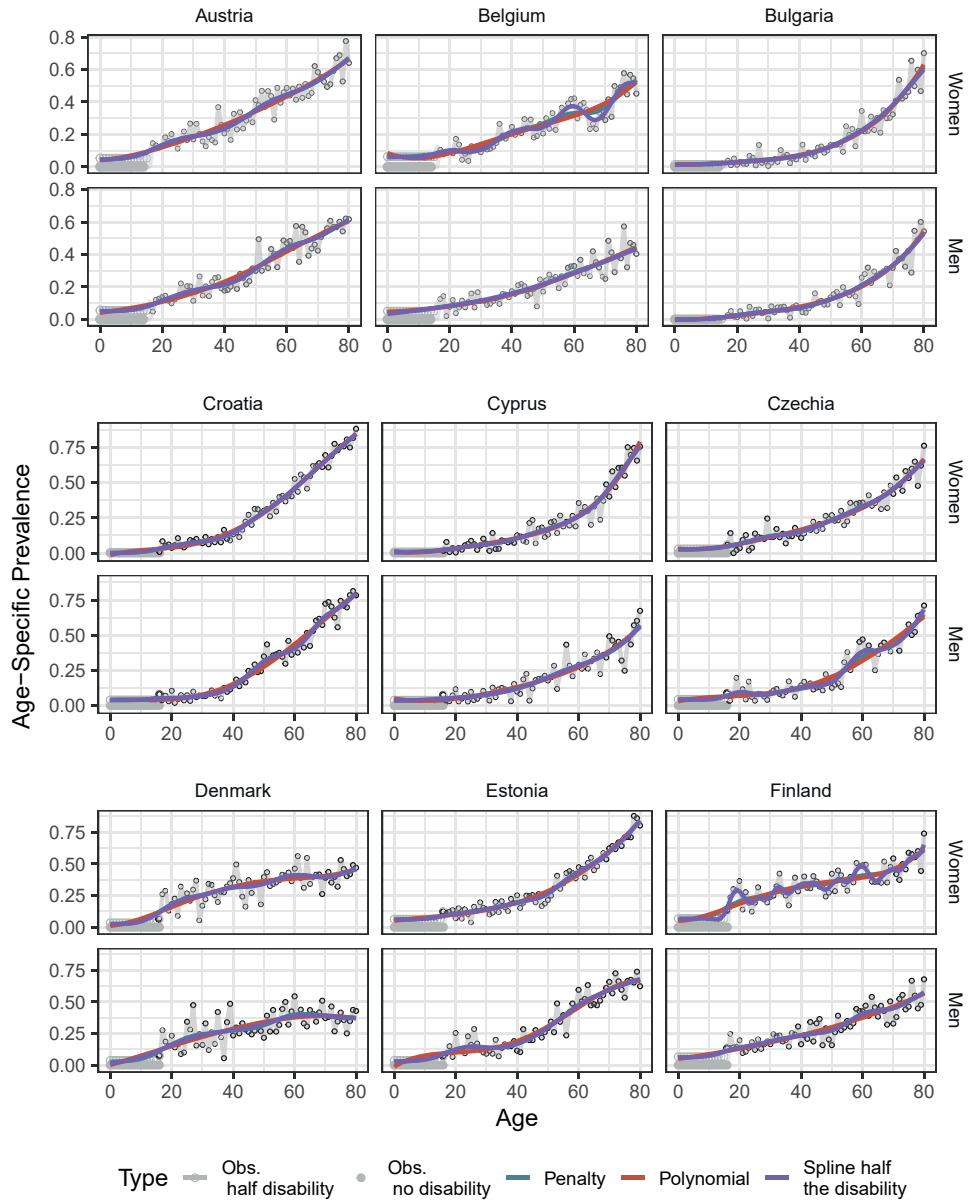


Fig. A1: Continuation

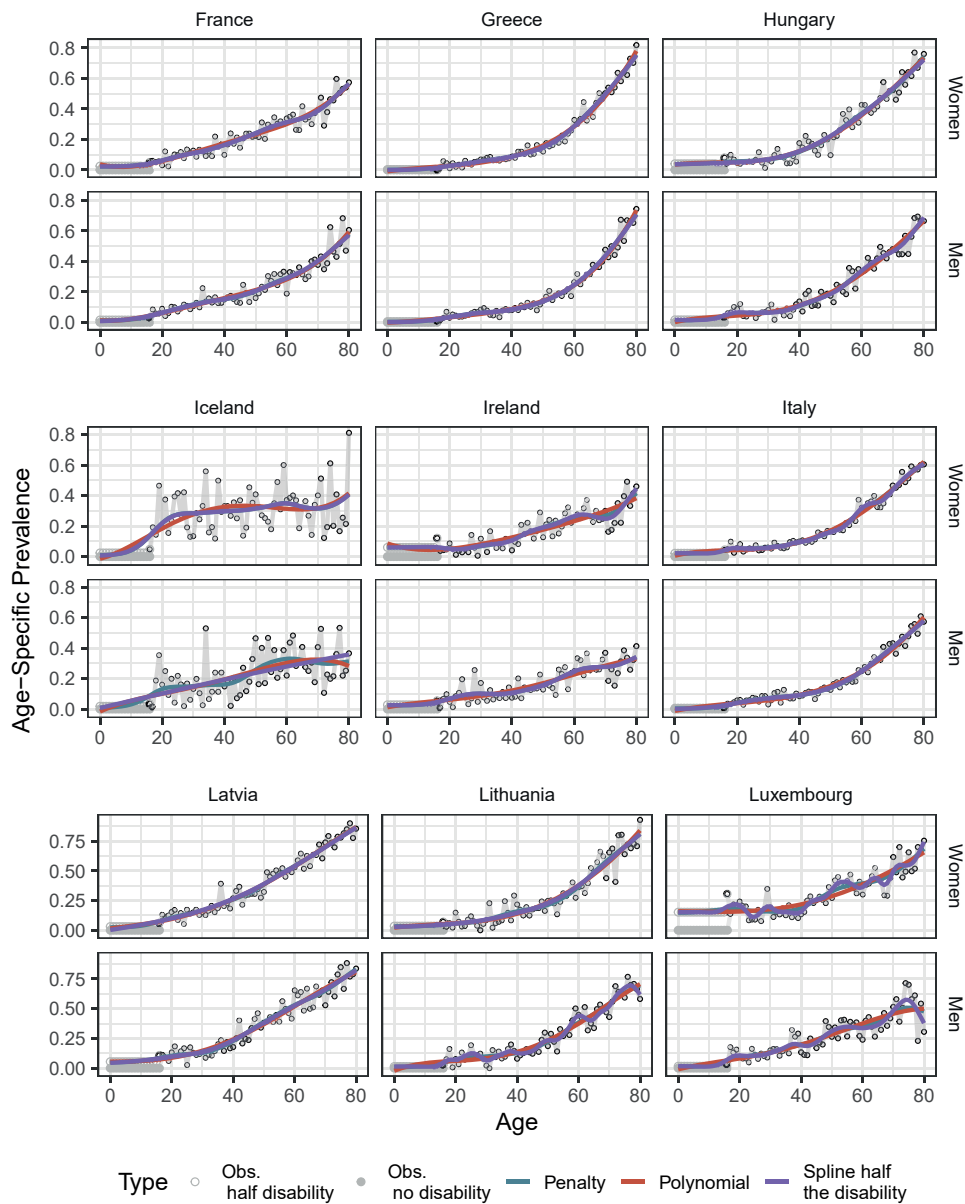


Fig. A1: Continuation

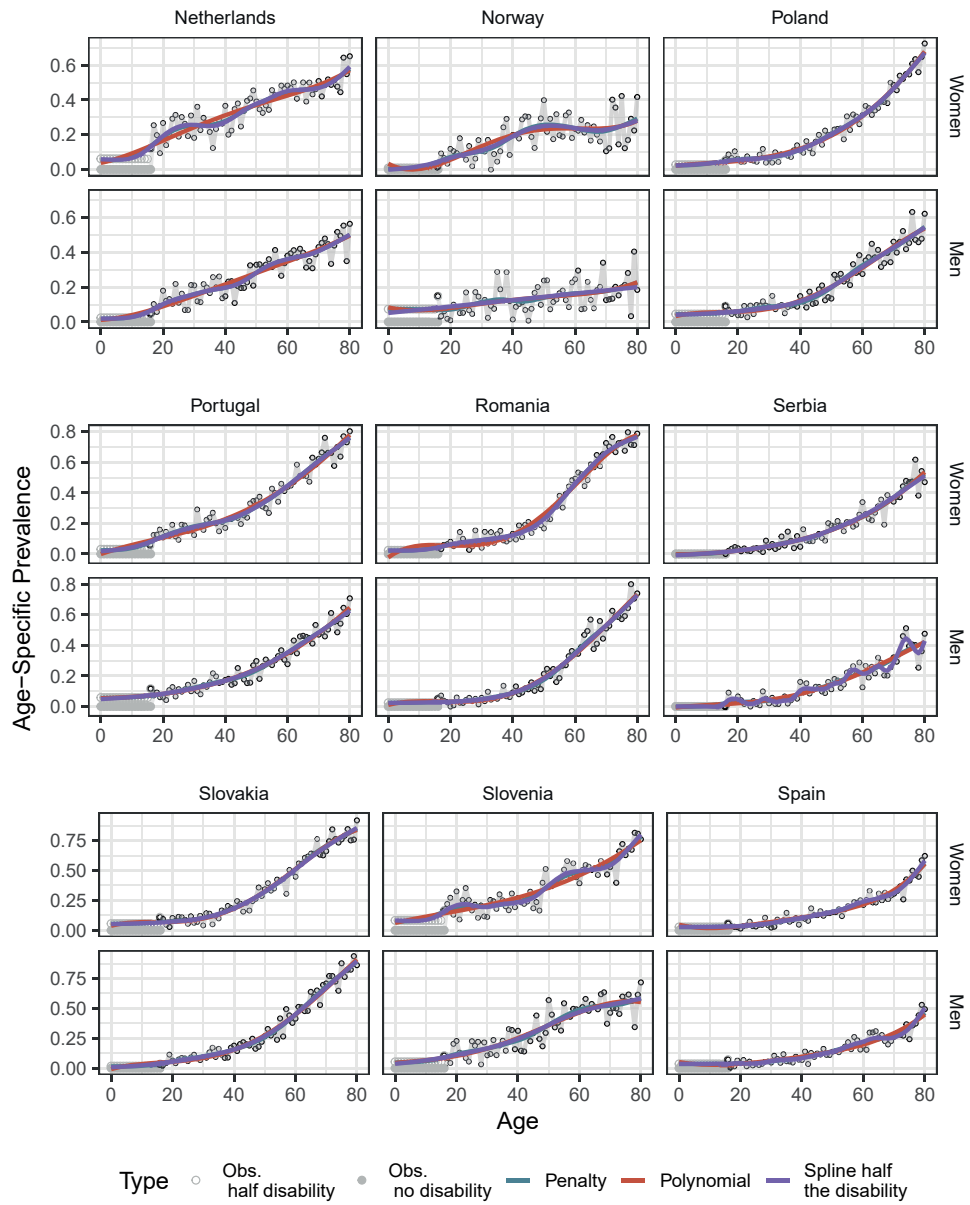
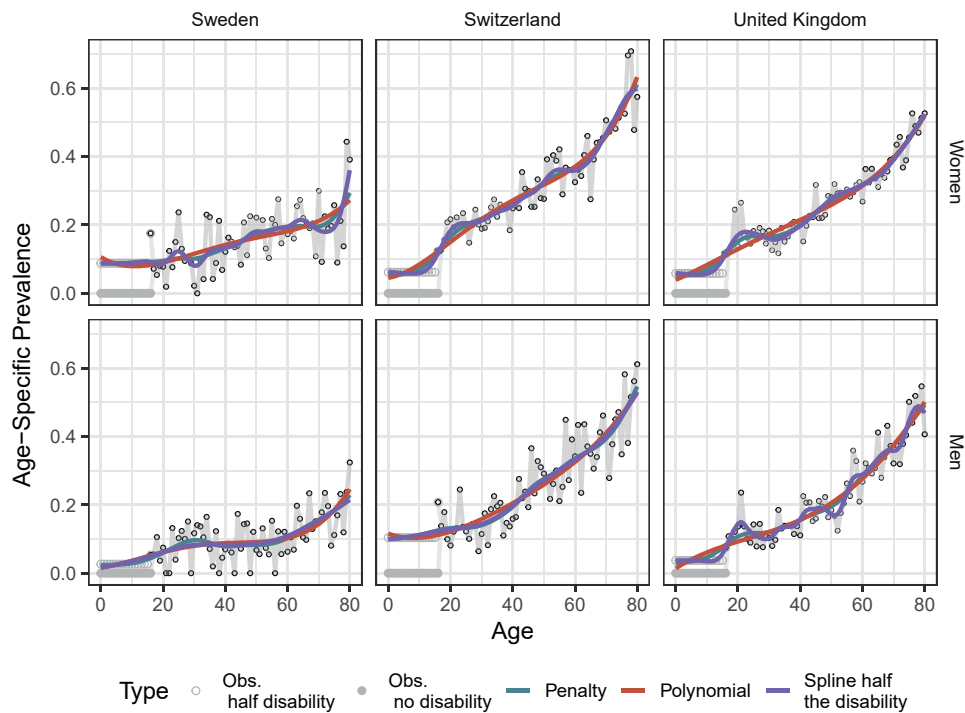
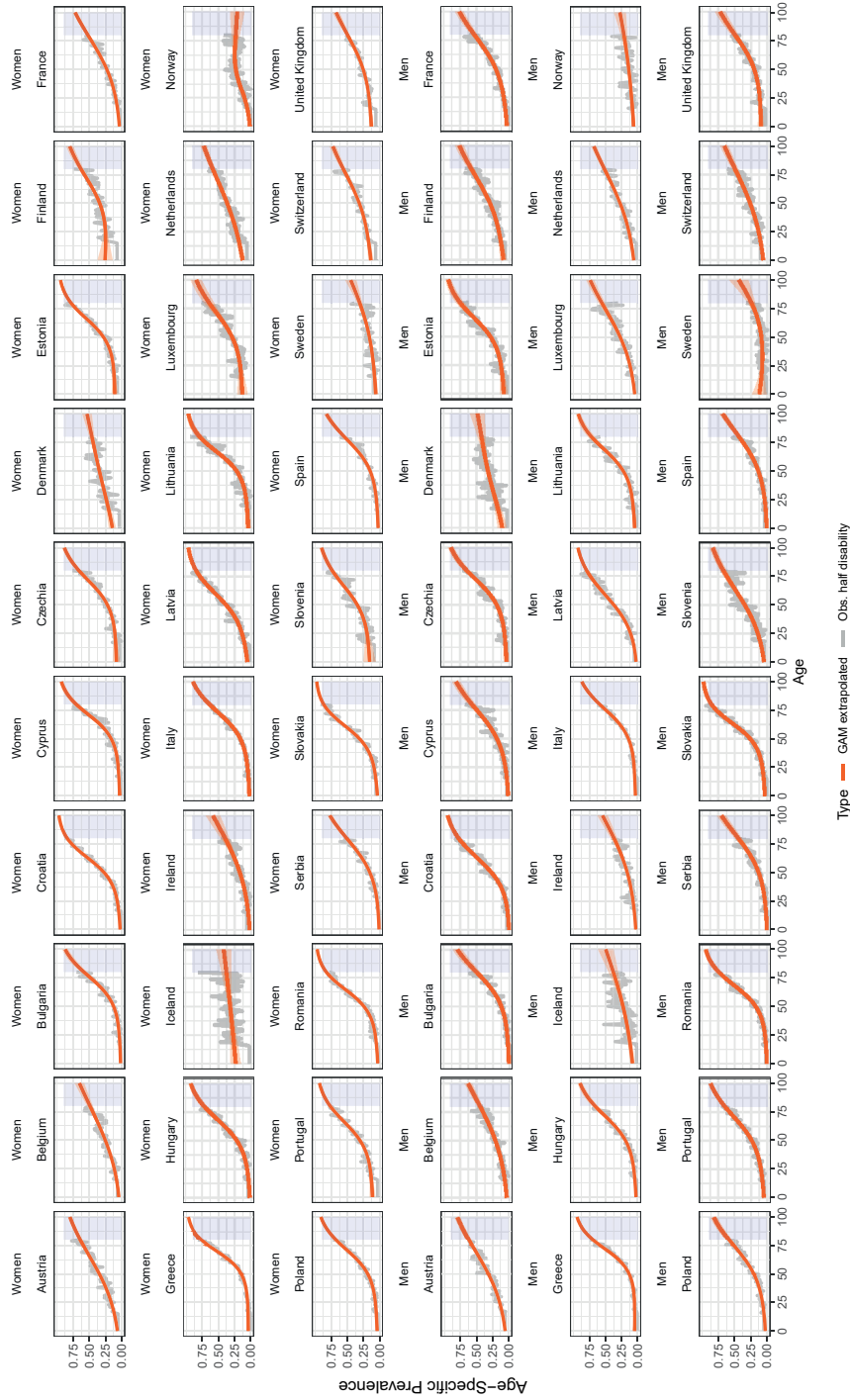


Fig. A1: Continuation



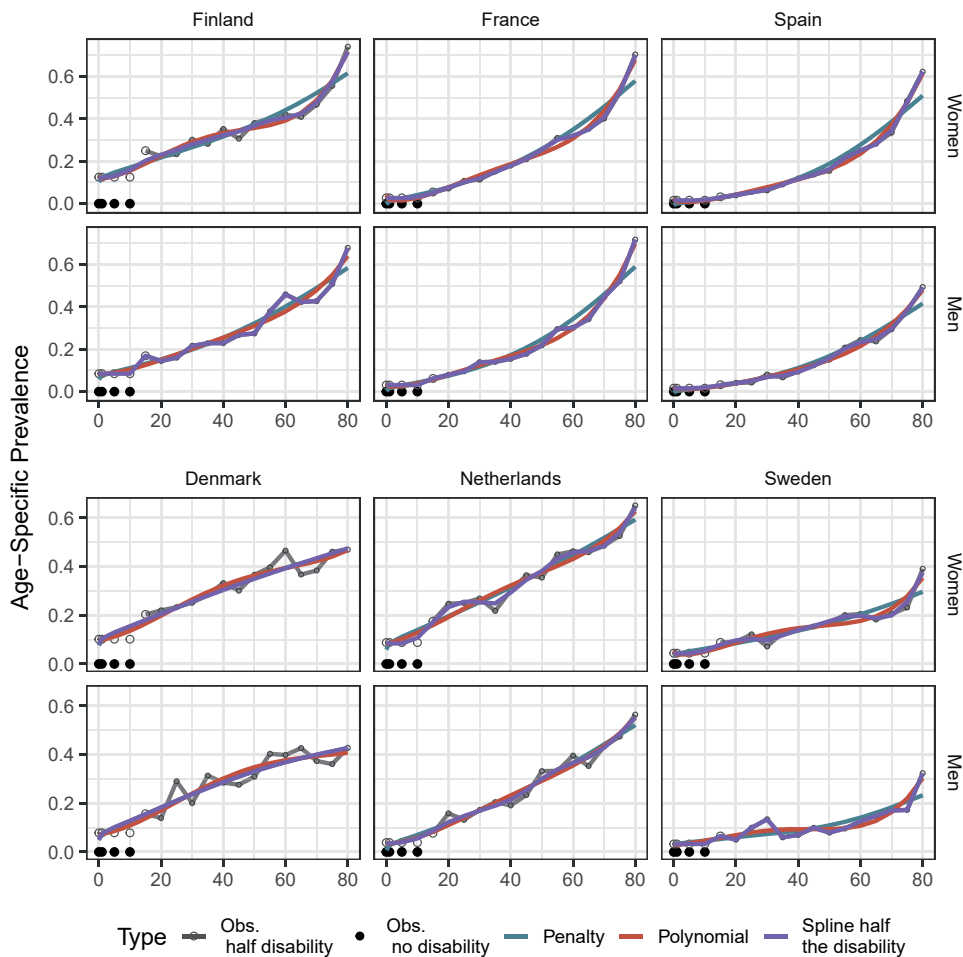
Source: Own calculations using EU-SILC prevalence data based on the GALI instrument

Fig. A2: Prevalence by sex smoothed by different methods and extrapolated to age 100+ by GAM, year 2017, European countries



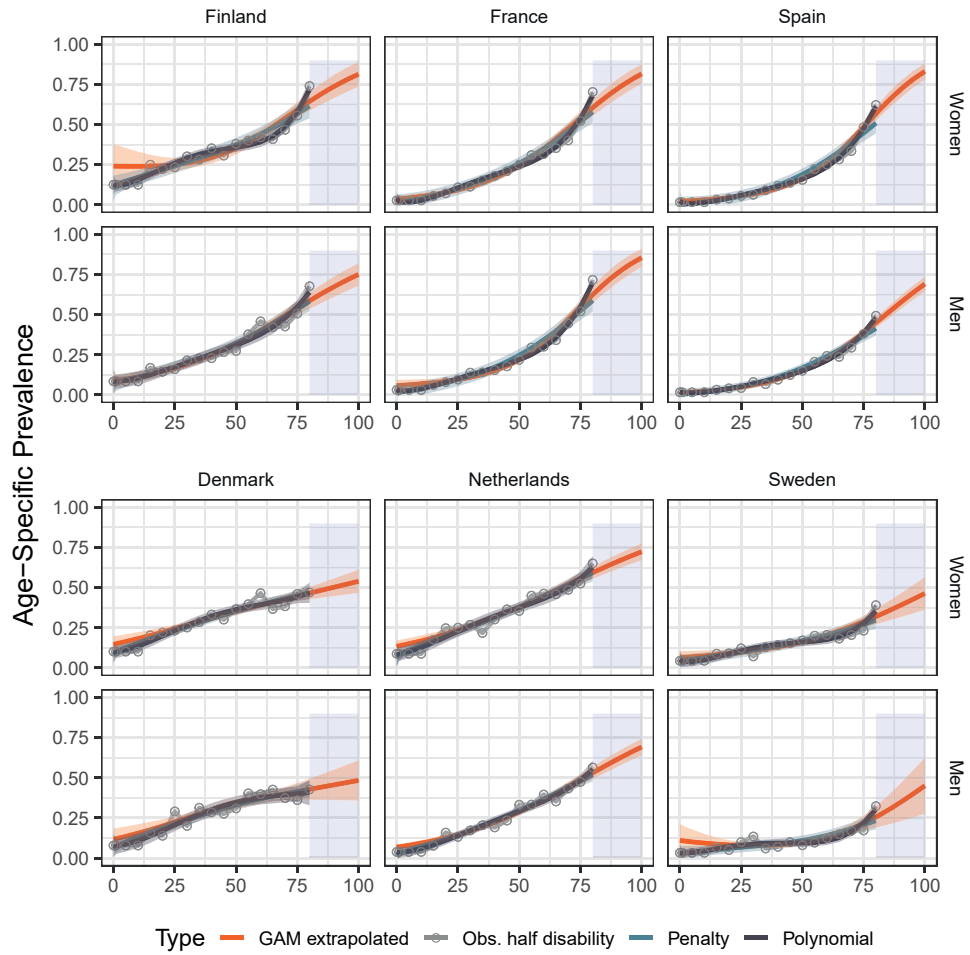
Source: Own calculations using EU-SILC prevalence data based on the GALI instrument

Fig. A3: Prevalence by sex smoothed by different methods considering 5-year age groups, year 2017, selected European countries



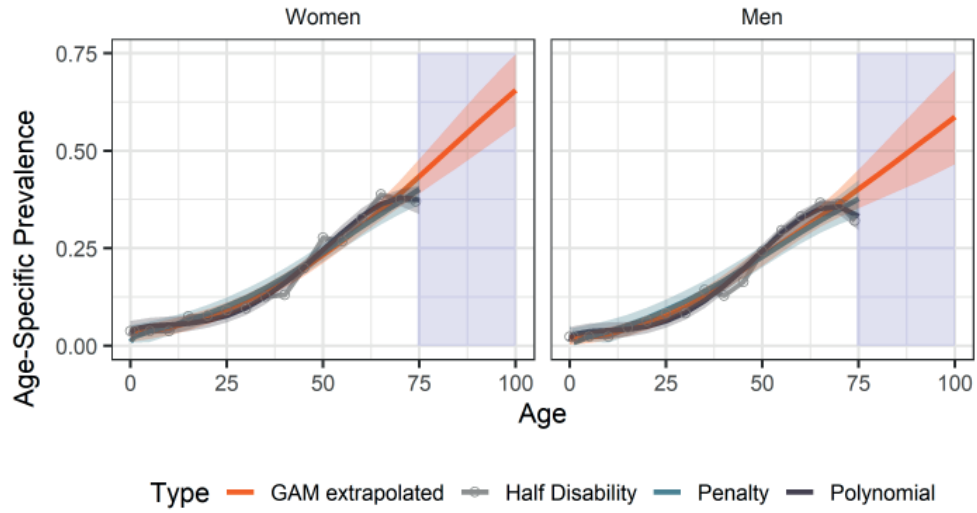
Source: Own calculations using EU-SILC prevalence data based on the GALI instrument

Fig. A4: Prevalence by sex smoothed by different methods and extrapolated to age 100+, considering 5-year age groups, by GAM, year 2017, selected European countries



Source: Own calculations using EU-SILC prevalence data based on the GALI instrument

Fig. A5: Prevalence by sex smoothed by different methods and extrapolated to age 100+, considering 5-year age groups, by GAM, year 2017, Germany



Source: Own calculations using EU-SILC prevalence data based on the GALI instrument

Tab. A1: Healthy Life Years (HLY) at birth and %HLY of total life expectancy, by sex and different smoothing methods, selected EU countries, 2017

Country	No disability		Half the disability		Splines penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
Women										
Austria	59.3	70.6	58.4	69.5	58.2	69.3	58.2	69.3	57.4	68.4
Belgium	65.9	78.5	64.8	77.2	64.2	76.5	64.3	76.6	64.1	76.4
Bulgaria	66.4	84.7	66.1	84.3	66.4	84.7	66.4	84.7	66.1	84.4
Croatia	58.5	72.2	58.4	72.1	58.6	72.3	58.6	72.3	57.8	71.3
Cyprus	66.1	78.5	66.0	78.4	65.9	78.3	65.8	78.1	65.1	77.4
Czechia	63.1	76.9	62.5	76.3	63.1	76.9	63.0	76.9	61.3	74.8
Denmark	60.4	72.7	59.8	72.0	59.9	72.0	59.9	72.0	57.4	69.1
Estonia	58.7	71.1	57.6	69.7	57.4	69.5	57.3	69.4	56.4	68.3
Finland	57.8	68.4	56.6	67.0	57.5	68.0	57.4	68.0	53.4	63.2
France	66.7	77.8	66.2	77.3	66.3	77.4	66.3	77.4	65.6	76.5
Germany**	68.1	81.6	67.5	80.9	67.1	80.4	67.1	80.4	66.2	79.4
Greece	65.4	78.0	65.4	77.9	65.8	78.4	65.6	78.2	64.3	76.6
Hungary	61.8	78.0	61.1	77.1	61.2	77.2	61.2	77.2	61.1	77.1
Iceland	60.2	71.4	59.8	70.9	62.4	74.0	62.3	73.9	58.0	68.8
Ireland	70.6	84.0	69.5	82.7	69.8	83.0	70.0	83.3	69.7	83.0
Italy	67.9	79.7	67.5	79.2	67.4	79.1	67.4	79.1	66.3	77.9
Latvia	53.5	67.1	52.9	66.4	52.9	66.3	52.8	66.3	52.0	65.2
Lithuania	59.9	74.4	59.3	73.7	59.9	74.4	59.7	74.2	59.5	73.9
Luxembourg	60.5	71.6	57.7	68.4	58.2	68.9	58.4	69.2	58.1	68.9
Netherlands	58.0	69.6	56.9	68.3	57.4	68.8	57.4	68.9	55.2	66.2
Norway	70.0	83.0	69.8	82.8	70.6	83.8	70.7	83.9	70.9	84.1
Poland	64.3	78.6	63.8	78.0	64.1	78.3	64.1	78.3	63.1	77.1
Portugal	58.2	68.8	57.6	68.1	57.9	68.5	57.8	68.3	55.8	66.0
Romania	59.0	74.6	58.5	74.1	58.6	74.2	58.6	74.1	57.9	73.3
Serbia	66.7	85.4	66.7	85.4	66.6	85.2	66.5	85.2	66.0	84.6
Slovakia	56.2	69.7	55.2	68.4	55.6	68.8	55.6	68.9	55.2	68.4
Slovenia	56.5	67.3	55.0	65.5	54.9	65.4	55.1	65.6	53.4	63.6
Spain	70.3	81.6	69.8	81.0	70.3	81.6	70.3	81.6	68.8	79.9
Sweden	72.1	85.7	70.5	83.9	71.2	84.6	71.3	84.8	70.8	84.2
Switzerland	61.5	71.8	60.4	70.6	60.1	70.2	60.0	70.0	58.5	68.3
UK	63.8	76.8	62.8	75.5	62.8	75.6	62.8	75.6	61.3	73.8
Men										
Austria	58.9	74.1	57.9	72.9	57.9	72.9	57.9	73.0	57.4	72.3
Belgium	65.2	82.3	64.3	81.1	64.1	80.9	64.1	80.9	63.7	80.4
Bulgaria	63.3	88.6	63.3	88.6	63.3	88.6	63.3	88.6	63.0	88.2
Croatia	57.8	77.1	57.1	76.2	57.0	76.1	57.0	76.2	57.4	76.6
Cyprus	65.4	81.5	64.7	80.7	65.1	81.2	65.2	81.3	64.5	80.4

Tab. A1: Continuation

Country	No disability		Half the disability		Splines penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
Czechia	61.5	80.8	60.7	79.8	60.9	80.0	60.9	80.1	60.6	79.6
Denmark	59.7	75.4	59.1	74.6	59.3	74.8	59.3	74.9	57.1	72.1
Estonia	55.9	75.8	55.3	74.9	55.1	74.7	55.2	74.7	53.8	72.9
Finland	59.0	74.8	57.8	73.3	58.3	73.9	58.3	73.9	57.0	72.2
France	63.8	80.1	63.5	79.8	63.6	79.9	63.6	79.9	62.8	78.9
Germany**	66.1	83.9	65.7	83.5	65.3	83.0	65.3	83.0	64.8	82.4
Greece	64.8	82.2	64.7	82.1	64.8	82.2	64.7	82.1	63.5	80.5
Hungary	60.3	83.2	60.0	82.8	60.0	82.7	60.0	82.8	59.4	81.9
Iceland	65.6	80.9	65.3	80.5	65.6	80.9	65.8	81.1	63.6	78.4
Ireland	68.6	85.3	68.1	84.7	68.5	85.1	68.5	85.2	67.8	84.3
Italy	67.0	83.0	66.9	82.8	66.9	82.8	66.8	82.7	65.8	81.4
Latvia	51.6	73.9	50.6	72.5	50.6	72.5	50.7	72.6	50.8	72.8
Lithuania	57.4	81.2	57.1	80.8	56.9	80.5	56.9	80.5	56.1	79.3
Luxembourg	62.8	78.6	62.5	78.2	61.7	77.2	61.6	77.1	60.4	75.6
Netherlands	62.1	77.4	61.6	76.9	61.9	77.2	61.9	77.2	60.4	75.3
Norway	72.1	89.1	70.8	87.4	70.6	87.2	70.6	87.2	70.4	86.9
Poland	61.2	82.9	60.4	81.8	60.6	82.0	60.7	82.1	60.4	81.7
Portugal	61.0	77.8	59.9	76.4	60.2	76.8	60.2	76.7	59.5	76.0
Romania	59.6	83.3	59.2	82.7	59.2	82.7	59.2	82.7	59.2	82.7
Serbia	64.6	88.3	64.6	88.3	64.7	88.5	64.7	88.5	64.3	87.9
Slovakia	56.1	76.0	55.8	75.6	55.7	75.5	55.7	75.4	55.2	74.8
Slovenia	56.9	72.8	56.0	71.6	56.5	72.2	56.6	72.4	55.1	70.5
Spain	69.3	86.0	68.6	85.2	68.8	85.3	68.9	85.4	68.5	85.0
Sweden	73.1	90.5	72.7	89.9	73.1	90.5	73.0	90.4	70.9	87.7
Switzerland	62.9	77.0	61.0	74.8	61.3	75.2	61.4	75.3	61.7	75.6
UK	64.9	81.6	64.2	80.8	63.8	80.3	63.8	80.2	62.4	78.5

Note: Small differences between the official EU HLY indicator may occur since Eurostat uses life tables that close at age 85+, while we recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001). However, we are using age-specific prevalence and Eurostat life tables by single years of age, while the official estimates are from 5-year age groups, so differences may occur for some countries.

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Tab. A2: Healthy Life Years (HLY) at age 65 and %HLY of total life expectancy, by sex and different smoothing methods, selected EU countries, 2017

Country	No disability		Half the disability		Splines penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
Women										
Austria	8.9	41.4	8.9	41.4	8.6	40.2	8.6	40.1	8.4	39.1
Belgium	12.8	58.6	12.8	58.6	11.9	54.5	11.9	54.3	11.6	53.0
Bulgaria	9.1	51.2	9.1	51.2	9.4	52.8	9.3	52.4	9.1	51.1
Croatia	4.8	25.4	4.8	25.4	5.0	26.6	5.0	26.6	4.5	23.7
Cyprus	8.5	40.1	8.5	40.1	8.4	39.9	8.3	39.0	8.1	38.4
Czechia	8.5	42.9	8.5	42.9	9.0	45.4	8.9	45.0	8.1	40.7
Denmark	12.0	57.7	12.0	57.7	11.9	57.3	11.9	57.1	11.4	55.0
Estonia	6.4	30.6	6.4	30.6	6.1	29.1	6.0	28.9	5.8	28.0
Finland	9.5	42.8	9.5	42.8	10.3	46.8	10.2	46.3	8.8	39.8
France	12.2	51.5	12.2	51.5	12.3	51.8	12.2	51.6	11.8	49.6
Germany**	13.2	62.1	13.2	62.1	12.8	60.2	12.8	60.3	11.8	55.8
Greece	7.8	36.4	7.8	36.4	8.2	38.2	8.1	37.7	7.1	33.1
Hungary	7.0	38.0	7.0	38.0	7.1	38.5	7.1	38.4	6.7	36.5
Iceland	11.1	51.8	11.1	51.8	13.7	64.1	13.6	63.7	13.1	61.2
Ireland	14.0	65.3	14.0	65.3	14.1	66.0	14.2	66.3	13.5	63.0
Italy	10.8	48.1	10.8	48.1	10.6	47.2	10.5	47.0	9.5	42.5
Latvia	4.4	23.4	4.4	23.4	4.3	22.9	4.3	22.8	4.2	22.1
Lithuania	5.3	27.2	5.3	27.2	6.0	31.2	6.0	31.0	5.9	30.4
Luxembourg	8.7	40.3	8.7	40.3	9.1	41.9	9.1	42.2	8.7	40.3
Netherlands	9.6	45.5	9.6	45.5	10.1	47.5	10.0	47.4	9.3	43.9
Norway	15.2	70.6	15.2	70.6	16.0	74.2	16.0	74.2	16.9	78.2
Poland	8.6	42.6	8.6	42.6	8.9	44.1	8.8	43.8	7.9	39.3
Portugal	6.8	30.7	6.8	30.7	7.1	32.0	7.0	31.6	6.3	28.3
Romania	5.3	29.1	5.3	29.1	5.5	29.9	5.5	30.1	4.8	26.1
Serbia	9.9	58.5	9.9	58.5	9.8	57.4	9.7	57.2	9.4	55.5
Slovakia	4.1	21.5	4.1	21.5	4.5	23.7	4.6	24.0	3.9	20.3
Slovenia	7.4	34.2	7.4	34.2	7.2	33.0	7.2	33.1	6.6	30.5
Spain	12.5	53.3	12.5	53.3	12.9	55.3	12.9	55.1	11.3	48.5
Sweden	15.7	72.8	15.7	72.8	16.3	75.6	16.3	75.8	15.2	70.7
Switzerland	10.9	47.6	10.9	47.6	10.5	46.0	10.3	45.4	10.4	45.6
UK	11.6	54.8	11.6	54.8	11.6	54.8	11.5	54.5	11.2	53.1
Men										
Austria	8.3	44.8	8.3	44.8	8.3	44.7	8.3	44.7	8.0	43.0
Belgium	11.5	61.9	11.5	61.9	11.2	60.6	11.2	60.6	10.9	58.9
Bulgaria	8.6	60.8	8.6	60.8	8.5	60.4	8.5	60.3	8.4	59.9
Croatia	5.0	32.4	5.0	32.4	5.0	32.5	5.0	32.5	5.0	32.0
Cyprus	9.6	51.8	9.6	51.8	10.1	54.2	10.1	54.1	9.3	49.9

Tab. A2: Continuation

Country	No disability		Half the disability		Splines penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
Czechia	7.6	46.9	7.6	46.9	7.7	47.8	7.7	47.6	7.2	44.5
Denmark	11.0	60.4	11.0	60.4	11.3	62.0	11.3	62.0	10.7	58.6
Estonia	6.2	39.7	6.2	39.7	5.9	37.7	5.9	37.8	5.2	33.3
Finland	8.8	47.8	8.8	47.8	9.2	49.7	9.1	49.6	8.5	46.0
France	10.1	51.7	10.1	51.7	10.2	52.0	10.1	51.6	9.9	50.7
Germany**	11.9	65.7	11.9	65.7	11.5	63.6	11.5	63.5	10.8	59.6
Greece	8.2	44.0	8.2	44.0	8.3	44.9	8.3	44.4	7.6	40.7
Hungary	6.7	46.3	6.7	46.3	6.7	46.2	6.7	46.2	6.4	43.9
Iceland	13.5	68.0	13.5	68.0	13.7	69.2	13.8	69.5	12.2	61.8
Ireland	12.9	68.0	12.9	68.0	13.2	69.5	13.2	69.6	12.4	65.3
Italy	10.0	52.1	10.0	52.1	10.0	51.9	9.9	51.7	9.4	48.8
Latvia	4.2	30.0	4.2	30.0	4.1	28.9	4.0	28.5	4.0	28.2
Lithuania	6.3	43.5	6.3	43.5	5.9	40.9	5.9	40.7	5.6	38.9
Luxembourg	10.7	57.3	10.7	57.3	9.8	52.8	9.8	52.5	9.1	49.0
Netherlands	10.1	54.2	10.1	54.2	10.3	55.3	10.3	55.1	9.7	51.7
Norway	15.7	81.5	15.7	81.5	15.5	80.1	15.4	79.9	15.2	78.8
Poland	8.3	52.1	8.3	52.1	8.5	53.2	8.4	53.1	7.8	48.9
Portugal	8.0	43.5	8.0	43.5	8.3	45.3	8.3	45.3	7.6	41.8
Romania	6.0	40.7	6.0	40.7	6.0	40.5	6.0	40.5	5.6	38.2
Serbia	9.3	64.4	9.3	64.4	9.5	65.4	9.4	65.2	9.1	62.7
Slovakia	3.8	25.1	3.8	25.1	3.8	25.0	3.9	25.2	3.9	25.2
Slovenia	7.4	42.2	7.4	42.2	8.0	45.2	8.0	45.4	6.6	37.6
Spain	12.3	63.9	12.3	63.9	12.4	64.1	12.4	64.0	11.7	60.5
Sweden	15.1	78.9	15.1	78.9	15.6	81.4	15.6	81.2	14.9	77.8
Switzerland	10.4	52.2	10.4	52.2	10.7	53.6	10.7	53.7	10.7	53.3
UK	11.2	59.8	11.2	59.8	10.8	57.5	10.8	57.3	10.4	55.2

Note: Small differences between the official EU HLY indicator may occur since Eurostat uses life tables that close at age 85+, while we recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001). However, we are using age-specific prevalence and Eurostat life tables by single years of age, while the official estimates are from 5-year age groups, so differences may occur for some countries.

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Tab. A3: Healthy Life Years (HLY) at birth, by different smoothing and extrapolation methods, with 95% confidence intervals, selected EU countries, 2017

Country	Splines penalty			Age 0 Polynomial			GAM*		
	HLY	95%CI		HLY	95%CI		HLY	95%CI	
Women									
Austria	58.2	55.1	61.2	58.2	55.9	60.6	57.4	55.8	59.1
Belgium	64.2	61.4	67.0	64.3	61.9	66.6	64.1	62.2	66.1
Bulgaria	66.4	64.0	68.3	66.4	64.7	67.8	66.1	64.7	67.6
Croatia	58.6	56.8	59.9	58.6	57.2	59.6	57.8	56.6	58.9
Cyprus	65.9	63.2	67.9	65.8	63.7	67.2	65.1	63.2	67.1
Czechia	63.1	60.5	65.5	63.0	61.1	64.8	61.3	59.0	63.6
Denmark	59.9	55.8	63.5	59.9	56.7	62.6	57.4	54.7	60.2
Estonia	57.4	55.1	59.6	57.3	55.6	59.1	56.4	54.5	58.3
Finland	57.5	53.5	61.4	57.4	54.4	60.4	53.4	49.7	57.1
France	66.3	64.1	68.4	66.3	64.6	68.1	65.6	64.3	66.9
Germany**	67.1	65.2	68.9	67.1	65.6	68.5	66.2	64.8	67.7
Greece	65.8	64.3	66.8	65.6	64.5	66.5	64.3	63.2	65.4
Hungary	61.2	59.0	63.4	61.2	59.6	62.9	61.1	59.6	62.6
Iceland	62.4	54.9	68.1	62.3	56.8	66.6	58.0	53.8	62.2
Ireland	69.8	66.9	72.6	70.0	67.6	72.3	69.7	67.7	71.8
Italy	67.4	66.0	68.8	67.4	66.3	68.4	66.3	65.3	67.4
Latvia	52.9	50.3	55.2	52.8	50.9	54.6	52.0	50.2	53.8
Lithuania	59.9	56.3	63.1	59.7	57.0	62.2	59.5	57.0	61.9
Luxembourg	58.2	54.3	62.1	58.4	55.2	61.6	58.1	54.6	61.7
Netherlands	57.4	54.3	60.4	57.4	54.9	59.9	55.2	53.1	57.3
Norway	70.6	66.6	73.5	70.7	67.6	72.8	70.9	68.1	73.7
Poland	64.1	62.5	65.6	64.1	62.9	65.2	63.1	61.9	64.3
Portugal	57.9	55.4	60.3	57.8	55.8	59.6	55.8	54.0	57.6
Romania	58.6	56.7	60.4	58.6	56.9	59.9	57.9	56.5	59.4
Serbia	66.6	64.5	67.7	66.5	65.0	67.4	66.0	65.1	67.0
Slovakia	55.6	53.3	57.9	55.6	53.9	57.3	55.2	53.8	56.6
Slovenia	54.9	51.1	58.7	55.1	51.9	58.3	53.4	50.1	56.8
Spain	70.3	68.4	72.1	70.3	68.8	71.8	68.8	67.3	70.3
Sweden	71.2	67.6	74.7	71.3	68.6	73.9	70.8	68.5	73.1
Switzerland	60.1	57.5	62.8	60.0	57.9	62.0	58.5	56.5	60.5
UK	62.8	61.0	64.6	62.8	61.3	64.3	61.3	59.7	62.9
Men									
Austria	57.9	55.4	60.4	57.9	55.9	59.9	57.4	56.0	58.9
Belgium	64.1	61.5	66.6	64.1	62.2	66.0	63.7	62.4	65.0
Bulgaria	63.3	61.4	64.3	63.3	61.9	64.0	63.0	62.0	64.0
Croatia	57.0	55.0	59.0	57.0	55.5	58.6	57.4	56.4	58.3

Tab. A3: Continuation

Country	Splines penalty			Age 0 Polynomial			GAM*		
	HLY	95%CI		HLY	95%CI		HLY	95%CI	
Cyprus	65.1	62.1	68.0	65.2	62.9	67.4	64.5	62.9	66.2
Czechia	60.9	58.5	63.2	60.9	59.0	62.8	60.6	58.7	62.5
Denmark	59.3	55.0	63.0	59.3	56.0	62.1	57.1	53.9	60.3
Estonia	55.1	52.4	57.7	55.2	53.0	57.0	53.8	51.4	56.3
Finland	58.3	55.1	61.5	58.3	55.9	60.7	57.0	54.7	59.2
France	63.6	61.3	65.6	63.6	61.8	65.0	62.8	61.3	64.3
Germany**	65.3	63.5	67.1	65.3	63.8	66.7	64.8	63.5	66.2
Greece	64.8	63.4	65.8	64.7	63.7	65.5	63.5	62.4	64.5
Hungary	60.0	58.1	61.6	60.0	58.6	61.2	59.4	58.1	60.7
Iceland	65.6	59.9	69.9	65.8	61.3	69.2	63.6	60.4	66.8
Ireland	68.5	65.7	71.0	68.5	66.3	70.4	67.8	66.2	69.4
Italy	66.9	65.6	67.9	66.8	65.7	67.6	65.8	64.8	66.8
Latvia	50.6	48.0	53.2	50.7	48.7	52.7	50.8	49.5	52.1
Lithuania	56.9	54.3	58.9	56.9	54.9	58.4	56.1	54.2	58.0
Luxembourg	61.7	57.4	65.0	61.6	58.3	64.1	60.4	58.3	62.4
Netherlands	61.9	59.2	64.3	61.9	59.9	63.7	60.4	58.9	61.9
Norway	70.6	66.8	74.4	70.6	67.8	73.4	70.4	68.1	72.6
Poland	60.6	58.6	62.6	60.7	59.2	62.1	60.4	59.2	61.5
Portugal	60.2	58.3	62.1	60.2	58.7	61.6	59.5	58.2	60.9
Romania	59.2	57.4	60.9	59.2	57.9	60.4	59.2	58.2	60.2
Serbia	64.7	62.5	65.9	64.7	63.1	65.6	64.3	63.3	65.3
Slovakia	55.7	53.6	57.5	55.7	54.1	57.0	55.2	53.9	56.5
Slovenia	56.5	52.5	60.3	56.6	53.6	59.4	55.1	53.0	57.2
Spain	68.8	66.9	70.7	68.9	67.4	70.4	68.5	67.6	69.5
Sweden	73.1	70.5	75.5	73.0	71.0	74.8	70.9	68.0	73.7
Switzerland	61.3	58.3	64.4	61.4	59.1	63.8	61.7	59.9	63.4
UK	63.8	61.6	66.0	63.8	62.1	65.4	62.4	60.6	64.3

Note: We recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001).

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Tab. A4: Healthy Life Years (HLY) at age 65, by different smoothing and extrapolation methods, with 95% confidence intervals, selected EU countries, 2017

Country	Splines penalty			Age 65 Polynomial			GAM*		
	HLY	95%CI		HLY	95%CI		HLY	95%CI	
	Women								
Austria	8.6	7.7	9.6	8.6	7.8	9.5	8.4	7.8	9.0
Belgium	11.9	11.0	12.8	11.9	11.0	12.7	11.6	10.7	12.5
Bulgaria	9.4	8.8	10.0	9.3	8.8	9.8	9.1	8.4	9.8
Croatia	5.0	4.5	5.5	5.0	4.6	5.5	4.5	4.2	4.8
Cyprus	8.4	7.6	9.3	8.3	7.6	9.0	8.1	7.3	9.0
Czechia	9.0	8.2	9.7	8.9	8.3	9.5	8.1	7.5	8.7
Denmark	11.9	10.7	13.2	11.9	10.8	13.0	11.4	10.7	12.2
Estonia	6.1	5.4	6.8	6.0	5.4	6.6	5.8	5.3	6.3
Finland	10.3	9.1	11.6	10.2	9.1	11.3	8.8	8.0	9.6
France	12.3	11.5	13.0	12.2	11.5	12.9	11.8	11.1	12.4
Germany**	12.8	12.1	13.4	12.8	12.2	13.4	11.8	11.2	12.5
Greece	8.2	7.7	8.6	8.1	7.7	8.5	7.1	6.7	7.5
Hungary	7.1	6.5	7.7	7.1	6.5	7.6	6.7	6.1	7.3
Iceland	13.7	11.4	16.0	13.6	11.7	15.6	13.1	11.8	14.4
Ireland	14.1	13.2	15.0	14.2	13.4	15.0	13.5	12.4	14.6
Italy	10.6	10.1	11.0	10.5	10.1	10.9	9.5	9.1	10.0
Latvia	4.3	3.6	5.1	4.3	3.7	4.9	4.2	3.8	4.6
Lithuania	6.0	5.0	7.1	6.0	5.1	6.9	5.9	5.1	6.7
Luxembourg	9.1	7.9	10.3	9.1	8.0	10.3	8.7	7.4	10.1
Netherlands	10.1	9.1	11.0	10.0	9.2	10.9	9.3	8.7	9.9
Norway	16.0	14.8	17.3	16.0	14.9	17.1	16.9	15.7	18.1
Poland	8.9	8.4	9.4	8.8	8.4	9.3	7.9	7.5	8.4
Portugal	7.1	6.3	7.9	7.0	6.3	7.7	6.3	5.8	6.7
Romania	5.5	4.9	6.0	5.5	5.0	6.0	4.8	4.3	5.2
Serbia	9.8	9.2	10.3	9.7	9.3	10.2	9.4	9.0	9.9
Slovakia	4.5	3.9	5.2	4.6	4.0	5.1	3.9	3.5	4.3
Slovenia	7.2	6.0	8.4	7.2	6.0	8.3	6.6	5.9	7.3
Spain	12.9	12.3	13.6	12.9	12.3	13.4	11.3	10.7	12.0
Sweden	16.3	15.2	17.3	16.3	15.4	17.2	15.2	14.4	16.0
Switzerland	10.5	9.6	11.4	10.3	9.6	11.1	10.4	9.7	11.1
UK	11.6	11.0	12.1	11.5	11.0	12.0	11.2	10.6	11.8
	Men								
Austria	8.3	7.6	9.0	8.3	7.6	8.9	8.0	7.4	8.5
Belgium	11.2	10.5	11.9	11.2	10.6	11.8	10.9	10.3	11.5
Bulgaria	8.5	8.1	9.0	8.5	8.1	8.9	8.4	7.9	8.9
Croatia	5.0	4.5	5.5	5.0	4.6	5.5	5.0	4.6	5.3

Tab. A4: Continuation

Country	Splines penalty		Age 65				GAM*		
	HLY	95%CI	HLY	95%CI	HLY	95%CI	HLY	95%CI	
	Men								
Cyprus	10.1	9.3	10.9	10.1	9.4	10.8	9.3	8.5	10.0
Czechia	7.7	7.1	8.3	7.7	7.1	8.3	7.2	6.7	7.8
Denmark	11.3	10.1	12.5	11.3	10.2	12.3	10.7	9.8	11.5
Estonia	5.9	5.2	6.6	5.9	5.3	6.5	5.2	4.5	5.9
Finland	9.2	8.2	10.1	9.1	8.3	9.9	8.5	7.8	9.1
France	10.2	9.5	10.9	10.1	9.5	10.7	9.9	9.3	10.6
Germany**	11.5	10.9	12.1	11.5	11.0	12.0	10.8	10.2	11.4
Greece	8.3	7.9	8.8	8.3	7.9	8.6	7.6	7.2	7.9
Hungary	6.7	6.3	7.1	6.7	6.3	7.1	6.4	5.8	6.9
Iceland	13.7	12.0	15.4	13.8	12.3	15.2	12.2	11.0	13.5
Ireland	13.2	12.4	14.0	13.2	12.5	13.9	12.4	11.6	13.2
Italy	10.0	9.6	10.3	9.9	9.6	10.3	9.4	8.9	9.8
Latvia	4.1	3.5	4.7	4.0	3.5	4.6	4.0	3.5	4.4
Lithuania	5.9	5.3	6.5	5.9	5.3	6.4	5.6	4.9	6.3
Luxembourg	9.8	8.6	11.0	9.8	8.7	10.8	9.1	8.2	10.0
Netherlands	10.3	9.6	11.1	10.3	9.7	11.0	9.7	9.1	10.2
Norway	15.5	14.4	16.5	15.4	14.5	16.3	15.2	14.3	16.1
Poland	8.5	7.9	9.0	8.4	8.0	8.9	7.8	7.3	8.3
Portugal	8.3	7.8	8.8	8.3	7.8	8.7	7.6	7.2	8.1
Romania	6.0	5.5	6.4	6.0	5.6	6.3	5.6	5.2	6.1
Serbia	9.5	9.0	10.0	9.4	9.0	9.9	9.1	8.6	9.6
Slovakia	3.8	3.3	4.3	3.9	3.4	4.3	3.9	3.5	4.3
Slovenia	8.0	6.9	9.0	8.0	7.1	8.9	6.6	5.9	7.3
Spain	12.4	11.8	12.9	12.4	11.9	12.9	11.7	11.2	12.2
Sweden	15.6	14.9	16.4	15.6	14.9	16.2	14.9	14.1	15.8
Switzerland	10.7	9.8	11.6	10.7	9.9	11.5	10.7	9.9	11.4
UK	10.8	10.2	11.5	10.8	10.2	11.3	10.4	9.7	11.1

Note: We recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001).

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Tab. A5: Healthy Life Years (HLY) at age 0 and %HLY of total life expectancy, by sex for different assumptions, smoothing and extrapolation methods estimated from 5-year age groups, selected EU countries, 2017

Country	Assumptions and smoothing methods, HLY at Age 0, 5-year age group									
	No disability		Half the disability		Splines penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
	Women									
Denmark	60.1	72.4	58.5	70.6	58.5	70.5	58.5	70.5	57.5	69.2
Spain	70.2	82.2	70.0	81.9	70.3	82.3	70.0	82.0	69.0	80.8
Finland	57.4	68.2	55.5	66.0	55.8	66.4	55.6	66.1	53.7	63.8
France	65.4	76.7	65.0	76.2	65.4	76.7	65.2	76.4	64.5	75.6
Netherlands	57.7	69.2	56.4	67.6	56.4	67.7	56.4	67.7	55.3	66.3
Sweden	72.0	85.5	71.3	84.7	71.5	85.0	71.5	84.9	70.8	84.2
Germany**	68.0	81.6	67.5	81.0	67.1	80.6	67.4	80.9	66.3	79.6
	Men									
Denmark	59.5	75.2	58.3	73.8	58.3	73.7	58.4	73.8	57.1	72.2
Spain	69.2	86.2	69.0	85.9	69.0	85.9	69.0	86.0	68.6	85.5
Finland	58.7	74.6	57.4	73.0	57.4	73.0	57.5	73.1	57.2	72.7
France	63.0	79.4	62.5	78.8	62.6	78.9	62.6	78.9	61.9	78.0
Netherlands	61.8	77.2	61.2	76.5	61.1	76.4	61.2	76.5	60.4	75.5
Sweden	72.8	90.3	72.4	89.7	72.4	89.8	72.4	89.8	71.1	88.1
Germany**	65.9	83.9	65.6	83.5	65.2	83.0	65.5	83.3	64.8	82.5

Note: We recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001).

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Tab. A6: Healthy Life Years (HLY) at age 65, and %HLY of total life expectancy, by sex for different assumptions, smoothing and extrapolation methods estimated from 5-year age groups, selected EU countries, 2017

Country	Assumptions and Smoothing methods, HLY at Age 65, 5-year age group									
	No disability		Half the disability		Splines Penalty		Polynomial		GAM*	
	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY	HLY	%HLY
	Women									
Denmark	12.0	57.9	12.0	57.9	11.6	56.1	11.7	56.6	11.5	55.4
Spain	12.5	55.1	12.5	55.1	13.2	58.3	12.4	54.7	11.6	51.2
Finland	9.4	43.5	9.4	43.5	9.8	45.3	9.3	43.1	8.9	41.1
France	11.0	47.1	11.0	47.1	11.7	50.2	10.9	46.9	10.5	45.3
Netherlands	9.6	45.4	9.6	45.4	9.7	45.6	9.5	45.0	9.4	44.5
Sweden	15.6	72.7	15.6	72.7	15.8	73.5	15.6	72.4	15.3	71.0
Germany**	13.2	62.8	13.2	62.8	13.1	62.3	13.3	63.0	12.0	56.7
	Men									
Denmark	10.9	60.2	10.9	60.2	10.8	59.7	11.0	60.6	10.9	60.0
Spain	12.3	64.9	12.3	64.9	12.5	66.0	12.2	64.2	10.7	56.2
Finland	8.9	48.8	8.9	48.8	8.9	49.0	8.7	47.8	8.6	47.3
France	9.3	48.2	9.3	48.2	9.8	50.7	9.3	48.0	9.0	46.7
Netherlands	10.1	54.6	10.1	54.6	10.0	54.2	9.9	53.6	9.7	52.4
Sweden	15.1	79.2	15.1	79.2	15.4	80.7	15.2	79.6	11.8	61.8
Germany**	11.9	66.2	11.9	66.2	11.6	64.9	11.9	66.2	15.0	83.8

Note: We recalculate the Eurostat life tables to close at either 80+ or 74+ by summing the person-years lived at each age and then computing the life table following the conventional procedure of *Preston et al.* (2001).

* For the HLY estimates performed by smoothing and extrapolating the age-specific prevalence using GAM, we extrapolated the Eurostat life tables to age 100+ using the Makeham Law of Mortality.

** For Germany, exceptionally, the closeout age was 74+ in all variants except GAM, when both the age-specific prevalence and the life tables are extrapolated to age 100+.

Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Technical Note: Criteria of smoothing methods and model

The GAM was fit using restricted maximum likelihood (REML) to choose the smoothing parameter that best fit the data (*Rigby et al.* 2005; *Wood* 2017). The typical maximum likelihood criterion is defined as (*Rigby et al.* 2005; *Wood* 2017):

$$ML(\lambda) = -\frac{1}{2} \{n + \log(|\Sigma_\lambda|) + n \log(\mathbf{r}^T \Sigma_\lambda^{-1} \mathbf{r}) + n \log(2\pi/n)\}$$

with the covariance matrix that depends on λ being: $\Sigma_\lambda = \frac{1}{n\lambda} \mathbf{ZQ}^{-1}\mathbf{Z}^T + \mathbf{I}$.

With an independent sample of n observations, the log-likelihood function is then (Rigby *et al.* 2005; Wood 2017):

$$L(\lambda, \sigma^2) = -\frac{1}{2} \{ \sigma^{-2} \mathbf{r}^T \Sigma_\lambda^{-1} \mathbf{r} + \log(|\Sigma_\lambda|) + n \log(\sigma^2) + n \log(2\pi) \}$$

where $\mathbf{r} = \mathbf{y} - \mathbf{X}\beta$

with the maximum likelihood estimate being $\sigma_{\lambda(ML)}^2 = \frac{1}{n} \mathbf{r}^T \Sigma_\lambda^{-1} \mathbf{r}$. In most cases,

σ^2 is not known. The restricted maximum likelihood (REML) then has the following form (Rigby *et al.* 2005; Wood 2017):

$$R(\lambda, \sigma^2) = L(\lambda, \sigma^2) - \frac{1}{2} \{ \log(|\mathbf{X}^T \Sigma_\lambda^{-1} \mathbf{X}|) + m \log(2\pi\sigma^2) \}$$

with the REML estimate of σ^2 thus being $\sigma_{\lambda(REML)}^2 = \frac{1}{n-m} \mathbf{r}^T \Sigma_\lambda^{-1} \mathbf{r}$, which yields the

restricted maximum likelihood criterion (Rigby *et al.* 2005; Wood 2017):

$$\text{REML}(\lambda) = -\frac{1}{2} \{ \tilde{n} + \log(|\Sigma_\lambda|) + \tilde{n} \log(\mathbf{r}^T \Sigma_\lambda^{-1} \mathbf{r}) + \tilde{n} \log\left(\frac{2\pi}{\tilde{n}}\right) + \log|\mathbf{X}^T \Sigma_\lambda^{-1} \mathbf{X}| \}$$

In order to compare the different smoothing methods, we used the root mean square error (RMSE). The RMSE is defined as the square root of the mean of the square of all of the error and it measures how far predicted values are from observed values or how concentrated the data is around the best fit (Christie/Neill 2022). Smaller values of RMSE indicate that the estimated curve is closer to the true curve and used as an indicator of best fit. The use of RMSE is advised as a general-purpose method to assess error metrics and has been used in different approaches that compare smoothing methods (Malloy *et al.* 2009; Ben Ghoul *et al.* 2019).

Let O_i be the observations, S_i the predicted values from each smoothing method and n the number of observations. The RMSE is thus defined as (Christie/Neill 2022):

$$\text{RMSE} = \sqrt{\frac{1}{n} \sum_{i=1}^n (S_i - O_i)^2}$$

which resembles the measure of Euclidean distance (Ballantine/Jerbert 1952; Smith 2013). We employed the score across all ages, by country and for women and men, as presented in Table A7, with the prevalence half the disability, as the official EU assumption. Overall, the scores are relatively similar within countries and different methods with the exception of Iceland, particularly for women, where the root mean

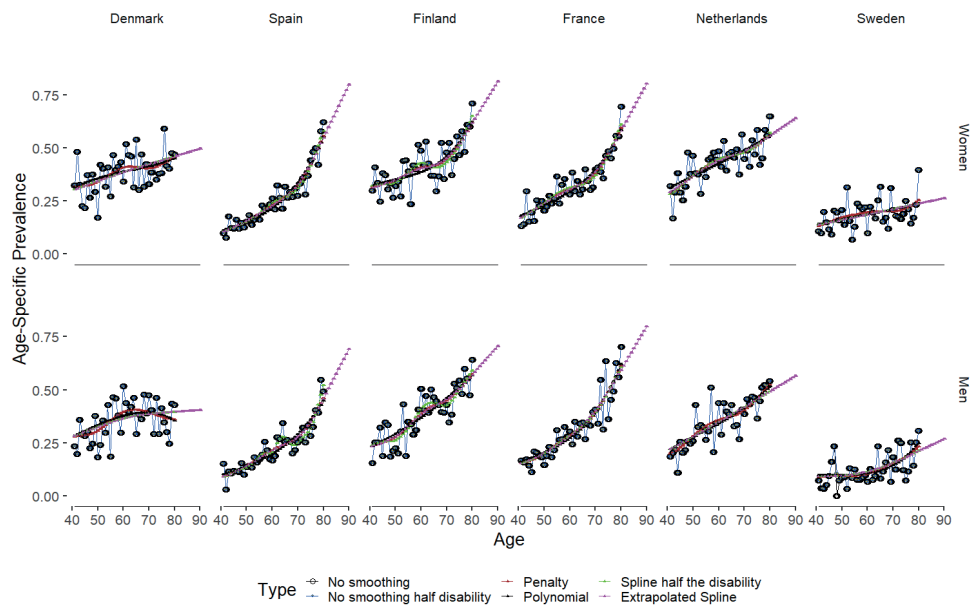
square error is not only higher when compared to other countries, but the different methods also yield different scores, suggesting that the age-specific prevalence is more sensitive to smoothing approaches, with an overall poorer fit for all methods. In addition, the error is also larger for countries that already graphically showed a larger distance in the main text, like Denmark and Finland. This may indicate that countries that have a smaller sample size and/or with a more linear age pattern are possibly more affected by smoothing. Nonetheless, further research is needed to address this issue.

Tab. A7: Root Mean Square Error (RMSE) scores for different smoothing methods, selected EU countries, by sex, 2017

Country	Root Mean Square Error (RMSE)							
	Women				Men			
	Splines	Penalty	Polynomial	GAM	Splines	Penalty	Polynomial	GAM
Austria	0.050	0.050	0.053	0.055	0.045	0.045	0.049	0.049
Belgium	0.037	0.046	0.052	0.054	0.046	0.046	0.046	0.046
Bulgaria	0.043	0.042	0.043	0.043	0.038	0.038	0.039	0.040
Switzerland	0.038	0.041	0.045	0.060	0.054	0.053	0.056	0.057
Cyprus	0.045	0.044	0.046	0.052	0.053	0.053	0.055	0.058
Czechia	0.043	0.043	0.044	0.054	0.041	0.045	0.051	0.052
Denmark	0.068	0.069	0.073	0.092	0.079	0.077	0.081	0.092
Estonia	0.037	0.038	0.040	0.046	0.054	0.054	0.060	0.067
Greece	0.025	0.024	0.026	0.033	0.026	0.025	0.026	0.034
Spain	0.028	0.029	0.031	0.038	0.029	0.032	0.036	0.039
Finland	0.048	0.064	0.067	0.107	0.056	0.057	0.060	0.063
France	0.036	0.036	0.038	0.041	0.042	0.041	0.042	0.047
Croatia	0.031	0.031	0.033	0.036	0.036	0.039	0.042	0.045
Hungary	0.041	0.039	0.041	0.042	0.036	0.038	0.040	0.041
Ireland	0.044	0.047	0.053	0.055	0.048	0.048	0.052	0.053
Iceland	0.119	0.118	0.124	0.156	0.106	0.099	0.105	0.111
Italy	0.019	0.023	0.024	0.025	0.022	0.022	0.025	0.028
Lithuania	0.064	0.062	0.065	0.065	0.043	0.054	0.057	0.059
Luxembourg	0.051	0.064	0.071	0.072	0.064	0.073	0.079	0.082
Latvia	0.046	0.044	0.046	0.049	0.056	0.055	0.058	0.059
Netherlands	0.049	0.051	0.057	0.069	0.046	0.046	0.050	0.055
Norway	0.066	0.065	0.069	0.071	0.067	0.065	0.066	0.066
Poland	0.027	0.026	0.028	0.030	0.039	0.038	0.041	0.043
Portugal	0.042	0.041	0.045	0.057	0.035	0.034	0.035	0.036
Romania	0.034	0.035	0.041	0.042	0.037	0.036	0.038	0.039
Serbia	0.038	0.037	0.038	0.039	0.030	0.042	0.044	0.045
Sweden	0.051	0.057	0.059	0.063	0.047	0.045	0.047	0.061
Slovenia	0.059	0.062	0.072	0.079	0.073	0.071	0.075	0.080
Slovakia	0.040	0.040	0.041	0.042	0.042	0.041	0.044	0.044
UK	0.027	0.030	0.035	0.047	0.032	0.039	0.042	0.049
Germany	0.026	0.028	0.030	0.032	0.031	0.031	0.033	0.036

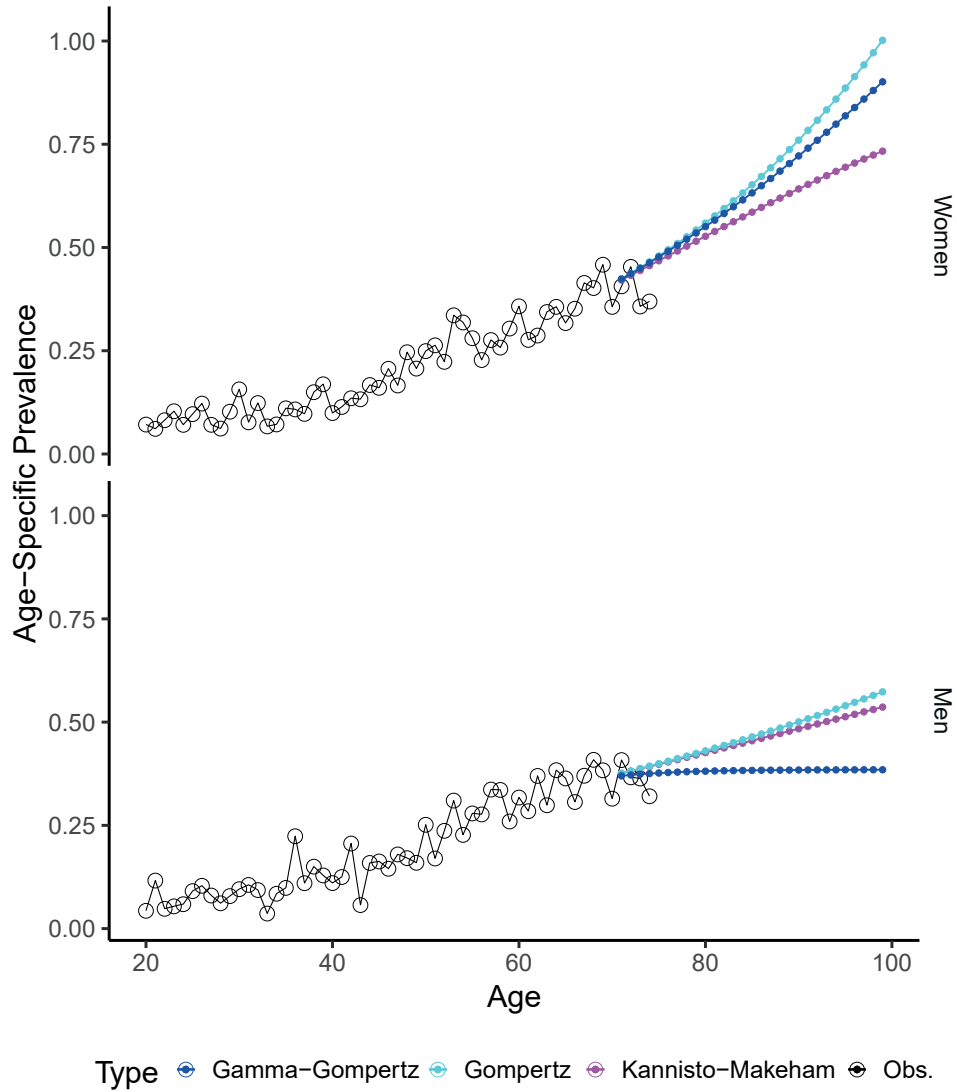
Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Eurostat

Fig. A6: Predicted values from splines to extrapolate after age 80, selected countries



Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Human Mortality Database (HMD)

Fig. A7: Using mortality laws to extrapolate age-specific prevalence after age 74+, Germany, 2017



Source: Own calculations using EU-SILC prevalence data based on the GALI instrument; Human Mortality Database (HMD)

The role of mortality data

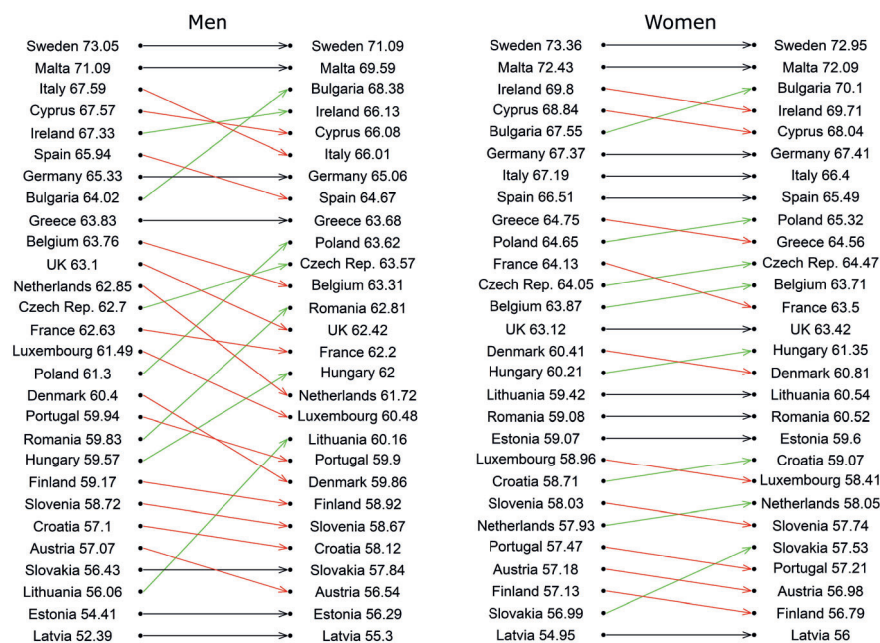
As described in the introduction and method sections, HLY combines health and mortality information and has been developed for monitoring population health in terms of the expected number of life years spent in good health. The mortality information represented by the age-specific survival trajectory from the period life table serves as the basis for the HLY indicator. This makes sense because surviving to a certain age is the essential precondition for spending a life year in good health. Intuitively, one would expect that countries with comparatively high mortality levels show lower numbers of HLY due to the aforementioned reason. Yet, the country ranking of HLY suggests no clear relationship between the country's mortality level and its performance in HLY. For instance, Bulgaria ranks surprisingly high in terms of HLY (rank 5 among EU-28 countries for women in 2016), even though its LE level is the lowest in the EU-28 in 2016 with 78.5 years.

As briefly mentioned in the results section, we investigated this further by calculating HLY with constant mortality information. More specifically, we estimated HLY for all EU-28 countries in 2016 with country-specific prevalence data and the EU-28 average mortality information. For this purpose, we did not use our own estimates of the GALI prevalence based on EU-SILC. Instead, we relied on the age-specific GALI prevalence and mortality rates provided by the European Health and Life Expectancy Information System (EHLEIS) available on www.eurohex.eu. We made this choice as our aim was to make comparisons across countries using standardised mortality and they provide the aggregate average information for the subset of EU-28 countries. The health prevalence refers to 5-year age intervals with 85+ being the last open-age interval. The mortality rates are obtained in single-age groups with 85+ again being the last open-age interval. Accordingly, HLY is estimated in accordance with the official calculation method and the presented HLY results correspond to the officially published HLY values on www.eurostat.eu.

Figure A8 shows HLY values for all EU-28 countries on the left-hand side of the graph. The right column presents country-specific HLY estimates with "standardised" mortality information, i.e., all 28 HLY values are calculated based on the exact same period life table (the EU-28 period life table). Consequently, differences in these "standardised" HLY estimates stem solely from differences in country-specific prevalence data. The values depicted in the graph are sorted by country ranking in decreasing order. For instance, Sweden shows the highest value of HLY in the EU-28, while HLY in Latvia is the lowest (for both women and men).

After controlling for differences in the country's mortality level, the ranking does not change substantially for women. In most cases, the country ranking in the left column either corresponds to the one in the right column or changes only by one place up or down. This indicates that the HLY indicator reflects mostly differences in GALI prevalence among women, while the mortality levels play a minor role. Among men, the country ranking is more affected by the mortality information. For countries like Bulgaria, Poland, Hungary, Romania and Lithuania where male mortality is below the average of the EU-28 countries, changing the mortality alone would improve their ranks considerably, with changes of up to 8 ranks. This effect is

Fig. A8: HLY ranks on the basis of official estimates (left column) and “standardised” HLY estimates with constant mortality information (right column) in 2016



Source: Age-specific GALI prevalence and mortality rates provided by www.eurohex.eu

less prominent for women at all countries. Changing mortality never affects rankings for more than 3 points. Interestingly, when changing mortality for men in countries with low levels to the average of the EU-28, the decline in ranking is never higher than 5, as in the case of the Netherlands. We performed the opposite exercise just as a robustness check and replaced the mortality information for Swedish women with the one from Bulgaria (the country with highest mortality levels in EU-28 in 2016). As we showed before, women in Sweden have comparatively low GALI prevalence and a very compressed health profile relative to their survival. Replacing their mortality with the highest observed in EU-28 countries would change their ranking only by 3 points, from 1 to 4 (not shown, available upon request).

Despite this difference in rankings, solely dramatically changing their mortality to higher levels does not yield such a strong effect as changing the mortality to lower levels for men for the aforementioned countries, where in Lithuania the change is of 8 ranks up. This demonstrates that large differences in GALI prevalence can only partly be explained by higher mortality and, at the same time, that the interaction of health and mortality between women and men is very different.

Comparative Population Studies

www.comparativepopulationstudies.de

ISSN: 1869-8980 (Print) – 1869-8999 (Internet)

Published by

Federal Institute for Population Research
(BiB)
65180 Wiesbaden / Germany

Managing Publisher

Dr. Nikola Sander



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