

Original Article

Tendency for age-specific mortality with hypertension in the European Union from 1980 to 2011

Lichan Tao^{1*}, Cunying Pu^{1*}, Shutong Shen^{1*}, Hongyi Fang¹, Xiuzhi Wang¹, Qinkao Xuan¹, Junjie Xiao^{1,2,3}, Xinli Li¹

¹Department of Cardiology, First Affiliated Hospital of Nanjing Medical University, Nanjing 210029, China;

²Regeneration Lab and Experimental Center of Life Sciences, School of Life Science, Shanghai University, Shanghai 200444, China; ³Shanghai Key Laboratory of Bio-Energy Crops, School of Life Sciences, Shanghai University, Shanghai 200444, China. *Equal contributors.

Received November 2, 2014; Accepted January 8, 2015; Epub February 15, 2015; Published February 28, 2015

Abstract: Tendency for mortality in hypertension has not been well-characterized in European Union (EU). Mortality data from 1980 to 2011 in EU were used to calculate age-standardized mortality rate (ASMR, per 100,000), annual percentage change (APC) and average annual percentage change (AAPC). The Joinpoint Regression Program was used to compare the changes in tendency. Mortality rates in the most recent year studied vary between different countries, with the highest rates observed in Slovakia men and Estonia women. A downward trend in ASMR was demonstrated over all age groups. Robust decreases in ASMR were observed for both men (1991-1994, APC = -13.54) and women (1996-1999, APC = -14.80) aged 55-65 years. The tendency of systolic blood pressure (SBP) from 1980 to 2009 was consistent with ASMR, and the largest decrease was observed among Belgium men and France women. In conclusion, SBP associated ASMR decreased significantly on an annual basis from 1980 to 2009 while a slight increase was observed after 2009. Discrepancies in ASMR from one country to another in EU are significant during last three decades. With a better understanding of the tendency of the prevalence of hypertension and its mortality, efforts will be made to improve awareness and help strict control of hypertension.

Keywords: Hypertension, mortality, tendency

Introduction

Hypertension, or elevated blood pressure, is among the most serious risk factors for cardiovascular disease (CVD). In 2008, approximately 40% of adults aged over 25 had been diagnosed with hypertension worldwide [1], and the number of people with hypertension rose from 600 million in 1980 to 1 billion in 2008 [2]. The estimated global mortality associated with hypertension has been increased since 2000 [3]. Complications of hypertension also account for 9.4 million deaths per year [4]. Hypertension is responsible for nearly 45% of deaths due to ischemic heart disease and 51% of deaths due to stroke [5]. The health consequences of hypertension can also be compounded by other risk factors such as hyperglycemia and hypercholesterolemia, which increase the odds of mortality [6]. Hypertension has been defined as a major public health problem by World Health Organization [7].

However, the prevalence and associated mortality of hypertension vary between different regions. The prevalence of hypertension is highest in the African region at 46% of adults aged 25 and above, while the lowest prevalence at 35% is in the Americans [8]. Generally, high-income countries have a lower prevalence of hypertension compared to low-income countries [9]. Among developed countries, European countries have been reported to have a much higher prevalence of hypertension comparing to Canada and the United States [10]. These maybe caused by less medical treatment and management in developing countries [11], and unhealthy lifestyle including increased salt and fat intake and lack of exercise [12].

The prevalence of CVD has been well-studied as a major cause of morbidity and mortality in the world [13]. However, hypertension, one of the most important risk factors of CVD, is less well-characterized, especially in the European

Tendency for age-specific mortality with hypertension in Europe

Table 1. Overview of available years of population and death numbers by country and sex for 2011(or the most recent years)

European Union	Males 2011 ^a				
	Data years	Total population	Total deaths	Hypertensive disease	Deaths (% total)
Austria	1980-2011	4105493	36539	1172	3.2075%
Belgium	1980-1999, 2003-2009	5290436	51356	261	0.5082%
Bulgaria	1980-2011	3577946	56634	3216	5.6786%
Czech Republic	1986-2011	5153009	54141	899	1.6605%
Denmark	1980-2011	2690179	25718	362	1.4076%
Estonia	1981-1982, 1985-2011	617809	7456	662	8.8788%
Finland	1980-2011	2645475	25152	364	1.4472%
France	1980-2009	30334982	273461	3113	1.1384%
Germany	1980-2011	40152977	407628	9975	2.4477%
Greece	1980-2010	5598793	56480	1446	2.5602%
Hungary	1980-2011	4737813	63883	2463	3.8555%
Ireland	1980-2010	2217664	15044	121	0.8043%
Italy	1980-2003, 2006-2010	29350339	285068	9796	3.4364%
Latvia	1980-2010	1033421	14584	308	2.1119%
Lithuania	1981-1982, 1985-2010	1527510	21536	244	1.1330%
Luxembourg	1980-2011	252018	1810	14	0.2210%
Malta	1980-2011	206909	1664	6	0.3606%
Netherlands	1980-2011	8263177	65259	448	0.6865%
Poland	1980-1996, 1999-2011	18650105	198178	2309	1.1651%
Portugal	1980-2003, 2007-2011	5042781	52786	643	1.2181%
Romania	1980-2011	10434143	137957	11173	8.0989%
Slovakia	1992-2010	2639896	27645	3183	11.5138%
Slovenia	1985-2010	1014716	9292	861	1.8618%
Spain	1980-2011	22697679	198121	3193	1.6116%
Sweden	1980-2010	4669629	43919	642	1.4618%
UK	1980-1999, 2001-2010	30643254	270945	2150	0.7935%
European Union	Females 2011 ^a				
	Data years	Total population	Total deaths	Hypertensive disease	Deaths (% total)
Austria	1980-2011	4105493	36539	2543	6.9596%
Belgium	1980-1999, 2003-2009	5290436	51356	617	1.1761%
Bulgaria	1980-2011	3577946	56634	3873	6.8386%
Czech Republic	1986-2011	5153009	54141	1203	2.2824%
Denmark	1980-2011	2690179	25718	523	1.9746%
Estonia	1981-1982, 1985-2011	617809	7456	1281	17.1808%
Finland	1980-2011	2645475	25152	673	2.7190%
France	1980-2009	30334982	273461	5839	2.2140%
Germany	1980-2011	40152977	407628	23587	5.7864%
Greece	1980-2010	5598793	56480	1684	3.2013%
Hungary	1980-2011	4737813	63883	4505	6.9402%
Ireland	1980-2010	2217664	15044	197	1.4220%
Italy	1980-2003, 2006-2010	29350339	285068	18866	6.6180%
Latvia	1980-2010	1033421	14584	507	0.2776%
Lithuania	1981-1982, 1985-2010	1527510	21536	330	1.6032%
Luxembourg	1980-2011	252018	1810	22	0.7178%
Malta	1980-2011	206909	1664	15	0.9357%
Netherlands	1980-2011	8263177	65259	704	1.0787%
Poland	1980-1996, 1999-2011	18650105	198178	3159	1.7815%
Portugal	1980-2003, 2007-2011	5042781	52786	1216	2.4120%
Romania	1980-2011	10434143	137957	16098	13.2204%

Tendency for age-specific mortality with hypertension in Europe

Slovakia	1992-2010	2639896	27645	784	1.5194%
Slovenia	1985-2010	1014716	9292	392	3.8317%
Spain	1980-2011	22697679	198121	6476	3.5210%
Sweden	1980-2010	4669629	43919	1163	2.4957%
UK	1980-1999, 2001-2010	30643254	270945	3051	1.0495%

^aData are for year 2011, or most recent years available.

Union (EU). A comprehensive and detailed investigation of mortality rate in the EU could provide insight into primary and secondary prevention of hypertension.

In the present study, we compared tendency in age-specific mortality and systolic blood pressure (SBP) in different EU countries from 1980 to 2011. This study may provide insights into the management of hypertension and eventually help reduce hypertension-related end-organ damage.

Methods

Data were extracted on country- and sex-specific death rate and population size from World Health Organization (WHO) global mortality database from 1980 to 2011 (or the most recent available year). All available European countries were included to analyze the age- and sex-specific mortality rate of hypertension [6]. We excluded records with invalid dates, missing age, or missing sex from the analysis, such as Cyprus [14]. Death and population data for Germany prior to 1990 were obtained by combining the former Federal Republic of Germany and the former Democratic Republic of Germany [6]. After this, data were analyzed from 26 European countries.

In our study, hypertension was defined as a blood pressure of $\geq 140/90$ mmHg among the population defined as having hypertension. Mean SBP, which in this study was presented as age-standardized SBP trends by sex and country - was analyzed using 25-year crude total percent change. This method resulted in more representative and stable rates and minimized the effect of year-to-year fluctuation in systolic blood pressure trends. The average change in the five most recent years was compared to the average change in the five years prior.

Age groups were defined as (i) < 45 years, (ii) 45-54 years, (iii) 55-64 years, (iv) 65 years and

over. All participants under 45 years of age were combined due to low mortality.

Age-standardized mortality rate (ASMR) was standardized according to the European standard population by the direct method. Annual percentage change (APC) and average annual percentage change (AAPC) for hypertensive disease during different periods were computed by Joinpoint Regression Program version 4.0. Joinpoint regression was performed to identify periods with distinct log-linear trends in death rates. We calculated all analyses separately according to sex due to different trends in the key variables. The two-sided significance level was set at p less than 0.05 for all tests [15].

Results

Hypertension-related mortality

Table 1 shows an overview of available years of population and death data by country and sex for 2011 (or the most recent year). Data were extracted from 1980 to 2011, for a period of up to 32 years. Eleven of the 26 countries had complete data for all 32 study years, and an additional four had 31 years, and three had 30 years, and seven had 25 to 29 years of data available. The least amount of data was from Slovakia, whose data were only available from 1992 onwards. The number of deaths was lower in men compared to women in 25 of 26 countries in 2011, except for Slovakia (784 in men and 392 in women). The mortality rate resulting from hypertension was from 0.5% to 11.5% in male (Belgium to Slovakia) and from 0.28% to 17.2% in female (Latvia to Estonia).

Tendency in age- and sex-specific mortality rate

ASMR for hypertension increased steadily from the youngest to the oldest age groups as shown in **Figures 1** and **2**. This trend was generally similar in males and females. In all age groups, four joinpoints were identified. The proportion

Tendency for age-specific mortality with hypertension in Europe

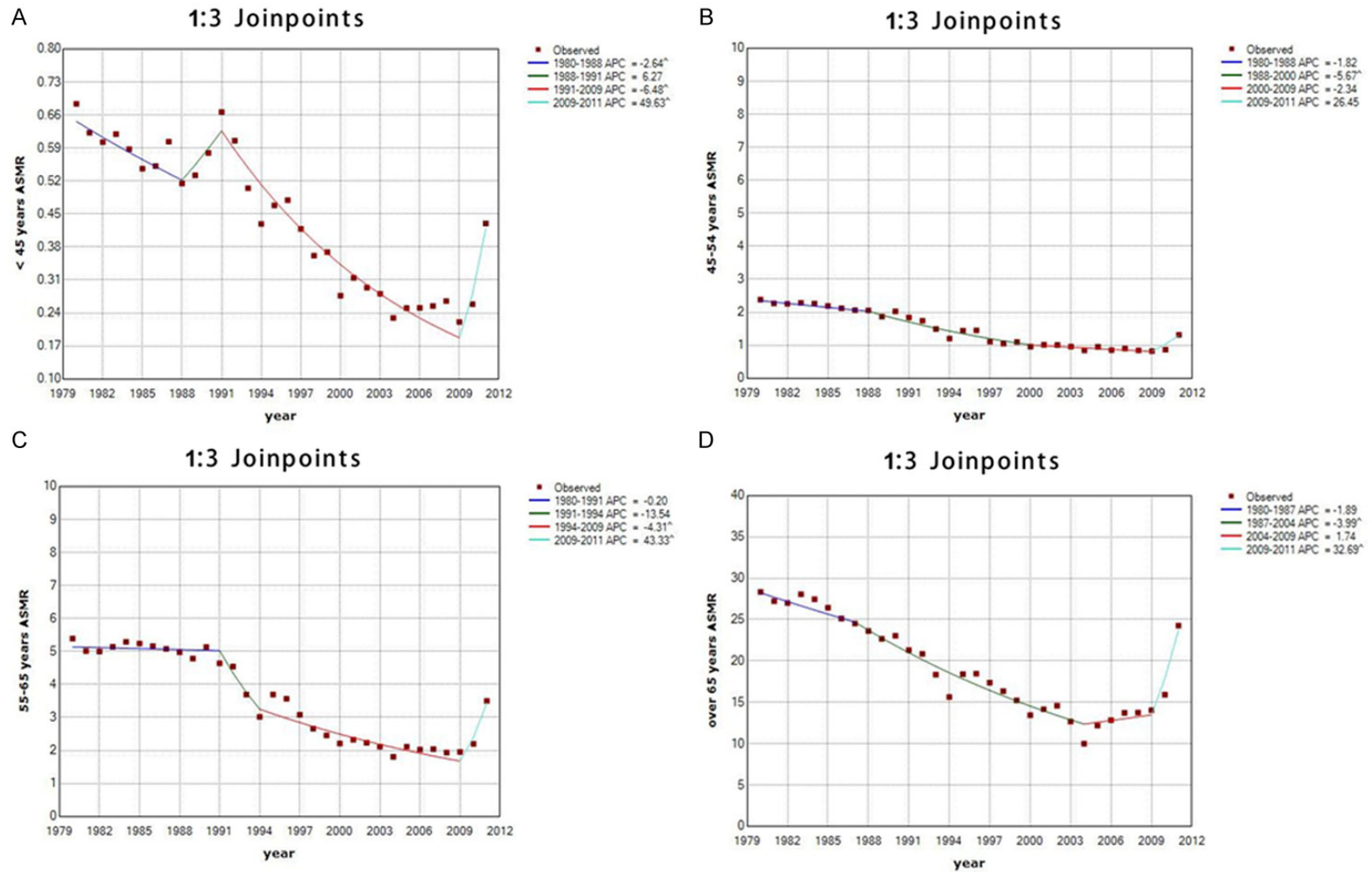


Figure 1. Age-specific mortality rates (per 100,000) for hypertension by age group in male in the EU, 1980-2011. A. < 45 years; B. 45-54 years; C. 55-64 years; D. 65 years and over.

Tendency for age-specific mortality with hypertension in Europe

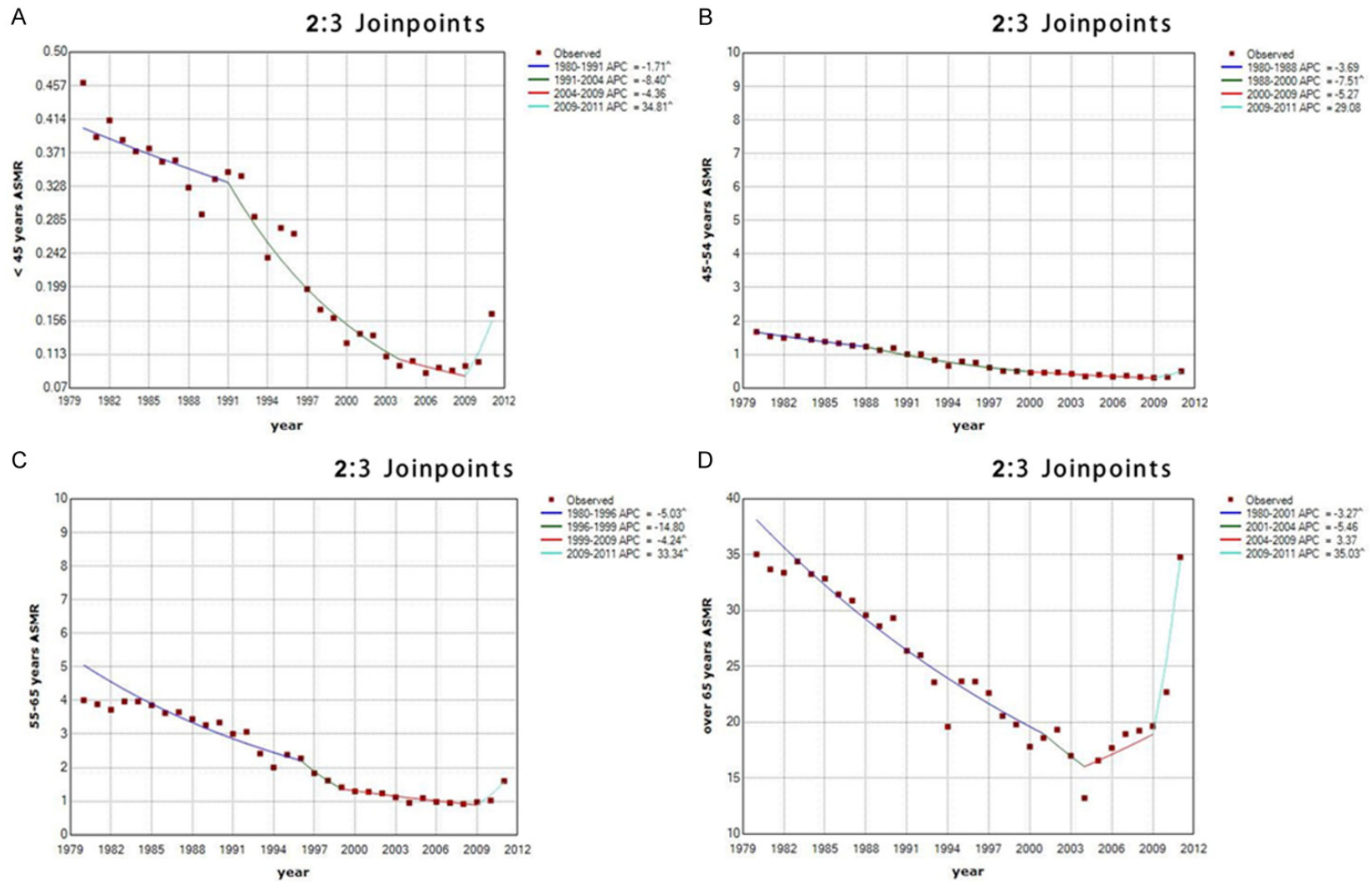


Figure 2. Age-specific mortality rates (per 100,000) for hypertension by age group in female in the EU, 1980-2011. A. < 45 years; B. 45-54 years; C. 55-64 years; D. 65 years and over.

Tendency for age-specific mortality with hypertension in Europe

increased with age, from 0.2 in 100000 people in their 20 s and 30 s to 14 in 100000 people in their 60 s and over (men) and 0.1 in 100000 people to 20 in 100000 people (women). Overall, almost all the age groups showed a statistically significant annual decrease in hypertensive disease. The most robust decreases in ASMR observed for both men (1991-1994, APC = -13.54) and women (1996-1999, APC = -14.80) were in the 55-65 year age group, while the weakest decreases were observed in the 55-65 year age group in men (1980-1991, APC = -0.20) and in the < 45 year age group in women (1980-1991 APC = -1.71). All four age groups demonstrated a slight tendency toward increasing ASMR from 2009 to the most recent years, which was in accordance with recent hypertension prevalence [16].

Joinpoint analysis: APC in ASMR in the EU

Table 2 shows inflection points and evidence for variable changes in ASMR from 1980 to 2011, and four joinpoints have been identified by Joinpoint analysis. The difference in the mortality rate associated with hypertensive disease between males and females was minimal for almost all countries. ASMR varied extensively between different countries, and over half the countries demonstrated continuous increases in recent years, especially Latvia, which has experienced sustained growth during the last three decades. Overall, we noted four patterns in mortality rates in the EU: 1): Up-down. Rose during the first, second or third trend and declined in the last trend, which included four countries (Belgium, Bulgaria, Denmark and Luxembourg). The notable exception to this pattern was Germany. 2): Up-down-up. The first or second trend was similar to 1, whereas in recent years, mortality rate consistently increased. This pattern was observed in ten countries. 3): Down-up-down. This pattern was reflected in six countries (Austria, Finland, Italy, Portugal, Slovenia, UK) and was notably different from pattern 2. 4): Down-up-down-up. This pattern was seen with three countries (Ireland, Poland, Slovakia).

5-year average SBP rates

Data for SBP were obtained from the Global Burden of Disease 2000 study and updated with the most recent, country-level data [3]. We analyzed mean systolic blood pressure trends

(age-standardized estimate) in each country's population over a span of 25 years (**Table 3**). Almost all countries in the EU demonstrated a significant decrease in mean SBP in the last three decades in both men and women (**Table 3**). Between 1980 and 2009, the largest decrease in 25-year crude total percent change among men was in Belgium (-8.9%), while the smallest decrease was in Romania (-1.6%). The exception to these decreases in 25-year crude total percent change was Denmark, which experienced nearly no change (0.58%). Among women, all the countries in the EU experienced a decrease, the largest being in France (-8.06%) while the smallest was in Spain (-3.1%).

Age-standardized mean SBP decreased from 1980 to 2009 in 25 countries of the EU with the exception of Hungary, which experienced almost no change during this period (**Figures S1-26**). Overall, SBP was higher in men than in women. The most significant change in SBP among men occurred in Belgium, where SBP decreased from 136.3 mmHg (95% CI: 129.1-143.3 mmHg) to 128.5 mmHg (95% CI: 121.5-135.8 mmHg). Among women, the most significant change occurred in France, from 138.8 mmHg (95% CI: 132-146 mmHg) to 119.5 (95% CI: 114.2-124.5 mmHg).

Elevated blood pressure (SBP \geq 140 or DBP \geq 90) (age-standardized)

Data regarding elevated blood pressure (SBP \geq 140 or DBP \geq 90) (age-standardized) by country over a period of 25 years ending in 2008 were extracted from the WHO database. As expected, age-standardized elevated blood pressure was substantially higher in the treated than in the untreated groups of both sexes (**Table 4**).

Discussion

This study reports recent trends in mortality rates related to hypertension and mean SBP trends between 1980 and 2011 in the EU. The results show that mortality rates decline over a period of 27 years with a slight increase in recent years. We report that the magnitude of this decline differs by age group. The biggest reduction of ASMR occurred in the age group 55-65 years among both men and women, with an AAPC -6.02 in men and -8.02 in women. This may be a result of delayed mortality or an improvement in treatment and adoption of

Tendency for age-specific mortality with hypertension in Europe

Table 2. Annual percentage change (APC) in age-standardized mortality rates in the EU of homogeneous variation identified by joinpoint analysis from 1980 to 2011. The Average Annual Percentage Change (AAPC) is significantly different from zero at $\alpha = 0.05$

Country	Trend1				Trend2				Trend3				Trend4			
	Males	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI
Austria	1980-2000	-3.4 [^]	-3.9	-2.9	2000-2003	-18.5	-38	7.2	2003-2006	23	-2.4	55.2	2006-2011	6.8 [^]	3	10.8
Belgium	1980-1982	-4	-33.9	39.5	1982-1985	28	-11.1	84.2	1985-1992	-12.8 [^]	-17.3	-7.9	1992-2009	-2.6 [^]	-4	-1.2
Bulgaria	1980-1993	5.0 [^]	3	7	1993-1996	14.9	-11.1	48.4	1996-2003	1.4	-2.1	5	2003-2011	-4.0 [^]	-6.2	-1.7
Czech Republic	1986-1993	4.6	-2.3	12	1993-1996	-36.1	-70.1	36.7	1996-1999	41.8	-20.8	154.1	1999-2011	5.2 [^]	2.9	7.6
Denmark	1985-1993	2.1	-0.7	4.9	1993-1996	-6	-25.8	19.2	1996-1999	18.7	-5	48.3	1999-2006	1.8	-0.6	4.3
Estonia	1981-1992	0.4	-8.3	10	1992-1995	61.4	-31.4	279.7	1995-1998	-22.2	-63.9	67.5	1998-2011	17.5 [^]	14.8	20.3
Finland	1980-1984	-5.5	-22	14.3	1984-1990	13.5 [^]	0.3	28.5	1990-2001	-9.5 [^]	-12.8	-6	2001-2011	12.5 [^]	9.2	15.8
France	1980-1995	0	-0.5	0.5	1995-1998	10	-1.2	22.5	1998-2001	-22.4 [^]	-31.1	-12.6	2001-2009	0.6	-0.8	2
Germany	1980-1989	-4.0 [^]	-5.8	-2.2	1989-1994	-15.3 [^]	-21.2	-8.9	1994-2000	-1.3	-7.9	5.6	2000-2011	4.2 [^]	2.7	5.7
Greece	1980-1984	0	-11.1	12.4	1984-1987	-32.1	-60.4	16.3	1987-1990	24.5	-25.5	108.1	1990-2010	1.4 [^]	0.4	2.3
Hungary	1980-1985	6.2 [^]	0.1	12.5	1985-1994	0.6	-2	3.3	1994-1997	-27.0 [^]	-46.6	-0.2	1997-2011	4.3 [^]	2.9	5.7
Ireland	1980-1994	-4.4 [^]	-5.6	-3.3	1994-1999	5.9	-2.8	15.3	1999-2006	1.4	-2.5	5.5	2006-2009	-36.0 [^]	-46.6	-23.3
Italy	1980-1989	-2.5 [^]	-3.1	-1.8	1989-2001	3.1 [^]	2.7	3.6	2001-2006	-12.8 [^]	-17.7	-7.6	2006-2010	5.3 [^]	3.5	7.3
Latvia	1980-1991	9.8 [^]	4.8	15.2	1991-1999	-6.7	-13.6	0.7	1999-2007	40.1 [^]	34.2	46.3	2007-2010	2.3	-5	10.1
Lithuania	1981-1990	-22	-43.5	7.7	1990-1993	524.3	-39.8	6375.9	1993-2001	-5.6	-11.2	0.3	2001-2010	8.4 [^]	4.6	12.3
Luxembourg	1980-1983	15.8	-15.8	59.4	1983-1991	-9.1 [^]	-17.3	0	1991-1994	18.6	-43.6	149.3	1994-2010	-8.1 [^]	-10.7	-5.4
Malta	1980-1985	-2.8	-11.9	7.3	1985-1988	-41.7	-81.2	81.4	1988-2000	-11.2 [^]	-18.5	-3.3	2000-2011	3.6	-4.9	13
Netherlands	1980-1985	2.1	-3.3	7.8	1985-1994	-1.1	-3.4	1.4	1994-1997	-20.3	-38.4	3	1997-2011	1.6 [^]	0.4	2.8
Poland	1980-1996	-1.0 [^]	-1.9	0	1996-2001	-16.3	-39.5	15.8	2001-2006	9.8	0	20.5	2006-2011	-0.9	-6.2	4.7
Portugal	1980-1993	-4.6 [^]	-5.9	-3.3	1993-2000	5.3 [^]	1.3	9.5	2000-2003	-17.7	-34.4	3.1	2003-2011	6.1 [^]	1.6	10.8
Romania	1980-1988	3.2	-0.6	7.1	1988-1997	-4.8 [^]	-8.1	-1.4	1997-2000	-14.3	-41.2	25	2000-2010	5.9 [^]	3.3	8.6
Slovakia	1980-1996	-23.3	-43.9	5	1996-2000	36.4	-15.1	119.3	2000-2005	-1.2	-20.2	22.4	2005-2010	-30.4 [^]	-44.7	-12.3
Slovenia	1980-1996	-6.1 [^]	-9.4	-2.7	1996-1999	-17.6	-59.2	66.6	1999-2006	6.6	-3.5	17.8	2006-2010	-6.8	-19.8	8.3
Spain	1980-1992	2.6 [^]	1.4	3.7	1992-1997	9.4 [^]	4.9	14.1	1997-2000	-23.3 [^]	-32.9	-12.4	2997-2010	5.2 [^]	4.1	6.2
Sweden	1980-1989	14.2 [^]	9.1	19.4	1989-1995	7	-0.8	15.4	1995-1998	-27	-49.8	6.1	1998-2010	7.6 [^]	5.4	9.8
UK	1980-1990	-6.2 [^]	-6.8	-5.5	1990-1999	-0.9	-2	0.1	1999-2003	-15.6 [^]	-26	-3.7	2003-2011	4.8 [^]	3.2	6.4

Country	Trend1				Trend2				Trend3				Trend4			
	Females	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI	Uper CI	Period	APC	Lower CI
Austria	1980-1994	-5.1 [^]	-5.8	-4.5	1994-2000	2.7	-0.9	6.4	2000-2003	-16.7	-31.2	0.9	2003-2011	11.7 [^]	10	13.5
Belgium	1980-1982	8.4	-23.2	53	1982-1985	25.9	-8.2	72.6	1985-1989	-16.8 [^]	-27.4	-4.6	1989-2009	-1.7 [^]	-2.5	-0.9
Bulgaria	1980-1993	3.6 [^]	1.5	5.8	1993-1996	14	-13.5	50.3	1996-2003	1.4	-2.3	-4.6	2003-2011	-2.9 [^]	-5.2	-0.6
Czech Republic	1986-1992	7.4	-0.9	16.3	1992-1995	-30.7	-58.6	15.8	1995-2007	12.2 [^]	8.5	-4.6	2007-2011	-1	-9.6	8.3
Denmark	1985-1996	0.3	-2	2.6	1996-1999	12.4	-17.8	53.7	1999-2004	6.3	-2	-4.6	2004-2006	-6	-26	19.5
Estonia	1981-1992	0.8	-8.7	11.2	1992-1995	84.6	-31.5	397.5	1995-1998	-29.9	-64.1	-4.6	1998-2011	21.1 [^]	18.8	23.5
Finland	1980-1994	4.4 [^]	2.5	6.4	1994-1997	-23.4	-48.5	14	1997-2005	1.1	-4.4	-4.6	2005-2011	13.3 [^]	7.6	19.4
France	1980-1995	0.4	-0.1	0.8	1995-1998	10.3 [^]	0.7	20.8	1998-2001	-21.8 [^]	-29.2	-4.6	2001-2009	0.7	-0.4	1.9

Tendency for age-specific mortality with hypertension in Europe

Germany	1980-1989	-3.5 [^]	-5.4	-1.7	1989-1994	-14.1 [^]	-20.2	-7.6	1994-2000	-0.7	-7.7	-4.6	2000-2011	4.8 [^]	3	6.6
Greece	1980-1984	0.6	-10.9	13.5	1984-1987	-34.6	-63.4	16.9	1987-1990	29.8	-24.3	-4.6	1990-2010	0.4	-0.5	1.4
Hungary	1980-1986	5.1 [^]	0.2	10.1	1986-1994	-0.7	-4.1	2.7	1994-1997	-26.8	-47.4	-4.6	1997-2011	3.9 [^]	2.4	5.3
Ireland	1980-1982	-15.1	-35	11	1982-1993	-3.3 [^]	-5.6	-0.9	1993-2006	3.2 [^]	1.5	-4.6	2006-2009	-28.9 [^]	-40.6	-14.9
Italy	1980-1989	-1.3 [^]	-2.3	-0.3	1989-2001	3.3 [^]	2.7	3.9	2001-2006	-12.4 [^]	-19.2	-4.6	2006-2010	6.1 [^]	3.5	8.8
Latvia	1980-1990	11.8 [^]	4.8	19.4	1990-1999	0.3	-5.7	6.8	1999-2007	40.6 [^]	36.3	-4.6	2007-2010	0.4	-4.8	5.9
Lithuania	1981-1993	56.4 [^]	30.5	87.5	1993-1996	18.2	-10.4	55.8	1996-2000	-18.0 [^]	-29.1	-4.6	2000-2010	9.3 [^]	7.1	11.4
Luxembourg	1980-1983	22.7	-7.7	63.1	1983-1989	-11.3	-21.7	0.4	1989-1997	5.9	-2.2	-4.6	1997-2010	-12.4 [^]	-15.8	-8.7
Malta	1980-1984	0.9	-10.2	13.4	1984-1987	-39.6	-66.1	7.5	1987-2000	-11.3 [^]	-16	-4.6	2000-2011	6.0 [^]	0.5	11.8
Netherlands	1980-1988	2.2 [^]	0.2	4.3	1988-1994	-0.4	-3.9	3.3	1994-1997	-23.9 [^]	-37.2	-4.6	1997-2011	2.5 [^]	1.6	3.4
Poland	1980-1996	-2.2 [^]	-3.1	-1.4	1996-2001	-16.3	-38.1	13.3	2001-2006	7.7	-1.3	-4.6	2006-2011	-0.5	-5.7	5.1
Portugal	1980-1992	-2.9 [^]	-3.9	-1.8	1992-2000	4.3 [^]	2.2	6.4	2000-2003	-16.2 [^]	-27.7	-4.6	2003-2011	6.2 [^]	3.4	9.1
Romania	1980-1988	3.2	-0.1	6.7	1988-1997	-4.7 [^]	-7.5	-1.8	1997-2000	-15.5	-38.8	-4.6	2000-2010	5.5 [^]	3.3	7.8
Slovakia	1980-1996	-22.6	-45.1	9.3	1996-2000	31	-21.2	117.8	2000-2005	-0.2	-20.8	-4.6	2005-2010	-28.5 [^]	-43.5	-9.6
Slovenia	1980-1990	-10.4 [^]	-16.3	-4.1	1990-1995	2.6	-6.9	13	1995-1998	-22	-44.4	-4.6	1998-2010	3.4 [^]	1.5	5.3
Spain	1980-1989	3.5 [^]	1.6	5.5	1989-1997	9.4 [^]	7.5	11.4	1997-2000	-21.0 [^]	-29.7	-4.6	2000-2010	4.3 [^]	3.3	5.2
Sweden	1980-1990	12.4 [^]	8.9	16	1990-1995	6.9	-1.6	16.1	1995-1998	-22.3	-41.5	-4.6	1998-2010	8.7 [^]	7	10.4
UK	1980-1994	-5.0 [^]	-5.4	-4.5	1994-1998	4.1	-1.5	10.2	1998-2002	-15.2 [^]	-20.6	-4.6	2002-2010	4.1 [^]	2.7	5.6

[^]P less than 0.05.

Tendency for age-specific mortality with hypertension in Europe

Table 3. Mean systolic blood trends (age-standardized estimate) by country in over 25-year population during 1980 to 2009

European Union	1980-1984	Mean systolic blood trends (age-standardized estimate)			
		Males	Mean systolic blood trends (age-standardized estimate)		
		1990-1994	2000-2004	2005-2009	25-year crude total % change
Austria	137.5	134.6	132.4	131.5	-4.4
Belgium	135.3	133.2	130.6	123.4	-8.9
Bulgaria	135.4	135.4	133.6	133.7	-1.28
Czech Republic	136.7	135.7	133.5	129.2	-5.46
Denmark	135.4	132.6	128.8	136.2	0.58
Estonia	140.5	138.6	129.8	129.4	-5.7
Finland	141.8	137.5	134.8	135.1	-4.7
France	137.8	134.4	130.8	129.8	-5.8
Germany	139.3	135.3	140.3	139.7	0.3
Greece	132.7	129.9	128.9	128.7	-3.0
Hungary	138.4	138.2	135.9	135.4	-2.1
Ireland	138.5	136.0	135.8	135.1	-2.5
Italy	136.2	135.1	131.8	131.1	-3.7
Latvia	138.6	136.8	135.4	136.2	-1.7
Lithuania	139.8	137.8	135.8	136.8	-2.2
Luxembourg	138.4	135.3	132.4	131.2	-5.2
Malta	135.7	133.3	132.5	132.1	-2.7
Netherlands	137.6	133.6	131.9	131.3	-4.6
Poland	136.8	135.3	133.8	134.5	-1.7
Portugal	137.5	135.5	135.1	134.7	-2.1
Romania	135.2	134.9	132.8	133.0	-1.6
Slovakia	137.4	137.1	135.1	135.0	-1.7
Slovenia	138.5	137.7	136.0	135.8	-2.0
Spain	135.3	131.1	130.2	130.3	-3.7
Sweden	137.4	133.9	132.7	131.9	-4.0
UK	136.1	136.7	133.9	131.6	-3.3

European Union	1980-1984	Mean systolic blood trends (age-standardized estimate)			
		Females	Mean systolic blood trends (age-standardized estimate)		
		1990-1994	2000-2004	2005-2009	25-year crude total % change
Austria	132.9	129.7	125.9	124.4	-6.4
Belgium	130.5	128.4	124.9	122.2	-6.4
Bulgaria	135.0	132.2	129.2	128.4	-4.9
Czech Republic	135.4	131.4	127.1	125.8	-7.07
Denmark	129.0	125.8	122.0	120.0	-7.06
Estonia	137.2	132.7	129.8	129.4	-5.7
Finland	137.4	133.3	128.8	127.0	-7.6
France	131.1	127.4	122.9	120.5	-8.06
Germany	134.5	132.1	128.0	125.4	-6.8
Greece	130.9	127.6	124.5	123.2	-5.9
Hungary	134.8	132.1	129.7	128.7	-4.6
Ireland	129.9	128.4	126.2	124.9	-3.9
Italy	134.4	129.9	126.7	124.1	-7.6
Latvia	136.4	132.8	130.1	129.6	-5.0
Lithuania	137.4	133.9	125.0	130.6	-4.93
Luxembourg	132.7	129.2	125	122.8	-7.5
Malta	134.4	130.8	126.7	124.7	-7.2

Tendency for age-specific mortality with hypertension in Europe

Netherlands	131.0	127.5	123.8	122.1	-6.8
Poland	136.7	132.2	130.0	129.7	-5.1
Portugal	134.6	127.6	129.2	127.6	-5.2
Romania	133.9	131.8	129.5	129.0	-3.7
Slovakia	135.3	132.9	130.2	129.5	-4.3
Slovenia	136.0	133.2	130.5	129.7	-4.6
Spain	132.1	127.4	124.3	128.0	-3.1
Sweden	132.0	128.8	125.1	123.2	-6.7
UK	130.9	131.7	127.8	124.6	-4.8

Table 4. Age-standardized mean and 95% confidence interval of SBP in adult population over 25 years of age, based on data from World Health Organization in 26 countries of EU, 1980-2009

Country	Overall (males)	On medication (males)
Austria	28.7 [17.7-41.2]	33.4 [23.6-43.7]
Belgium	24.6 [15.7-35.4]	42.6 [32.9-52.9]
Bulgaria	40.0 [28.3-52.0]	39.3 [30.7-48.5]
Czech Republic	39.3 [31.4-47.3]	48.1 [39.4-56.8]
Denmark	26.5 [18.0-36.3]	47.6 [41.4-53.6]
Estonia	47.3 [35.5-59.3]	40.6 [32.4-48.8]
Finland	34.9 [25.9-44.3]	52.9 [44.3-61.7]
France	29.1 [22.0-36.4]	47.4 [39.6-55.7]
Germany	31.1 [23.1-40.0]	42.3 [35.6-49.2]
Greece	25.1 [16.3-35.4]	44.8 [37.3-52.8]
Hungary	42.7 [31.7-53.2]	43.8 [35.0-53.0]
Ireland	34.9 [27.1-43.3]	50 [42.0-57.6]
Italy	28.6 [22.2-35.3]	47 [39.8-54.5]
Latvia	44.5 [29.7-59.3]	42.2 [35.9-48.8]
Lithuania	45.5 [33.2-58.3]	51.2 [40.7-61.9]
Luxembourg	28.5 [16.6-42.1]	52.1 [43.5-61.2]
Malta	29.9 [19.2-42.1]	42.1 [31.6-52.7]
Netherlands	28.9 [20.1-38.9]	43.3 [34.0-53.2]
Poland	41.3 [32.4-50.3]	42.4 [34.5-50.8]
Portugal	34.5 [25.7-44.6]	49.3 [42.8-56.1]
Romania	39.0 [26.6-52.0]	46.5 [38.8-54.9]
Slovakia	42.1 [27.9-56.9]	47.1 [37.9-56.7]
Slovenia	43.3 [28.9-57.9]	50.4 [40.1-60.6]
Spain	27.7 [20.7-35.5]	41.5 [34.8-48.5]
Sweden	29.7 [21.9-38.6]	43.1 [35.9-50.9]
United Kingdom	27.7 [21.9-34.0]	42.2 [36.3-48.7]
Country	Overall (females)	On medication (males)
Austria	19.8 [11.1-30.7]	33.4 [23.6-43.7]
Belgium	16.8 [9.8-26.4]	30.4 [21.6-40.4]
Bulgaria	31.2 [19.6-42.9]	40.9 [30.7-50.6]
Czech Republic	27.7 [21.1-34.3]	37.6 [31.6-43.4]
Denmark	15.6 [9.3-23.9]	28.4 [20.6-37.2]
Estonia	33.2 [22.3-44.0]	42.2 [32.7-51.1]
Finland	22.7 [16.1-29.8]	36.3 [28.9-43.7]

healthy lifestyle. The smallest reduction of ASMR occurs in age groups 55-65 years in men and < 45 years in women.

In our analysis, the SBP trend over 25 years from 1980 to 2009 is consistent with ASMR in the EU, suggesting a correlation between mortality and SBP. Several prospective cohort studies have similarly revealed that lower SBP at baseline is associated with reduced CVD mortality and incidence [17, 18]. It has also been reported that a decline of 2 mmHg SBP is related to a 5% reduction in 16-year mortality from CVD [19]. During the past few decades, countries in the EU have conducted large-scale health surveys to decrease the prevalence and mortality of CVD [20]. According to the WHO Monitoring of Trends and Determinants in CVD (WHO MONICA) Project [21], widespread diagnosis and treatment with low-cost medications have also significantly reduced SBP across populations, and this has in turn contributed to a reduction in mortality due to hypertension [22].

Interestingly, from 2009 to the most recent years examined, there was a slight increase in ASMR across all age groups. It is possible that the increasing prevalence of cardiovascular risk factors, such as hyperlipidemia, diabetes, and obesity, may explain the upward trend observed in the most recent three years [23]. For instance, blood pressure levels could be lowered by approximately 0.06 mmHg by reducing saturated fat consumption by 1% or by increasing monounsaturated and polyunsaturated fat consumption by 0.5% [24]. However, mortality due to hypertension could not be established conclusively from the data available because of the diagnosis criteria

Tendency for age-specific mortality with hypertension in Europe

France	16.2 [11.4-21.3]	29.3 [23.0-35.4]
Germany	20.7 [14.1-27.4]	34.3 [27.0-41.5]
Greece	19.8 [12.6-28.3]	32.7 [24.9-41.1]
Hungary	31.3 [21.1-42.2]	41 [31.9-50.2]
Ireland	20.7 [15.2-26.7]	34.2 [27.7-40.7]
Italy	20.6 [15.2-26.2]	33.6 [27.4-39.8]
Latvia	32.7 [19.2-46.4]	42.2 [30.6-53.5]
Lithuania	34.3 [23.0-45.3]	43.4 [33.7-52.7]
Luxembourg	17.9 [9.0-29.2]	31.3 [20.5-42.6]
Malta	20.3 [11.0-30.6]	33.8 [23.7-43.9]
Netherlands	17.6 [11.4-25.3]	30.8 [23.4-38.9]
Poland	33.0 [25.4-41.0]	42.4 [35.8-49.0]
Portugal	24.3 [17.0-32.5]	37.4 [29.9-45.4]
Romania	32.9 [21.9-44.0]	41.7 [32.3-51.0]
Slovakia	32.5 [19.8-45.5]	42.3 [30.6-53.6]
Slovenia	32.8 [19.5-46.5]	31.7 [25.8-38.2]
Spain	18.6 [13.6-24.7]	32.5 [25.8-39.5]
Sweden	19.3 [13.6-26.3]	32.8 [27.0-39.0]
United Kingdom	19.1 [14.5-24.4]	33.4 [23.6-43.7]

and treatment time [25]. The trend toward an increase in ASMR will require more studies to draw any definitive conclusions.

The trend in mortality observed during the last three decades was variable between different countries. There may be two reasonable explanations for this observation: Firstly, as a consequence of discrepancies in economic development, population structure and health care systems, the number of people with uncontrolled or severe hypertension differs from one country to another in the EU. For example, this number rose from 600 million in 1980 to nearly 1 billion in 2008 in some of the EU countries [26]. Secondly, the initial time of diagnosis and treatment. Because high blood pressure may present free of the symptoms, it is usually asymptomatic for years, even when values are dangerously high [27]. Thus, hypertension often remains undiagnosed until symptoms of high blood pressure appear. The initial diagnosis and treatment of this condition in different countries could have a significant effect on the mortality associated with hypertension.

In conclusion, SBP associated ASMR decreased significantly on an annual basis from 1980 to 2009 while a slight increase was observed after 2009 in the EU. Discrepancies in ASMR from one country to another in the EU are significant during last three decades. With a bet-

ter understanding of the tendency of the prevalence of hypertension and its mortality, efforts will be made to improve awareness and help strict control of hypertension, which eventually help improve survival of hypertension-related disease and facilitate the gradual movement towards a healthy lifestyle.

Acknowledgements

This work was supported by grants from the National Natural Science Foundation of China (81370332 and 81170201 to XL Li, 81200169 to JJ Xiao), the Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD2010-2013 to XL Li), the Innovation Program of Shanghai Municipal Education Commission (13YZ014 to JJ Xiao), the Foundation for University Young Teachers by Shanghai Municipal Education Commission (year 2012, to JJ Xiao), an Innovation fund from Shanghai University (sdcx2012038 to JJ Xiao), and the Program for the integration of production, teaching and research for University Teachers supported by the Shanghai Municipal Education Commission (year 2014, to JJ Xiao). Dr XL Li is an Associate Fellow at the Collaborative Innovation Center for Cardiovascular Disease Translational Medicine.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Xinli Li or Junjie Xiao, Department of Cardiology, First Affiliated Hospital of Nanjing Medical University, 300 Guangzhou Road, Nanjing 210029, China. Tel: 0086-25-843-52775; Fax: 0086-25-84352775; E-mail: xinli3267_nj@hotmail.com (XLL); junjiexiao@live.cn (JJX)

References

- [1] Mathers CD, Boerma T and Fat DM. Global and regional causes of death. *Br Med Bul* 2009; 92: 7-32.
- [2] Alwan A. Global status report on noncommunicable diseases 2010. World Health Organization 2011.
- [3] Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK and He J. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005; 365: 217-223.
- [4] Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Amann M, Anderson HR,

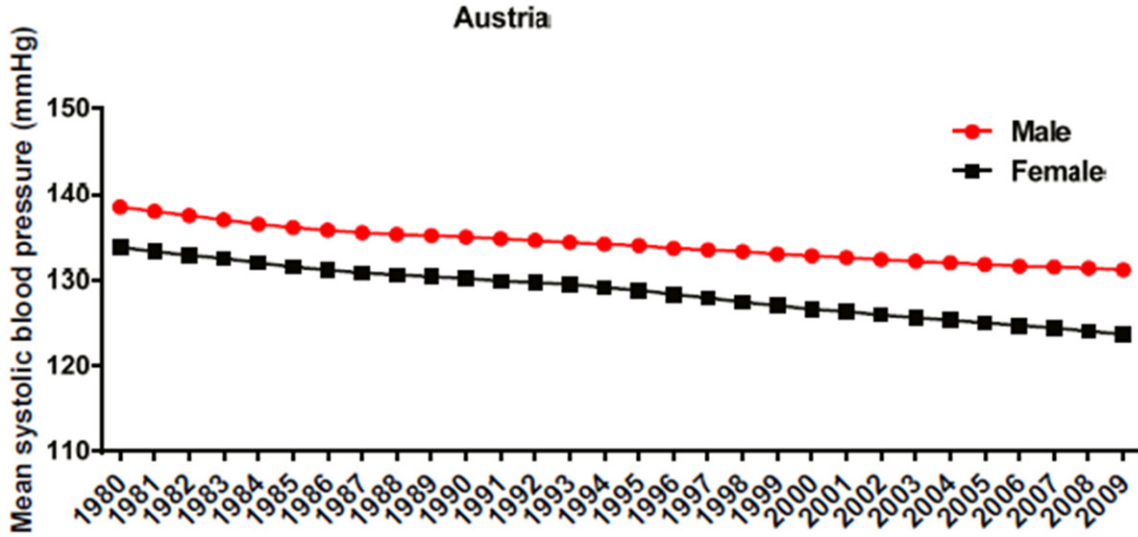
Tendency for age-specific mortality with hypertension in Europe

- Andrews KG, Aryee M, Atkinson C, Bacchus LJ, Bahalim AN, Balakrishnan K, Balmes J, Barker-Collo S, Baxter A, Bell ML, Blore JD, Blyth F, Bonner C, Borges G, Bourne R, Boussinesq M, Brauer M, Brooks P, Bruce NG, Brunekreef B, Bryan-Hancock C, Bucello C, Buchbinder R, Bull F, Burnett RT, Byers TE, Calabria B, Carapetis J, Carnahan E, Chafe Z, Charlson F, Chen H, Chen JS, Cheng AT, Child JC, Cohen A, Colson KE, Cowie BC, Darby S, Darling S, Davis A, Degenhardt L, Dentener F, Des Jarlais DC, Devries K, Dherani M, Ding EL, Dorsey ER, Driscoll T, Edmond K, Ali SE, Engell RE, Erwin PJ, Fahimi S, Falder G, Farzadfar F, Ferrari A, Finucane MM, Flaxman S, Fowkes FG, Freedman G, Freeman MK, Gakidou E, Ghosh S, Giovannucci E, Gmel G, Graham K, Grainger R, Grant B, Gunnell D, Gutierrez HR, Hall W, Hoek HW, Hogan A, Hosgood HD 3rd, Hoy D, Hu H, Hubbell BJ, Hutchings SJ, Ibeanusi SE, Jacklyn GL, Jasrasaria R, Jonas JB, Kan H, Kanis JA, Kassebaum N, Kawakami N, Khang YH, Khatibzadeh S, Khoo JP, Kok C, Laden F, Lalloo R, Lan Q, Lathlean T, Leasher JL, Leigh J, Li Y, Lin JK, Lipshultz SE, London S, Lozano R, Lu Y, Mak J, Malekzadeh R, Mallinger L, Marcenes W, March L, Marks R, Martin R, McGale P, McGrath J, Mehta S, Mensah GA, Merriman TR, Micha R, Michaud C, Mishra V, Mohd Hanafiah K, Mokdad AA, Morawska L, Mozaffarian D, Murphy T, Naghavi M, Neal B, Nelson PK, Nolla JM, Norman R, Olives C, Omer SB, Orchard J, Osborne R, Ostro B, Page A, Pandey KD, Parry CD, Passmore E, Patra J, Pearce N, Pelizzari PM, Petzold M, Phillips MR, Pope D, Pope CA 3rd, Powles J, Rao M, Razavi H, Rehfues EA, Rehm JT, Ritz B, Rivara FP, Roberts T, Robinson C, Rodriguez-Portales JA, Romieu I, Room R, Rosenfeld LC, Roy A, Rushton L, Salomon JA, Sampson U, Sanchez-Riera L, Sanman E, Sapkota A, Seedat S, Shi P, Shield K, Shivakoti R, Singh GM, Sleet DA, Smith E, Smith KR, Stapelberg NJ, Steenland K, Stöckl H, Stovner LJ, Straif K, Straney L, Thurston GD, Tran JH, Van Dingenen R, van Donkelaar A, Veerman JL, Vijayakumar L, Weintraub R, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams W, Wilson N, Woolf AD, Yip P, Zielinski JM, Lopez AD, Murray CJ, Ezzati M, AlMazroa MA and Memish ZA. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2013; 380: 2224-2260.
- [5] Tibazarwa KB and Damasceno AA. Hypertension in developing countries. *Can J Cardiol* 2014; 30: 527-533.
- [6] Nichols M, Townsend N, Scarborough P and Rayner M. Trends in age-specific coronary heart disease mortality in the European Union over three decades: 1980-2009. *Eur Heart J* 2013; 34: 3017-3027.
- [7] Koudryavtcev SA and Lazarev VM. Validation of the BPLab1 24-hour blood pressure monitoring system according to the European standard BS EN 1060-4: 2004 and British Hypertension Society protocol. *Med Devices* 2011; 4: 193-196.
- [8] Mathers C, Stevens G and Mascarenhas M. Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization 2009.
- [9] Petersen PE. Global policy for improvement of oral health in the 21st Century-implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol* 2009; 37: 1-8.
- [10] Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense HW, Joffres M, Katarinen M, Poulter N, Primatesta P, Rodríguez-Artalejo F, Stegmayr B, Thamm M, Tuomilehto J, Vanuzzo D and Vescio F. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *JAMA* 2003; 289: 2363-2369.
- [11] Goroll AH. When it comes to primary care, more may be more: comment on "Encounter frequency and serum glucose level, blood pressure, and cholesterol level control in patients with diabetes mellitus". *Arch Intern Med* 2011; 171: 1550-1551.
- [12] Agyemang C, Bruijnzeels MA and Owusu-Dabo E. Factors associated with hypertension awareness, treatment, and control in Ghana, West Africa. *J Hum Hypertens* 2006; 20: 67-71.
- [13] Narayanaswamy N, Moodithaya S, Halahalli H and Mirajkar AM. Assessment of Risk Factor for Cardiovascular Disease Using Heart Rate Variability in Postmenopausal Women: A Comparative Study between Urban and Rural Indian Women. *ISRN Cardiol* 2013; 2013: 858921.
- [14] Rayner M, Allender S, Scarborough P; British Heart Foundation Health Promotion Research G. Cardiovascular disease in Europe. *Eur J Cardiovasc Prev Rehabil* 2009; S2: S43-47.
- [15] Bertuccio P, Levi F, Lucchini F, Chatenoud L, Bosetti C, Negri E, La Vecchia C. Coronary heart disease and cerebrovascular disease mortality in young adults: recent trends in Europe. *Eur J Cardiovasc Prev Rehabil* 2011; 18: 627-634.
- [16] Sabanayagam C and Shankar A. Association between plasma homocysteine and microalbuminuria in persons without hypertension, diabetes mellitus, and cardiovascular disease. *Clin Exp Nephrol* 2011; 15: 92-99.

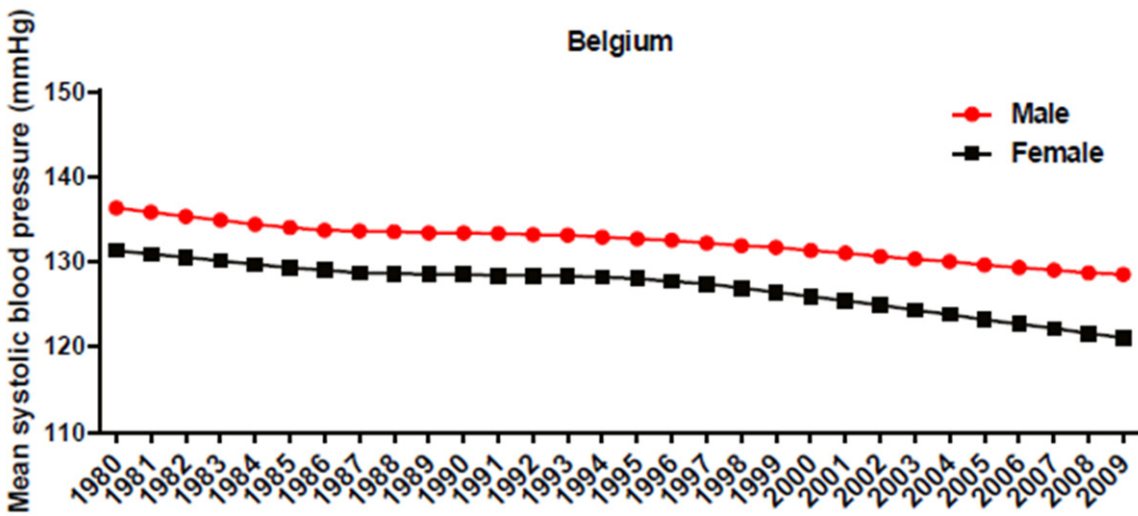
Tendency for age-specific mortality with hypertension in Europe

- [17] Lawes CM, Bennett DA, Lewington S and Rodgers A. Blood pressure and coronary heart disease: a review of the evidence. *Semin Vasc Med* 2002; 2: 355-368.
- [18] Lawes CM, Bennett DA, Feigin VL and Rodgers A. Blood pressure and stroke: an overview of published reviews. *Stroke* 2004; 35: 1024.
- [19] O'Brien E, Atkins N, Stergiou G, Karpettas N, Parati G, Asmar R, Imai Y, Wang J, Mengden T, Shennan A; Working Group on Blood Pressure Monitoring of the European Society of Hypertension. European Society of Hypertension International Protocol revision 2010 for the validation of blood pressure measuring devices in adults. *Blood Press Monit* 2010; 15: 23-38.
- [20] Primatesta P, Brookes M and Poulter NR. Improved hypertension management and control: results from the health survey for England 1998. *Hypertension* 2001; 38: 827-832.
- [21] Kainen RL, Moltchanov VA, Chukwuma C Sr, Kuulasmaa KA, Marques-Vidal PM, Sans S, Wilhelmsen L, Tuomilehto JO; WHO MONICA Project. Trends in the prevalence, awareness, treatment and control of hypertension: the WHO MONICA Project. *Eur J Cardiovasc Prev Rehabil* 2006; 13: 13-29.
- [22] Topouchian J, Agnoletti D, Blacher J, Youssef A, Ibanez I, Khabouth J, Khawaja S, Beaino L and Asmar R. Validation of four automatic devices for self-measurement of blood pressure according to the international protocol of the European Society of Hypertension. *Vasc Health Risk Manag* 2011; 7: 709-717.
- [23] Bello M. Nigerians wake up to high blood pressure. *Bull World Health Organ* 2013; 91: 242-243.
- [24] Robbins CL, Dietz PM, Bombard JM, Gibbs F, Ko JY and Valderrama AL. Blood pressure and cholesterol screening prevalence among U.S. women of reproductive age opportunities to improve screening. *Am J Prev Med* 2011; 41: 588-595.
- [25] O'Brien E, Parati G, Stergiou G, Asmar R, Beilin L, Bilo G, Clement D, de la Sierra A, de Leeuw P, Dolan E, Fagard R, Graves J, Head GA, Imai Y, Kario K, Lurbe E, Mallion JM, Mancia G, Mengden T, Myers M, Ogedegbe G, Ohkubo T, Omboni S, Palatini P, Redon J, Ruilope LM, Shennan A, Staessen JA, vanMontfrans G, Verdecchia P, Waeber B, Wang J, Zanchetti A, Zhang Y; European Society of Hypertension Working Group on Blood Pressure Monitoring. European society of hypertension position paper on ambulatory blood pressure monitoring. *J Hypertens* 2013; 31: 1731-1768.
- [26] Zanchetti A. Is hypertension a fatal disease today? Proceedings of a satellite symposium held during the 21st European Meeting on Hypertension and Cardiovascular Prevention Milan (Italy), June 17-20, 2011. Foreword. *J Hypertens* 2011; S1: S1.
- [27] Ikeda N, Gakidou E, Hasegawa T and Murray CJ. Understanding the decline of mean systolic blood pressure in Japan: an analysis of pooled data from the National Nutrition Survey, 1986-2002. *Bull World Health Organ* 2008; 86: 978-988.

Tendency for age-specific mortality with hypertension in Europe

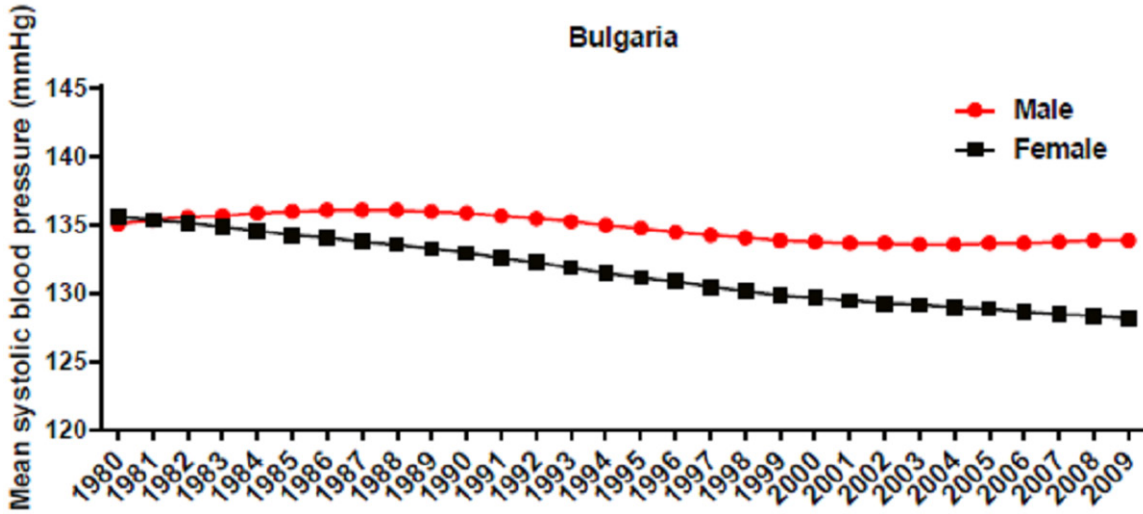


Supplemental Figure 1. SBP trend in Austria from 1980 to 2009. Mean systolic blood pressure (mmHg).

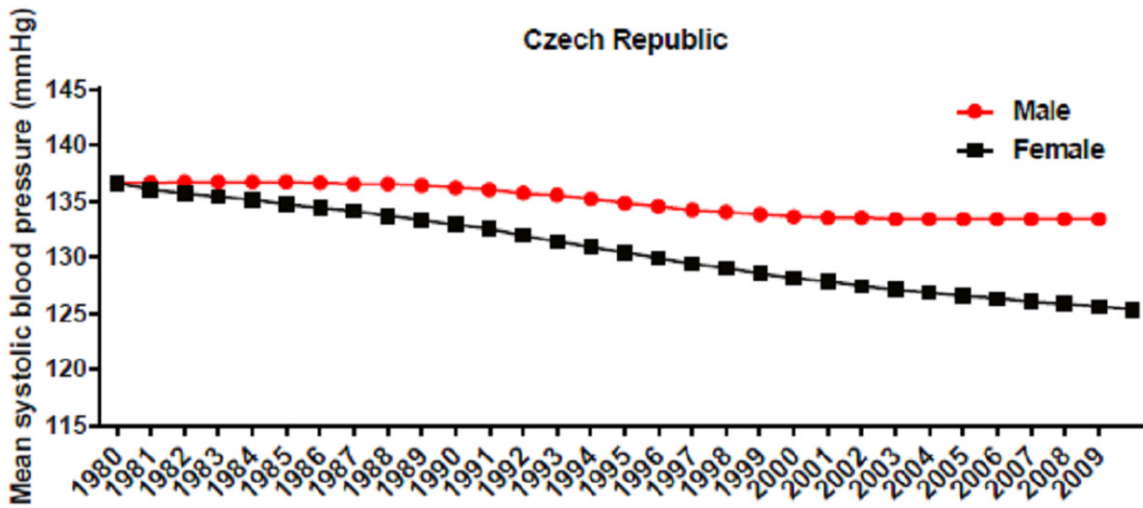


Supplemental Figure 2. SBP trend in Belgium from 1980 to 2009. Mean systolic blood pressure (mmHg).

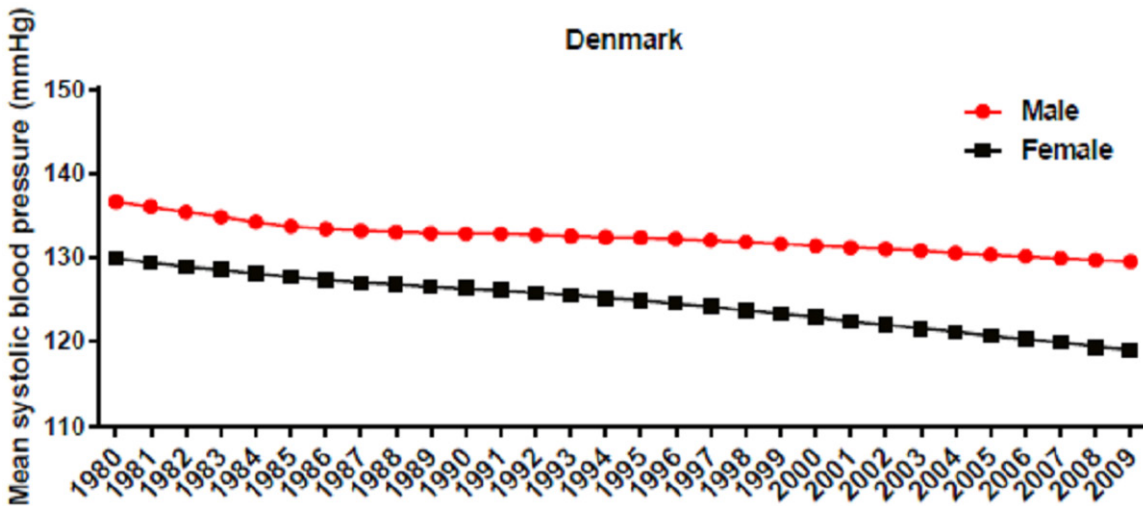
Tendency for age-specific mortality with hypertension in Europe



Supplemental Figure 3. SBP trend in Bulgaria from 1980 to 2009. Mean systolic blood pressure (mmHg).

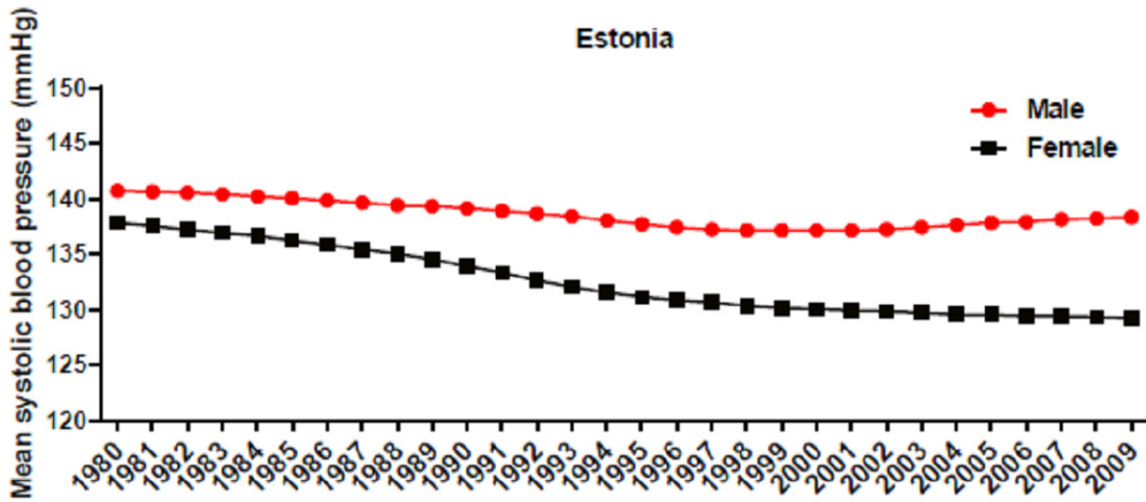


Supplemental Figure 4. SBP trend in Czech Republic from 1980 to 2009. Mean systolic blood pressure (mmHg).

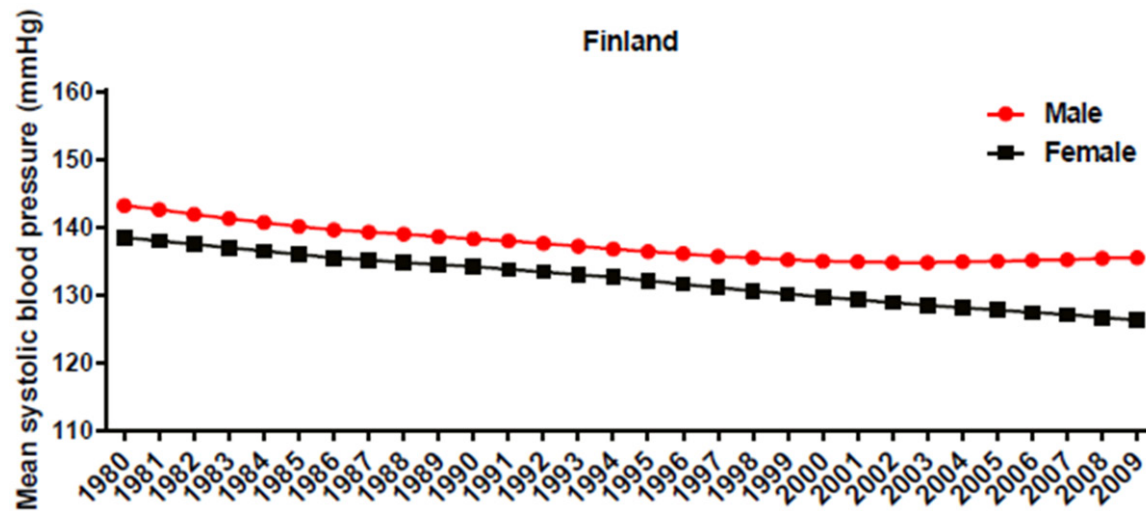


Tendency for age-specific mortality with hypertension in Europe

Supplemental Figure 5. SBP trend in Denmark from 1980 to 2009. Mean systolic blood pressure (mmHg).

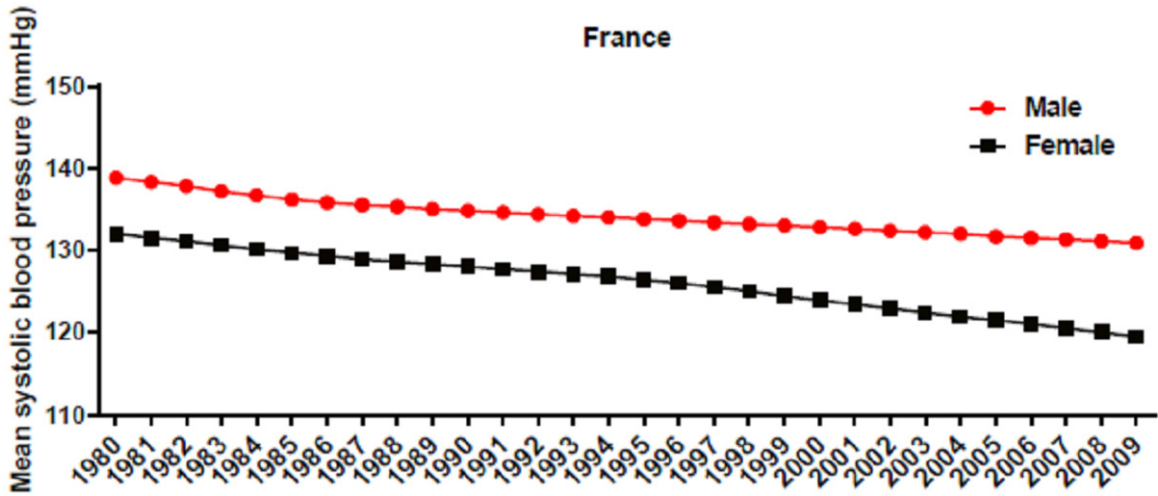


Supplemental Figure 6. SBP trend in Estonia from 1980 to 2009. Mean systolic blood pressure (mmHg).

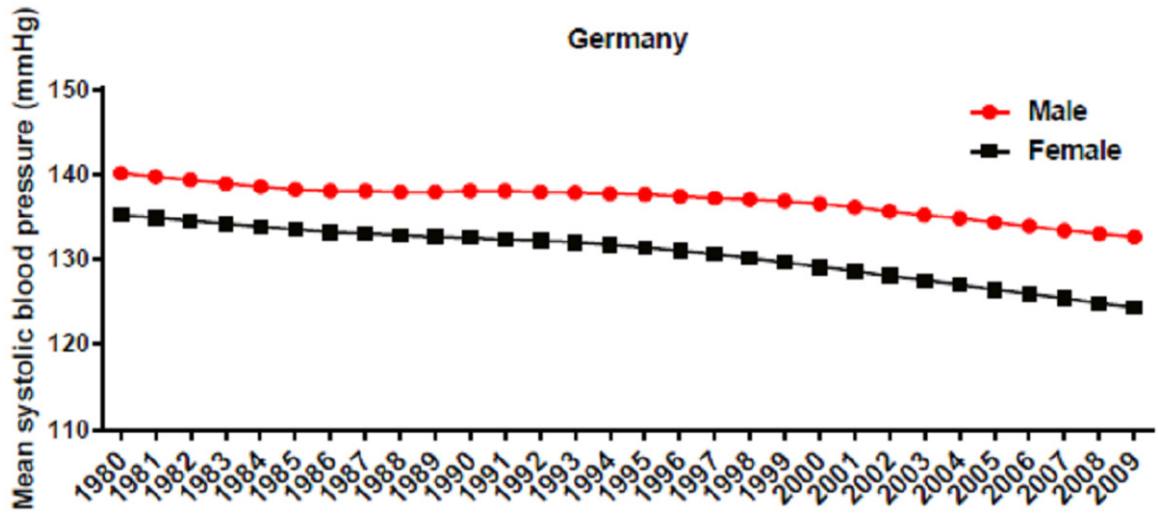


Supplemental Figure 7. SBP trend in Finland from 1980 to 2009. Mean systolic blood pressure (mmHg).

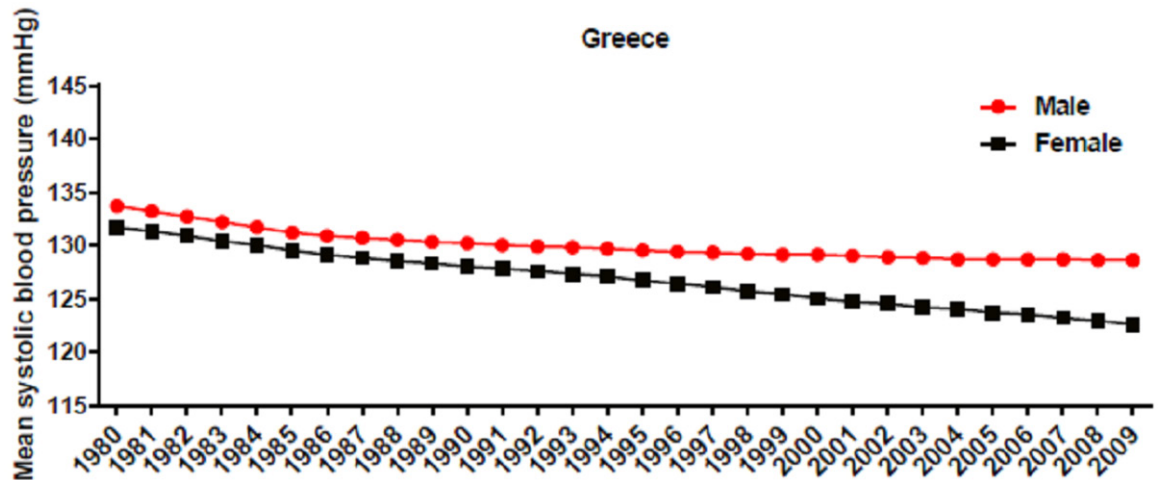
Tendency for age-specific mortality with hypertension in Europe



Supplemental Figure 8. SBP trend in France from 1980 to 2009. Mean systolic blood pressure (mmHg).

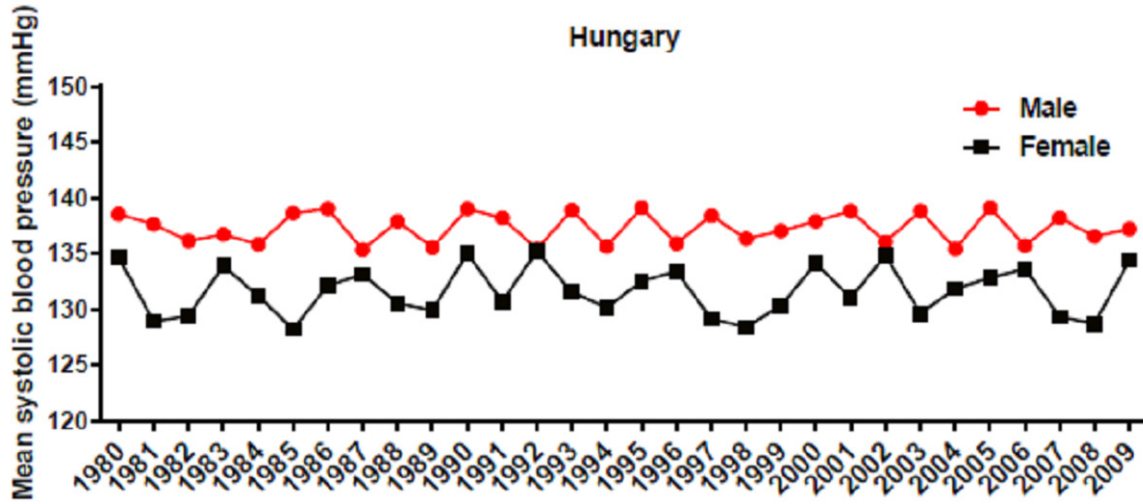


Supplemental Figure 9. SBP trend in Germany from 1980 to 2009. Mean systolic blood pressure (mmHg).

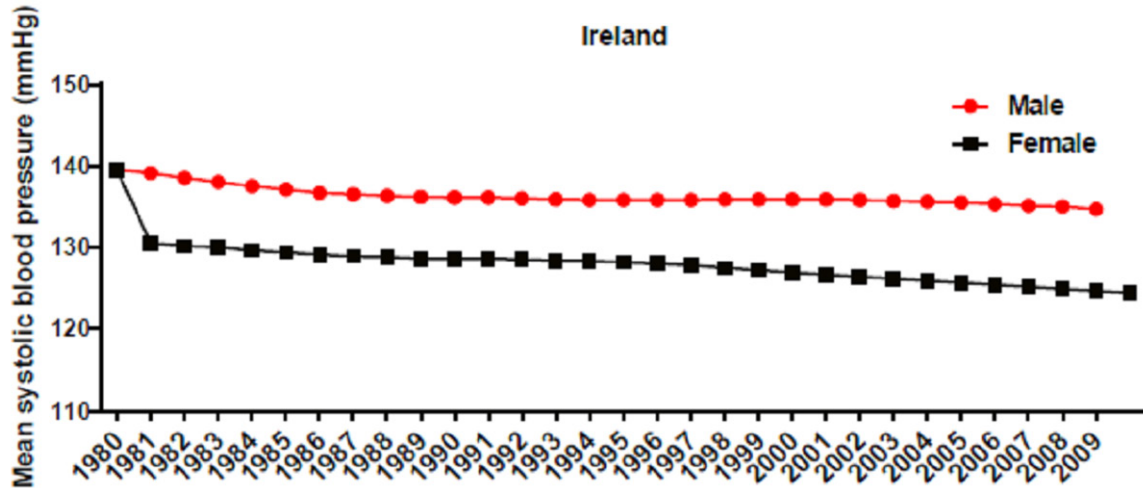


Tendency for age-specific mortality with hypertension in Europe

Supplemental Figure 10. SBP trend in Greece from 1980 to 2009. Mean systolic blood pressure (mmHg).

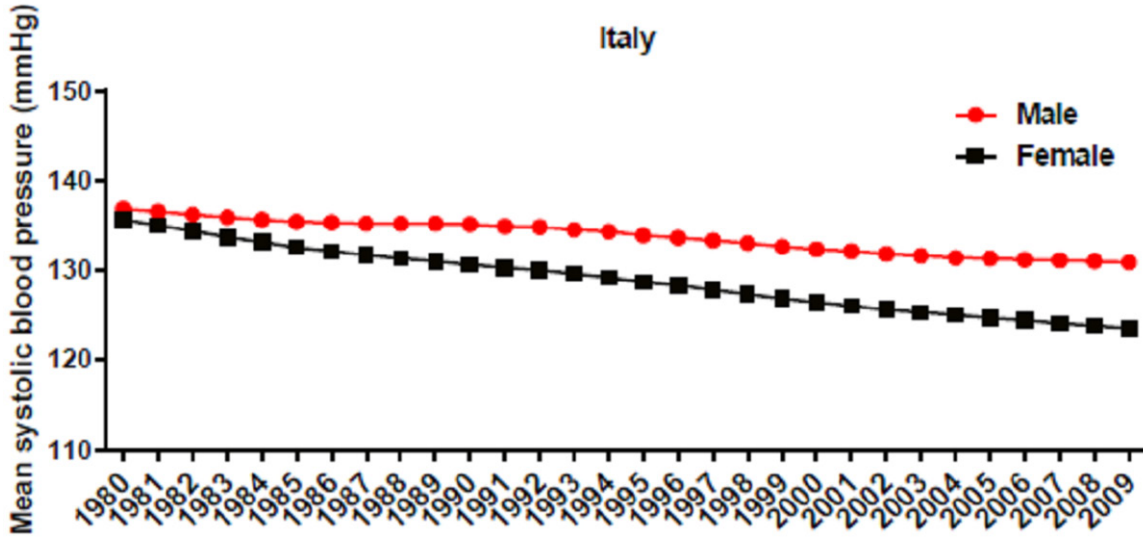


Supplemental Figure 11. SBP trend in Hungary from 1980 to 2009. Mean systolic blood pressure (mmHg).

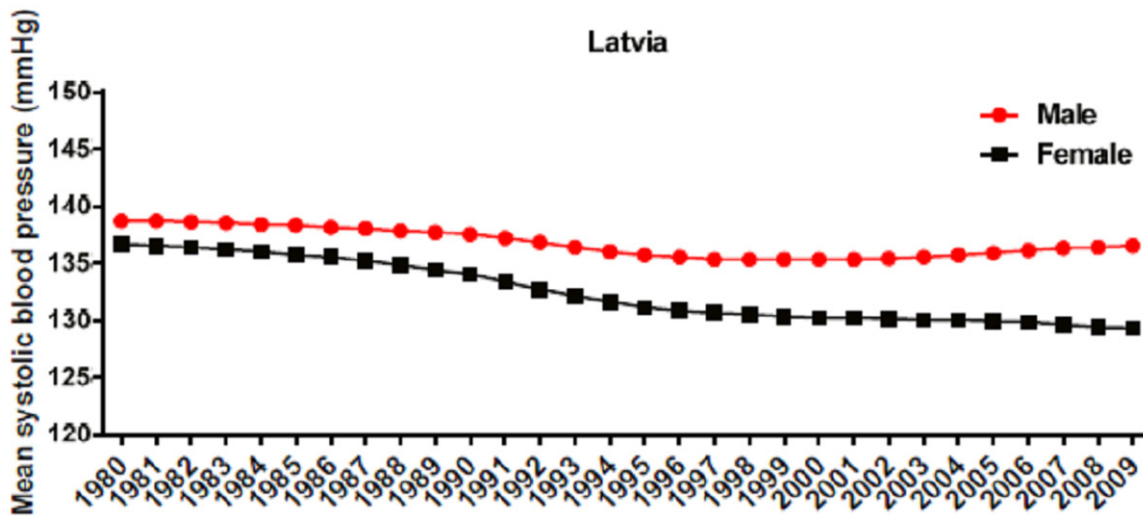


Supplemental Figure 12. SBP trend in Ireland from 1980 to 2009. Mean systolic blood pressure (mmHg).

Tendency for age-specific mortality with hypertension in Europe

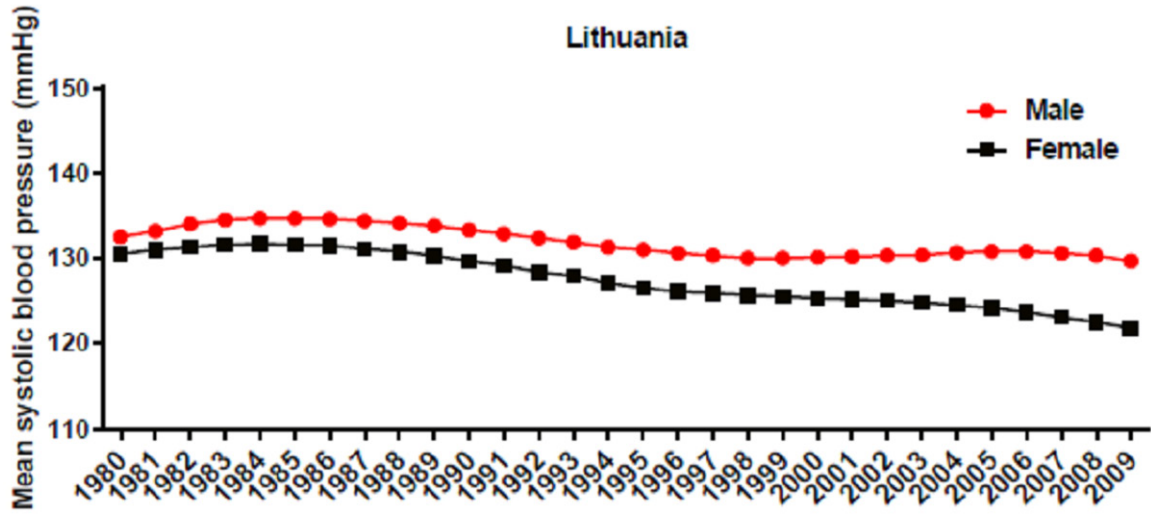


Supplemental Figure 13. SBP trend in Italy from 1980 to 2009. Mean systolic blood pressure (mmHg).

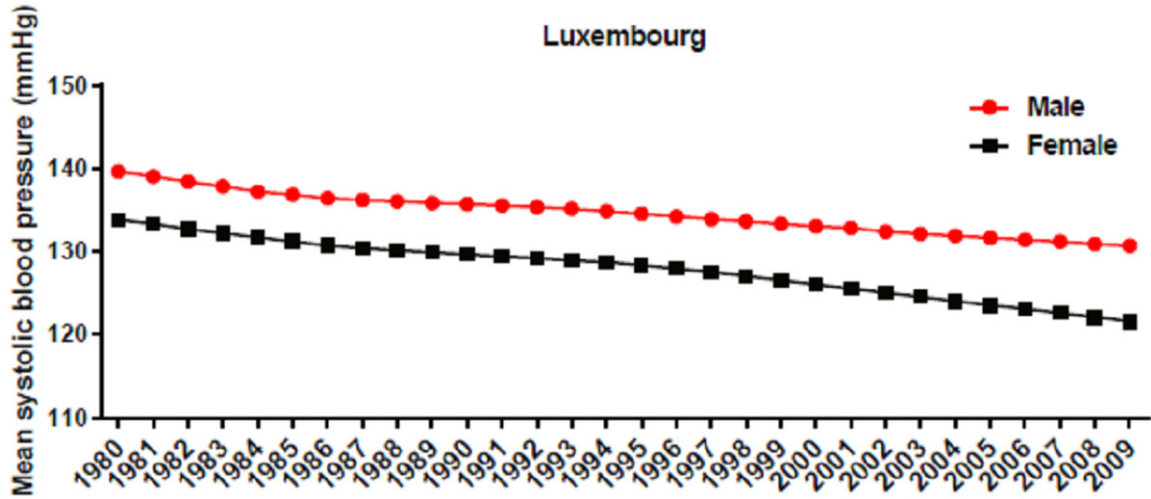


Supplemental Figure 14. SBP trend in Latvia from 1980 to 2009. Mean systolic blood pressure (mmHg).

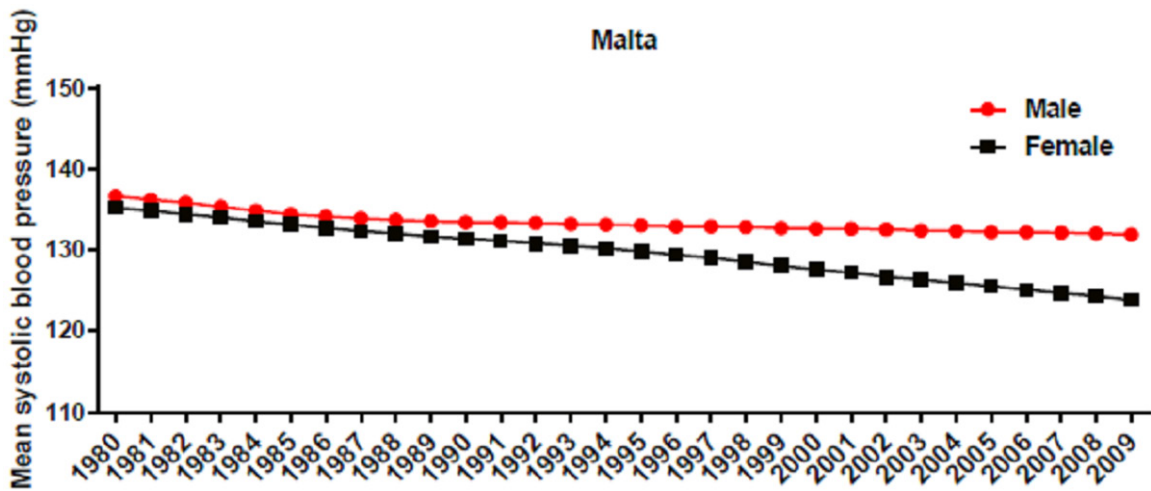
Tendency for age-specific mortality with hypertension in Europe



Supplemental Figure 15. SBP trend in Lithuania from 1980 to 2009. Mean systolic blood pressure (mmHg).

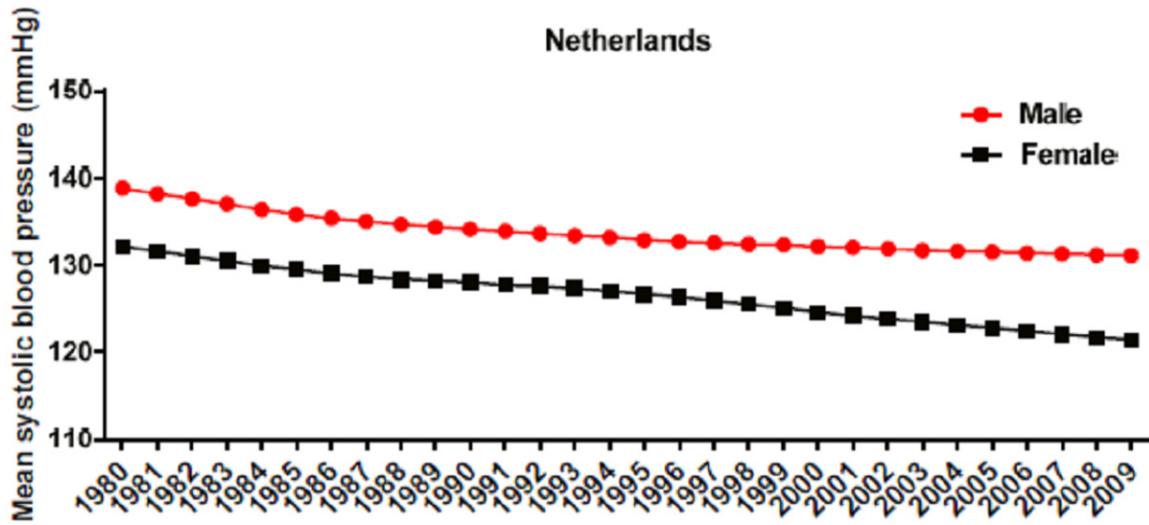


Supplemental Figure 16. SBP trend in Luxembourg from 1980 to 2009. Mean systolic blood pressure (mmHg).

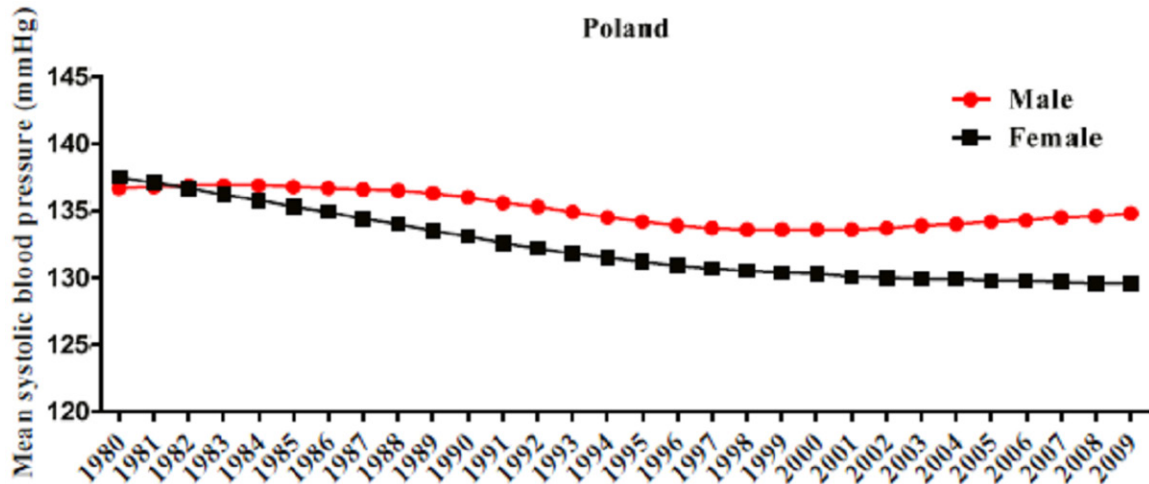


Tendency for age-specific mortality with hypertension in Europe

Supplemental Figure 17. SBP trend in Malta from 1980 to 2009. Mean systolic blood pressure (mmHg).

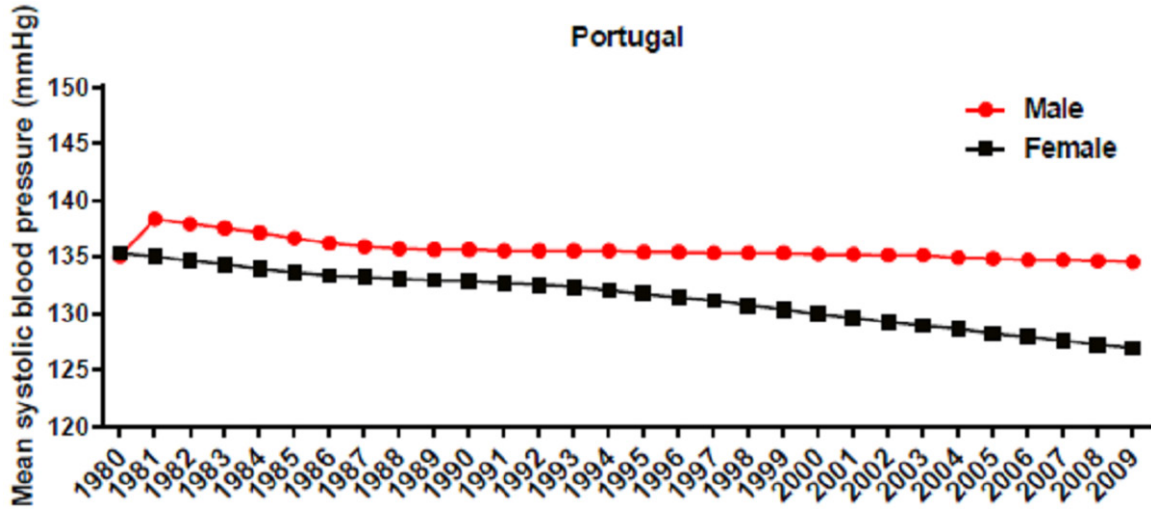


Supplemental Figure 18. SBP trend in Netherlands from 1980 to 2009. Mean systolic blood pressure (mmHg).

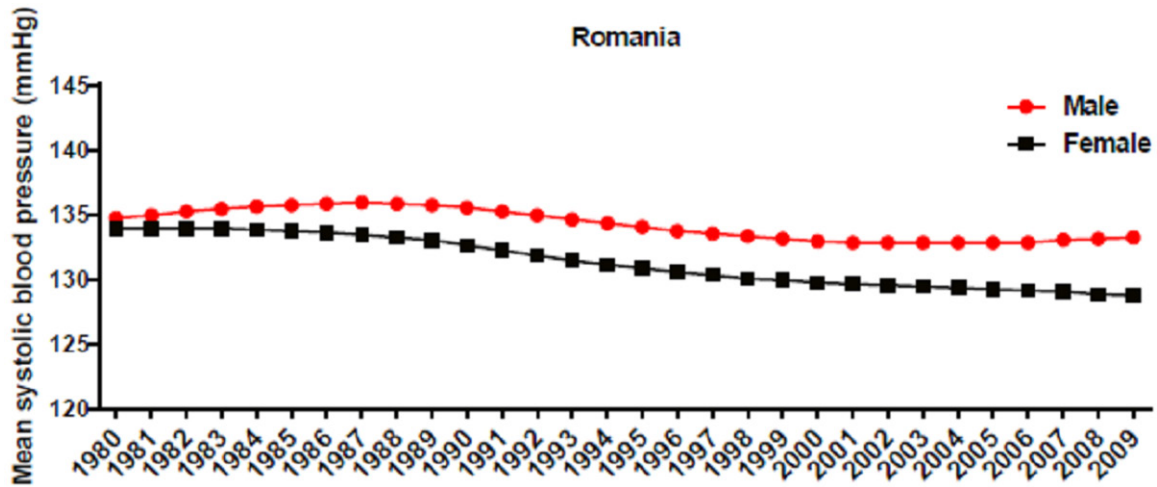


Supplemental Figure 19. SBP trend in Poland from 1980 to 2009. Mean systolic blood pressure (mmHg).

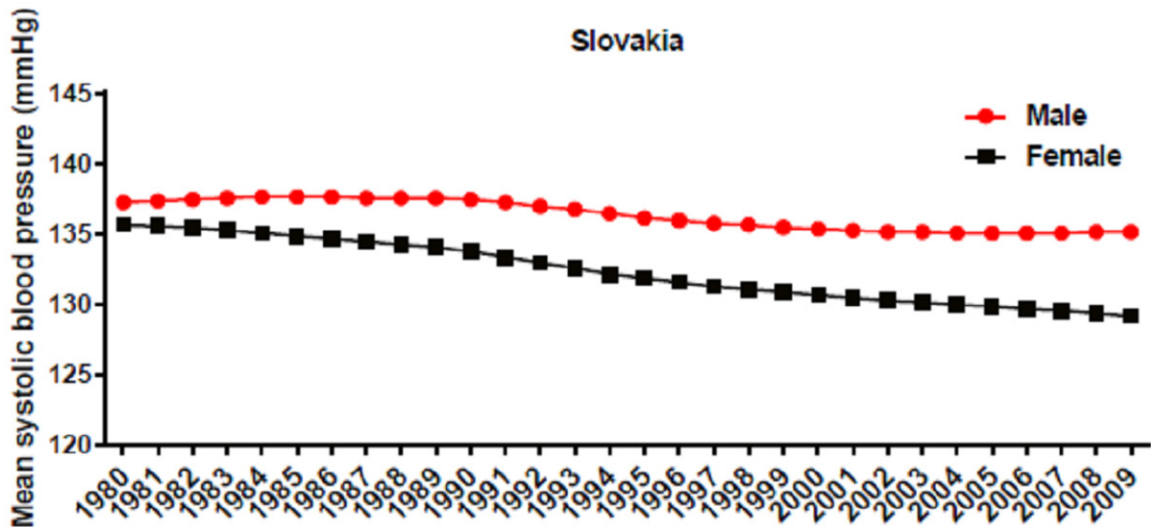
Tendency for age-specific mortality with hypertension in Europe



Supplemental Figure 20. SBP trend in Portugal from 1980 to 2009. Mean systolic blood pressure (mmHg).

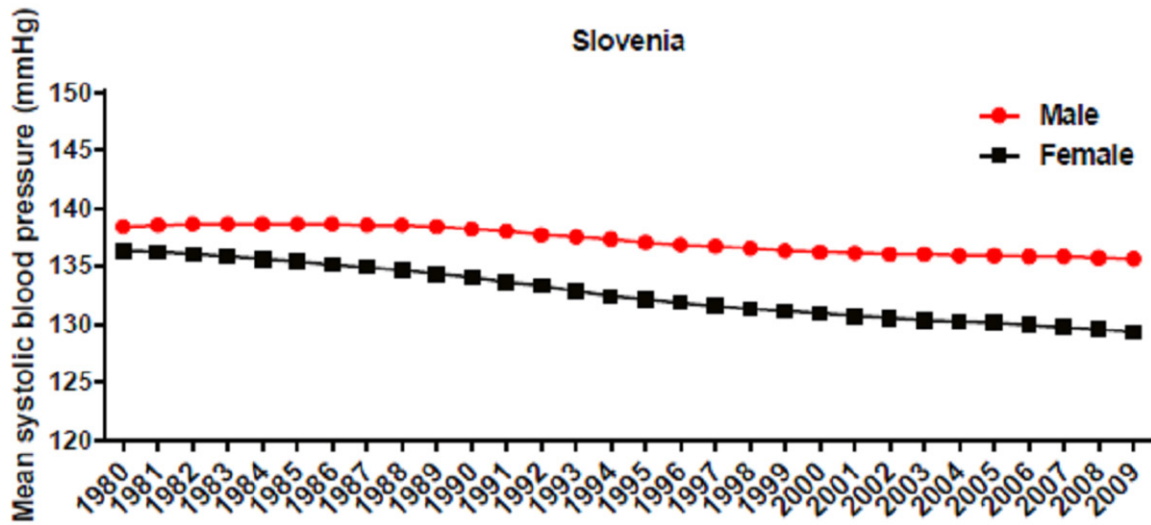


Supplemental Figure 21. SBP trend in Romania from 1980 to 2009. Mean systolic blood pressure (mmHg).

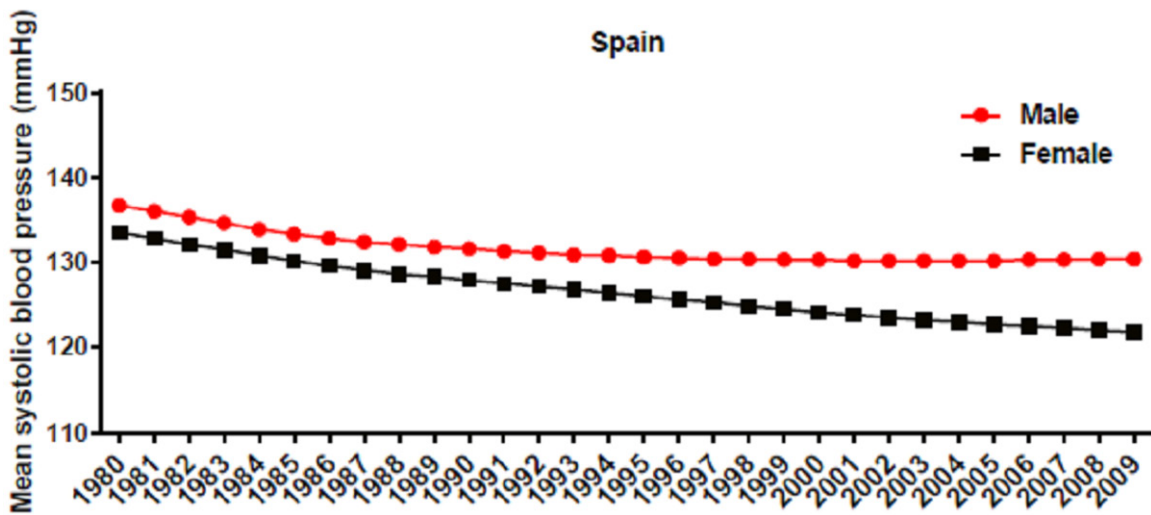


Tendency for age-specific mortality with hypertension in Europe

Supplemental Figure 22. SBP trend in Slovakia from 1980 to 2009. Mean systolic blood pressure (mmHg).

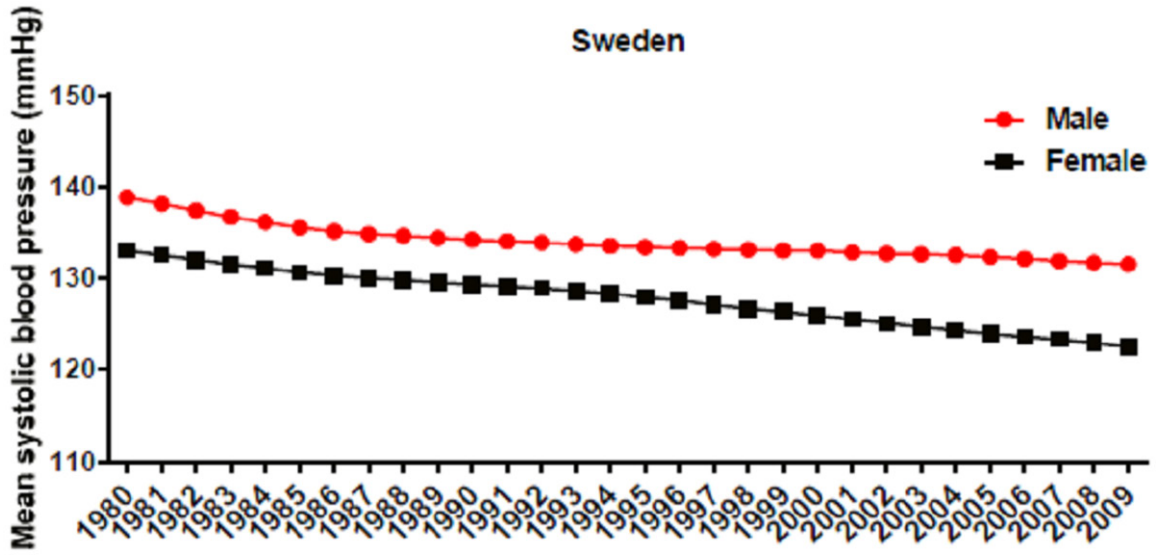


Supplemental Figure 23. SBP trend in Slovenia from 1980 to 2009. Mean systolic blood pressure (mmHg).

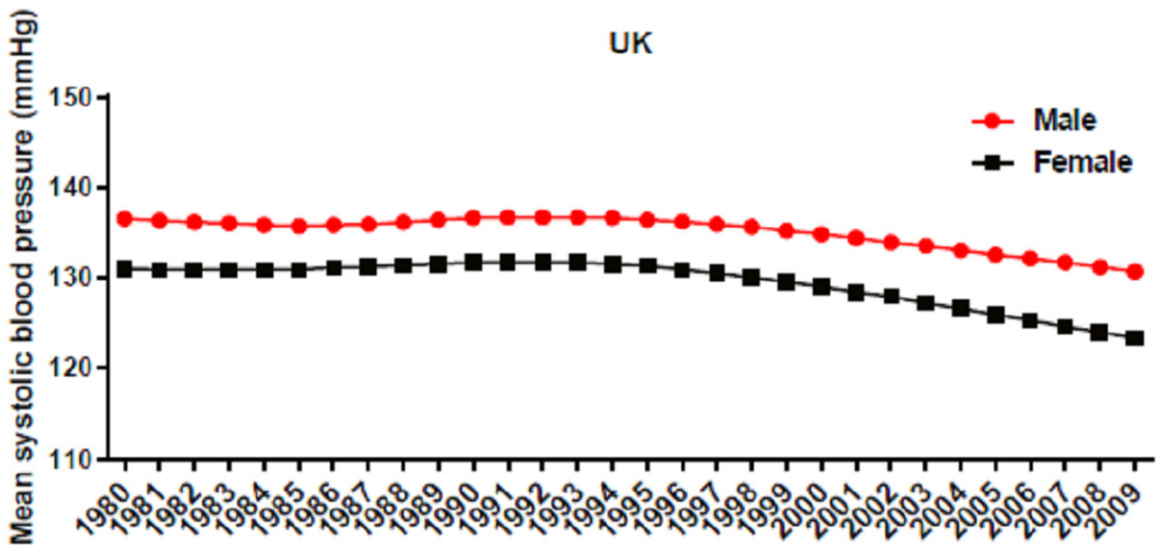


Supplemental Figure 24. SBP trend in Spain from 1980 to 2009. Mean systolic blood pressure (mmHg).

Tendency for age-specific mortality with hypertension in Europe



Supplemental Figure 25. SBP trend in Sweden from 1980 to 2009. Mean systolic blood pressure (mmHg).



Supplemental Figure 26. SBP trend in UK from 1980 to 2009. Mean systolic blood pressure (mmHg).