

Trends in cardiovascular diseases and cancer mortality in 45 countries from five continents (1980–2010)

Fábio Araújo^{1,2}, Cláudia Gouvêas^{1,2}, Filipa Fontes^{1,2},
Carlo La Vecchia^{2,3}, Ana Azevedo^{1,2} and Nuno Lunet^{1,2}

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Abstract

Background: Cardiovascular diseases (CVD) and cancer are worldwide main causes of death with mortality trends varying across countries with different levels of economic development.

Design and methods: We analysed trends in CVD and cancer mortality for 37 European countries, five high-income non-European countries and four leading emerging economies (BRICS) using data from the World Health Organization database for the period 1980–2010.

Results: In high-income countries, CVD mortality trends are characterized by steep declines over the last decades, while a downward trend in cancer mortality started more recently and was less pronounced. This resulted in the gradual convergence of the CVD and cancer mortality rates, and the latter are already higher in some countries. The absolute number of CVD deaths decreased in most settings, while cancer deaths increased in nearly all countries. Among the BRICS, China and South Africa share a similar pattern of no meaningful variation in both CVD and cancer age-standardized mortality rates and an increase in the overall number of deaths by these causes. Brazil presents trends similar to those of high-income countries, except for the still increasing number of CVD deaths.

Conclusions: The substantial decreases in CVD mortality over the last decades have overcome the impact of the growth and ageing of populations in the overall number of deaths, while stabilization in the number of cancer deaths was observed only in some of the high-income countries.

Keywords

Cardiovascular diseases, mortality, neoplasms, trends

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Introduction

In high-income countries, cardiovascular diseases (CVD) are the main cause of death and cancer the second, while in low- and middle-income countries these are expected to be the most important determinants of the death toll by 2030.¹

In many countries, the age-standardized mortality rates (ASMR) from CVD have been declining for four or five decades, and those of cancer for over two decades now.^{2–4} However, the trends are heterogeneous, reflecting differences in the importance of cause-specific mortality determinants across settings. The variation in the absolute number of deaths will also depend on demographic trends, namely regarding population size and age structure.⁵

Understanding the variation in CVD and cancer mortality across countries from different regions and levels

of economic development is essential to predict the death burden associated with these major noncommunicable diseases, in particular using high-income countries, where accurate death certification has long been available, as benchmarks. Therefore, we considered the

¹Department of Clinical Epidemiology, Predictive Medicine and Public Health, University of Porto Medical School, Porto, Portugal

²Institute of Public Health of the University of Porto (ISPUP), Porto, Portugal

³Department of Clinical Sciences and Community Health, Università degli Studi di Milano, Milan, Italy

Corresponding author:

Nuno Lunet, Departamento de Epidemiologia Clínica, Medicina Preditiva e Saúde Pública, Faculdade de Medicina da Universidade do Porto, Al. Prof. Hernâni Monteiro, 4200–319 Porto, Portugal.

Email: nlunet@med.up.pt

trends in CVD and cancer mortality in 45 countries from five continents over the last three decades.

Methods

For the present study, we selected all available European countries, high-income non-European countries and also Brazil, India, China, and South Africa. The latter four, together with the Russian Federation, are leading emerging economies that have been jointly referred as BRICS.⁶ We obtained the CVD and cancer mortality data (all and selected diseases of the circulatory system and cancers, as described in Appendix 1, available online) from the World Health Organization (WHO) database (update 24 November 2011)⁷ for the period 1980–2010.

India was not considered because there were no data available on electronic support from the WHO database. Bosnia and Herzegovina, Cyprus, and Montenegro were excluded because the data available in the WHO database refers to less than 10 calendar years. After these exclusions, data was available from 37 European countries, five high-income non-European countries (Australia, Canada, Japan, New Zealand, and USA), and from Brazil, China (including data from less than 10% of the country population, as well as data from Hong Kong Special Administrative Region (SAR)), and South Africa.

Mid-year estimates of the resident population were obtained from the United Nations, World Prospects Population, the 2010 revision;⁶ for China, population estimates were obtained from WHO database since mortality data refers to <10% of the population. Cause- and sex-specific ASMR were computed through the direct method, using the World Standard Population⁸ as reference. The annual percentage change (APC) in the ASMR for all CVD and all cancers, and the corresponding 95% confidence intervals (CI), as well as the points in time when trends changed significantly were estimated through joinpoint regression, using the software Joinpoint 3.5.4.⁹ Additionally, we computed the cause- and sex-specific absolute and relative variation in number of deaths, by all CVD and all cancers, in the whole period.

We present the results for each country with at least 10 million inhabitants in 2010, as well as for the groups of high-income non-European and the European Union (15 member states (EU-15) as defined in January 1995 and 27 member states (EU-27) as defined in January 2007).⁶ The results referring to countries with less than 10 million inhabitants are also provided in Appendices 2–6.

To discuss the overall trends in CVD and cancer mortality, we present graphically the trends in ASMR and number of deaths for specific CVD and cancers, in

high-income non-European and EU countries (Appendices 7 and 8).

Results

ASMR

The CVD ASMR decreased markedly between 1980 and 2010 in most high-income countries, while cancer ASMR decreased more slowly mainly since the 1990s (Figures 1 and 2, Tables 1 and 2, and Appendices 2–5).

While in the beginning of the period under analysis the CVD ASMR were substantially higher in most settings, its declining trends over three decades resulted in a substantial reduction in the gap between CVD and cancer rates; in several countries the CVD ASMR are already lower than the ones observed for cancer, mostly among men (Figures 1 and 2 and Appendices 2 and 3; for example France, Japan, The Netherlands, Spain).

Overall, the tendency for lower ASMR for CVD than for cancer were more pronounced in high-income non-European countries and in EU-15 than in EU-27. By the end of the period analysed the latter presented CVD ASMR approximately 25% higher.

In the Russian Federation, the increasing trends of CVD ASMR lead to mortality rates 3–4.5-fold higher than in the more affluent settings, while decreasing trends were observed since the early 2000s. The cancer ASMR started to decrease in the early 1990s and remained much lower than that observed for CVD. A similar pattern was observed for other Eastern European countries, namely Belarus, Republic of Moldova, Ukraine, and Latvia.

In Brazil, a considerable decrease in CVD ASMR has occurred in the last three decades, while cancer rates increased significantly since the 1990s (APC 0.7%).

In China, the CVD ASMR decreased in both sexes, though there was no significant variation in women since 1991, while cancer ASMR have been relatively stable among men and increasing among women since 1996 (APC 1.6%). Specifically in Hong Kong SAR, CVD and cancer mortality experienced steep declines, with cancer ASMR being already higher than that of CVD.

South Africa had low CVD ASMR with no significant variation since the late 1990s, while in the same period cancer ASMR decreased significantly in men (APC –2.0%).

Absolute number of deaths

The absolute number of CVD deaths decreased in all high-income non-European countries and most EU member states. The relative variation in the absolute

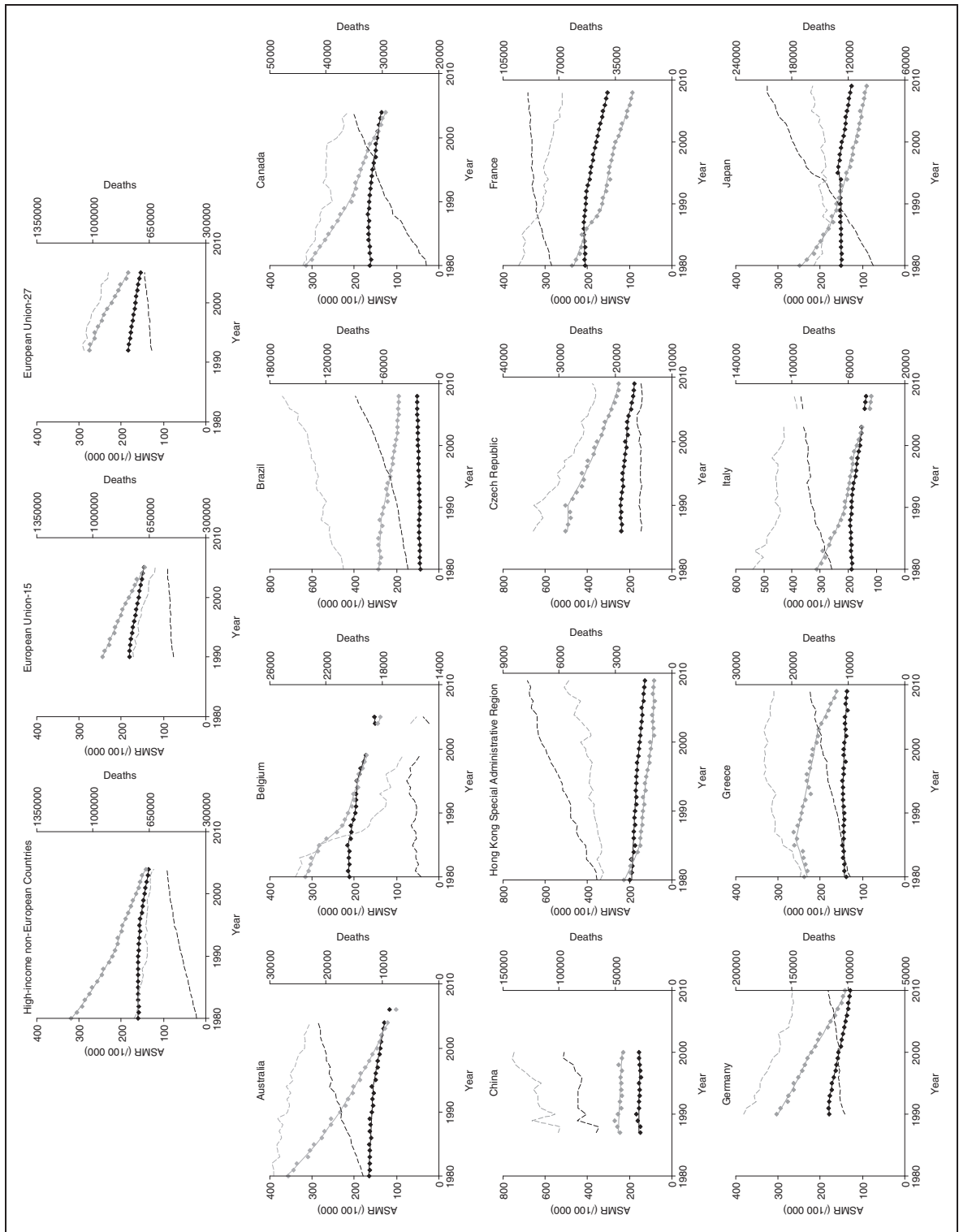


Figure 1. Trends in age-standardized mortality rate and number of deaths by cause in men. The analyses of aggregated data of high-income non-European countries and the EU refer to the periods with available data for all the countries (high-income non-European, 1980–2004; EU-15, 1990–2005; EU-27, 1992–2005); interpolation of missing years was performed in these groups.

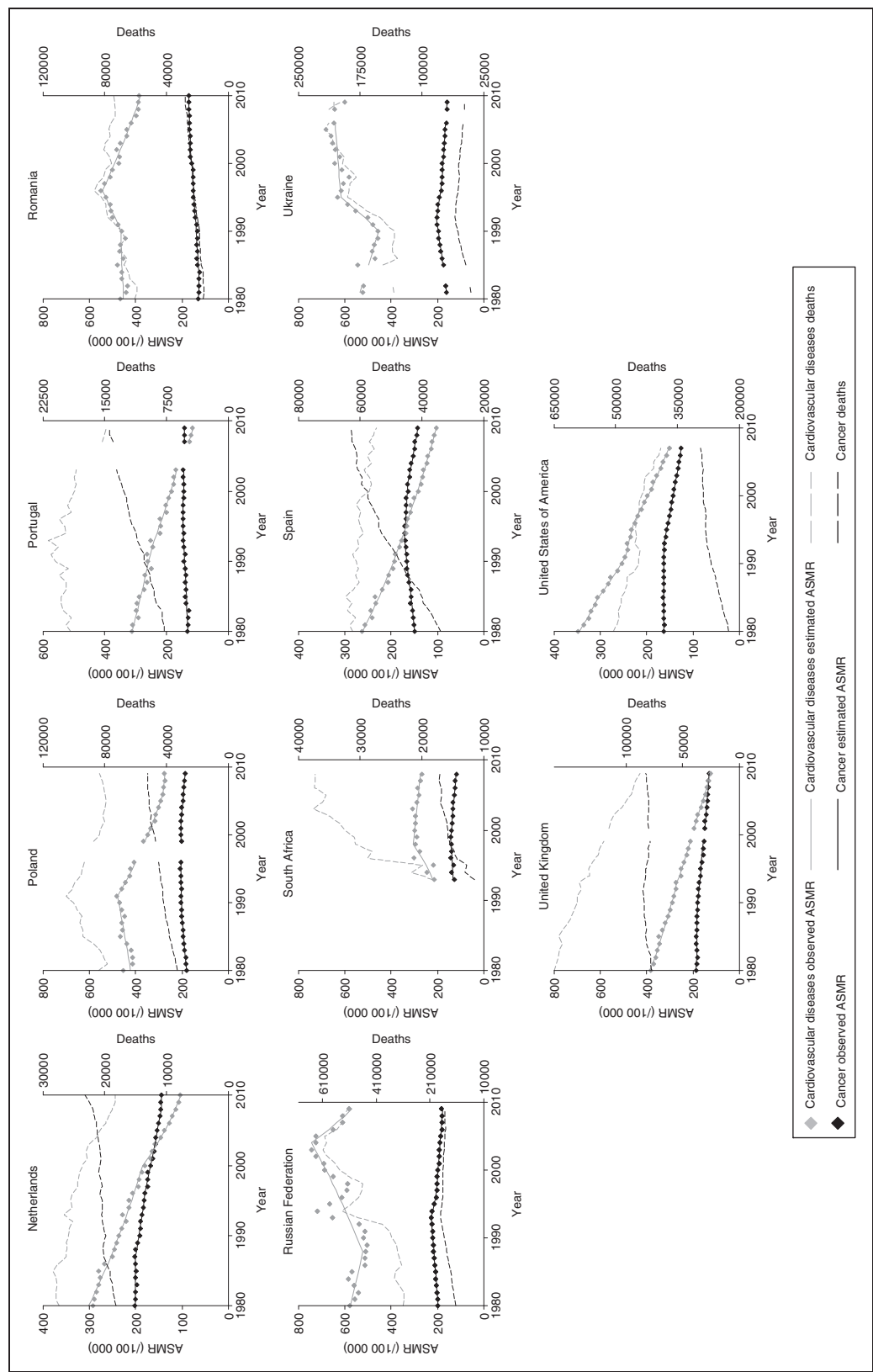


Figure 1. Continued.

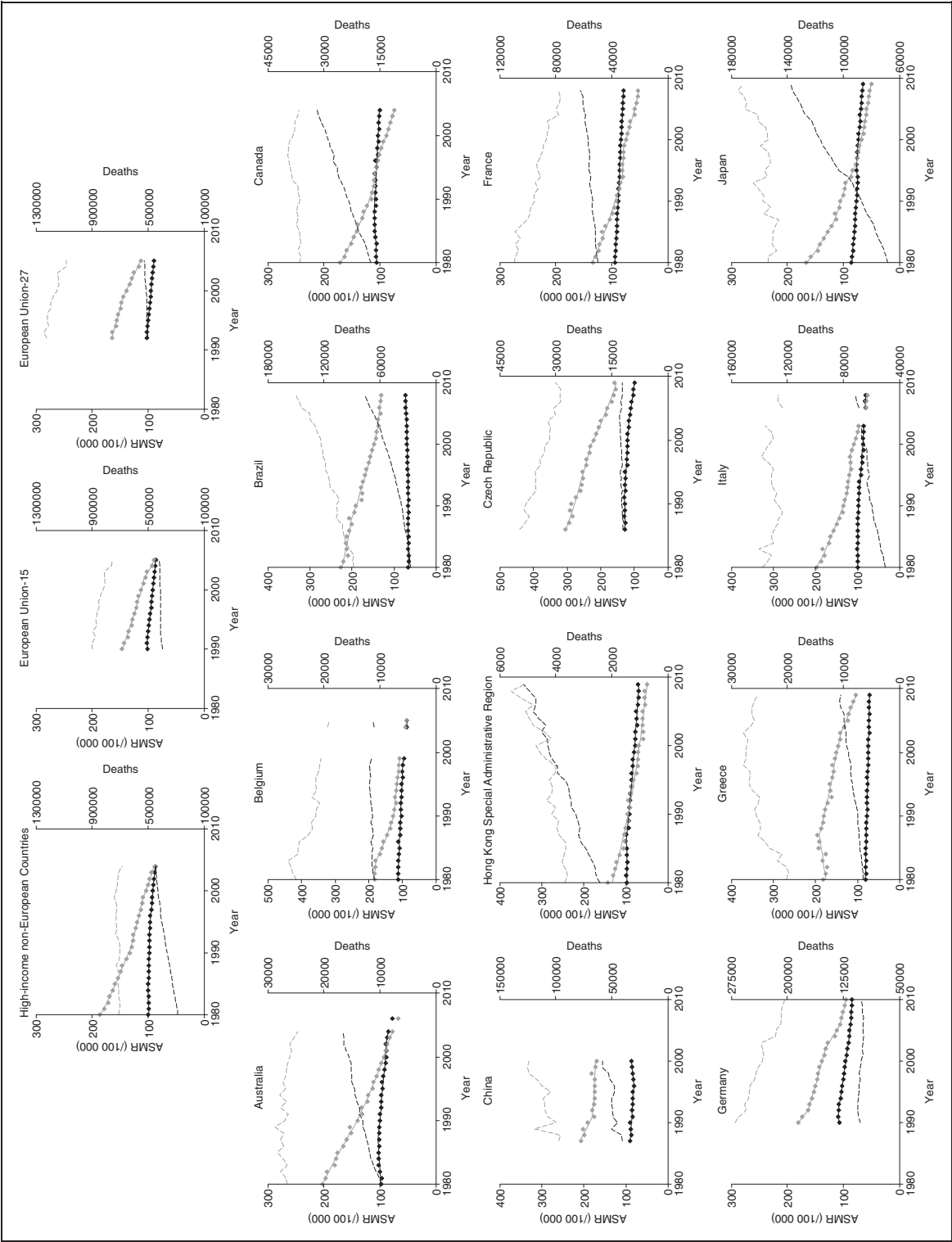


Figure 2. Trends in age-standardized mortality rate and number of deaths by cause in women. The analyses of aggregated data of high-income non-European countries and the EU refer to the periods with available data for all the countries (high-income non-European, 1980–2004; EU-15, 1990–2005; EU-27, 1992–2005); interpolation of missing years was performed in these groups.

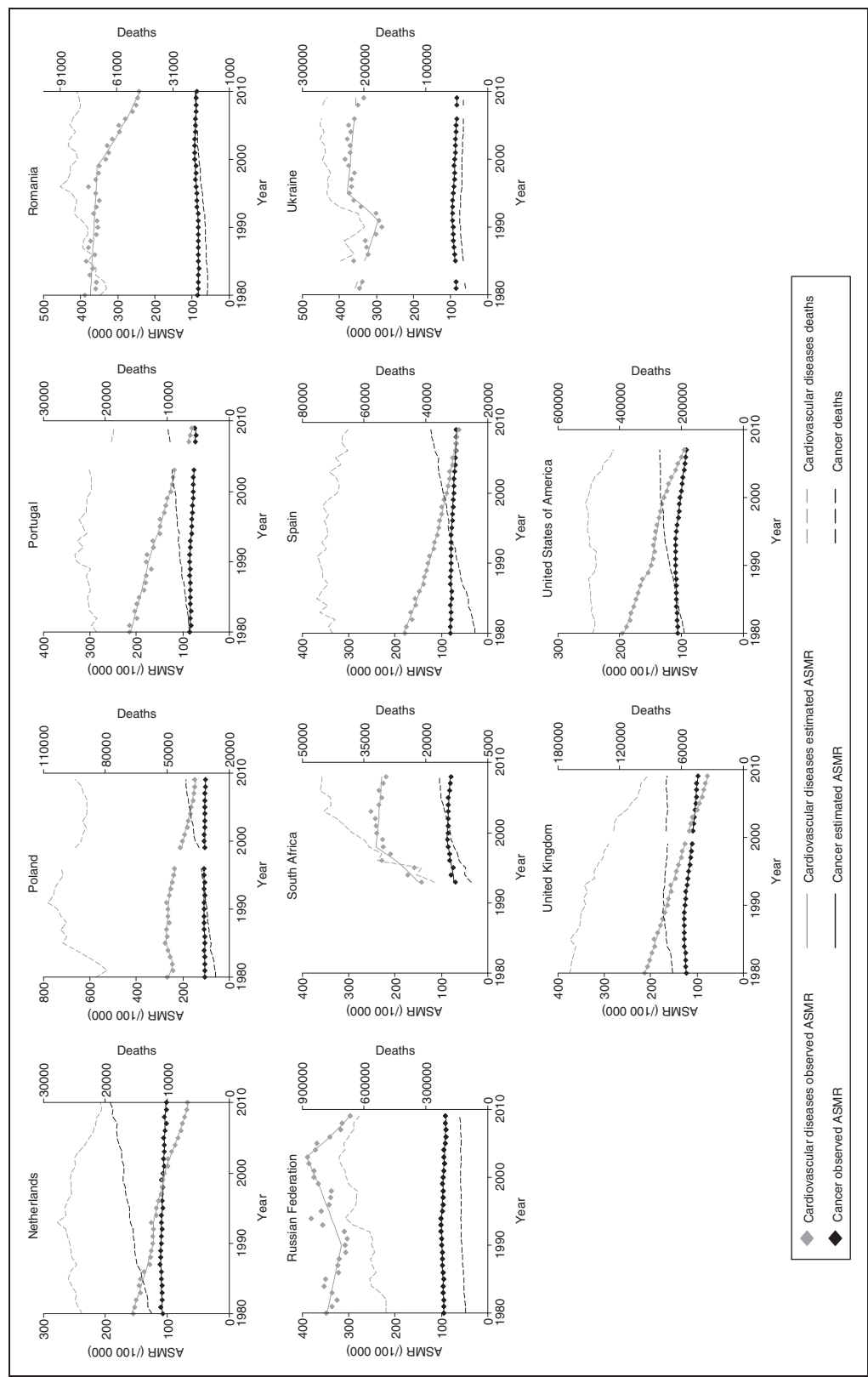


Figure 2. Continued.

Table 1. Annual percentage change (APC) in age-standardized mortality rates (world population) in the periods of homogeneous variation identified by joinpoint analysis by cause of death in men

Country	Cause	Trend 1			Trend 2			Trend 3			Trend 4		
		Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI
HI non-European	CVD	1980–1991	–3.5	–3.7 to –3.3	1991–1995	–2.1	–3.5 to –0.8	1995–2004	–3.4	–3.7 to –3.2			
	Cancer	1980–1990	0.0	–0.1 to 0.1	1990–1996	–0.5	–0.8 to –0.3	1996–2004	–1.7	–1.8 to –1.6			
EU-15	CVD	1990–1999	–2.7	–3.0 to –2.4	1999–2005	–4.4	–5.0 to –3.9						
	Cancer	1990–1993	–0.6	–1.0 to –0.2	1993–2003	–1.6	–1.6 to –1.5	2003–2005	–2.0	–2.8 to –1.2			
EU-27	CVD	1992–1998	–2.2	–2.8 to –1.7	1998–2005	–3.9	–4.3 to –3.5						
	Cancer	1992–2002	–1.2	–1.3 to –1.2	2002–2005	–1.7	–2.1 to –1.3						
Australia	CVD	1980–1996	–4.2	–4.3 to –4.0	1996–2003	–4.9	–5.7 to –4.0	2003–2006	–7.5	–10.1 to –4.8			
	Cancer	1980–1994	–0.5	–0.6 to –0.3	1994–2003	–1.8	–2.2 to –1.5	2003–2006	–3.6	–5.1 to –2.1			
Belgium	CVD	1980–1985	–2.1	–3.0 to –1.2	1985–1988	–7.4	–11.3 to –3.3	1988–1996	–2.3	–2.9 to –1.7	1996–2005	–3.2	–3.7 to –2.8
	Cancer	1980–1985	0.2	–0.6 to 1.0	1985–1991	–1.4	–2.2 to –0.6	1991–1995	–0.4	–2.2 to 1.4	1995–2005	–2.5	–2.8 to –2.2
Brazil	CVD	1980–1988	–0.5	–1.1 to 0.1	1988–2002	–2.3	–2.5 to –2.0	2002–2008	–0.7	–1.5 to 0.1			
	Cancer	1980–1985	0.9	0.4 to 1.4	1985–1991	–0.1	–0.6 to 0.4	1991–2008	0.7	0.7 to 0.8			
Canada	CVD	1980–1991	–3.9	–4.1 to –3.6	1991–1998	–2.7	–3.3 to –2.0	1998–2004	–4.9	–5.6 to –4.2			
	Cancer	1980–1988	0.4	0.2 to 0.7	1988–1994	–0.9	–1.4 to –0.4	1994–2004	–1.4	–1.6 to –1.3			
China	CVD	1987–2000	–0.6	–1.1 to –0.1									
	Cancer	1987–2000	–0.2	–0.7 to 0.3									
Hong Kong SAR	CVD	1980–1985	–7.5	–9.7 to –5.2	1985–1995	–2.2	–3.1 to –1.3	1995–2001	–4.8	–6.9 to –2.8	2001–2009	–0.7	–1.7 to 0.3
	Cancer	1980–1996	–0.9	–1.1 to –0.7	1996–2009	–1.9	–2.2 to –1.7						
Czech Republic	CVD	1986–1990	–0.1	–2.1 to 2.0	1990–2009	–3.5	–3.7 to –3.3						
	Cancer	1986–1990	0.6	–0.4 to 1.7	1990–2004	–1.2	–1.3 to –1.0	2004–2007	–4.2	–7.4 to –1.0	2007–2009	–0.6	–3.9 to 2.8
France	CVD	1980–1986	–2.3	–3.1 to –1.5	1986–1989	–6.0	–10.6 to –1.2	1989–1999	–2.0	–2.4 to –1.5	1999–2008	–4.3	–4.8 to –3.9
	Cancer	1980–1987	0.2	0.0 to 0.4	1987–1992	–0.7	–1.2 to –0.1	1992–2000	–1.4	–1.6 to –1.2	2000–2008	–2.1	–2.2 to –1.9
Germany	CVD	1990–2000	–3.0	–3.3 to –2.6	2000–2010	–4.6	–5.0 to –4.3						
	Cancer	1990–1993	–0.3	–1.4 to 0.9	1993–2010	–1.9	–2.0 to –1.8						
Greece	CVD	1980–1986	1.9	0.8 to 3.1	1986–2003	–1.3	–1.6 to –1.1	2003–2009	–4.0	–5.1 to –3.0			
	Cancer	1980–1994	0.2	0.0 to 0.4	1994–2009	–0.4	–0.6 to –0.3						
Italy	CVD	1980–1990	–3.8	–4.2 to –3.4	1990–1999	–1.9	–2.5 to –1.2	1999–2008	–4.8	–5.3 to –4.2			
	Cancer	1980–1988	0.4	0.1 to 0.7	1988–1993	–1.0	–1.8 to –0.2	1993–2008	–1.9	–2.0 to –1.8			
Japan	CVD	1980–1986	–5.1	–6.0 to –4.1	1986–2009	–3.0	–3.1 to –2.8						
	Cancer	1980–1993	0.1	0.0 to 0.2	1993–1996	1.4	–0.5 to 3.2	1996–2009	–1.7	–1.8 to –1.6			
Netherlands	CVD	1980–2000	–2.4	–2.6 to –2.3	2000–2010	–5.7	–6.2 to –5.2						
	Cancer	1980–1987	0.0	–0.3 to 0.3	1987–1996	–1.2	–1.5 to –0.9	1996–2008	–1.8	–1.9 to –1.6	2008–2010	0.0	–2.3 to 2.3
Poland	CVD	1980–1991	1.1	0.6 to 1.7	1991–2006	–3.5	–3.8 to –3.1	2006–2009	–0.9	–4.9 to 3.2			
	Cancer	1980–1988	1.5	1.3 to 1.8	1988–2002	0.1	0.0 to 0.2	2002–2009	–1.4	–1.7 to –1.1			

(continued)

Table 1. Continued.

Country	Cause	Trend 1			Trend 2			Trend 3			Trend 4		
		Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI
Portugal	CVD	1980–1992	−1.9	−2.4 to −1.4	1992–2003	−3.5	−4.1 to −2.9	2003–2009	−6.3	−10.8 to −1.5			
	Cancer	1980–1995	0.8	0.6 to 1.0	1995–2009	−0.3	−0.4 to −0.1						
Romania	CVD	1980–1990	0.2	−0.3 to 0.8	1990–1996	2.7	1.1 to 4.2	1996–2010	−2.5	−2.9 to −2.2			
	Cancer	1980–1983	−0.9	−3.7 to 1.9	1983–2002	1.4	1.2 to 1.5	2002–2010	0.6	0.1 to 1.1			
Russian Federation	CVD	1980–1988	−1.2	−3.8 to 1.5	1988–2004	2.2	1.4 to 3.1	2004–2009	−5.2	−9.0 to −1.1			
	Cancer	1980–1993	1.1	0.9 to 1.3	1993–1996	−3.1	−5.9 to −0.3	1996–2009	−1.1	−1.3 to −1.0			
South Africa	CVD	1993–1998	6.8	1.9 to 11.9	1998–2008	−1.1	−2.4 to 0.3						
	Cancer	1993–1999	1.5	0.1 to 2.8	1999–2008	−2.0	−2.7 to −1.4						
Spain	CVD	1980–1998	−2.9	−3.1 to −2.8	1998–2009	−3.6	−3.9 to −3.2						
	Cancer	1980–1993	1.0	0.9 to 1.2	1993–2001	−0.5	−0.8 to −0.2	2001–2009	−1.7	−2.0 to −1.5			
UK	CVD	1980–1993	−2.7	−2.9 to −2.5	1993–2002	−4.0	−4.5 to −3.5	2002–2009	−5.6	−6.2 to −5.0			
	Cancer	1980–1990	−0.2	−0.4 to 0.0	1990–2009	−1.7	−1.8 to −1.7						
Ukraine	CVD	1981–1990	−1.8	−3.1 to −0.5	1990–1995	6.3	2.1 to 10.7	1995–2009	0.4	−0.2 to 0.9			
	Cancer	1981–1992	2.2	2.0 to 2.4	1992–1996	−2.6	−4.0 to −1.2	1996–2009	−1.2	−1.3 to −1.0			
USA	CVD	1980–1985	−2.5	−3.1 to −1.9	1985–1991	−3.5	−4.1 to −2.9	1991–1996	−1.5	−2.4 to −0.6	1996–2007	−3.6	−3.8 to −3.4
	Cancer	1980–1993	0.0	−0.1 to 0.0	1993–2007	−1.8	−1.9 to −1.8						

The analyses of aggregated data of high-income non-European countries and the EU refer to the periods with available data for all the countries (high-income non-European, 1980–2004; EU-15, 1990–2005; EU-27, 1992–2005); interpolation of missing years was performed in these groups. The maximum number of joinpoints allowed was set to three. CVD, cardiovascular diseases; EU-15, European Union 15; EU-27, European Union 27; HI, High-income; SAR, Special Administrative Region.

Table 2. Annual percentage change (APC) in age-standardized mortality rates (world population) in the periods of homogeneous variation identified by joinpoint analysis by cause of death in women

Country	Cause	Trend 1			Trend 2			Trend 3			Trend 4		
		Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI
HI non-European	CVD	1980–1991	-3.1	-3.3 to -2.9	1991–1999	-2.3	-2.7 to -1.9	1999–2004	-3.8	-4.5 to -3.1			
	Cancer	1980–1984	0.1	-0.1 to 0.4	1984–1995	-0.3	-0.3 to -0.2	1995–2004	-1.2	-1.2 to -1.1			
EU-15	CVD	1990–2002	-2.6	-2.8 to -2.3	2002–2005	-5.7	-7.6 to -3.7						
	Cancer	1990–1993	-0.4	-0.9 to 0.0	1993–1996	-1.5	-2.4 to -0.7	1996–2005	-1.1	-1.2 to -1.0			
EU-27	CVD	1992–1999	-1.9	-2.4 to -1.4	1999–2005	-3.9	-4.5 to -3.3						
	Cancer	1992–2005	-1.0	-1.0 to -1.0									
Australia	CVD	1980–1985	-3.1	-4.2 to -1.9	1985–2003	-4.0	-4.2 to -3.9	2003–2006	-6.4	-9.2 to -3.6			
	Cancer	1980–1987	0.7	0.1 to 1.4	1987–2003	-1.0	-1.2 to -0.9	2003–2006	-3.7	-5.6 to -1.7			
Belgium	CVD	1980–1983	-1.1	-3.2 to 1.1	1983–1990	-4.8	-5.6 to -4.0	1990–1999	-1.7	-2.2 to -1.1	1999–2005	-3.5	-8.5 to 1.9
	Cancer	1980–1997	-0.7	-0.9 to -0.6	1997–2005	-1.8	-2.3 to -1.3						
Brazil	CVD	1980–1988	-1.4	-2.0 to -0.7	1988–2003	-2.5	-2.7 to -2.2	2003–2008	-1.0	-2.0 to 0.1			
	Cancer	1980–1995	0.1	0.0 to 0.2	1995–2008	0.7	0.6 to 0.7						
Canada	CVD	1980–1991	-3.6	-3.8 to -3.4	1991–1997	-1.8	-2.5 to -1.2	1997–2004	-4.4	-4.8 to -4.0			
	Cancer	1980–1988	0.5	0.1 to 0.9	1988–2004	-0.5	-0.7 to -0.4						
China	CVD	1987–1991	-3.9	-6.1 to -1.7	1991–2000	-0.5	-1.1 to 0.1						
	Cancer	1987–1996	-1.1	-1.5 to -0.7	1996–2000	1.6	0.3 to 3.0						
Hong Kong SAR	CVD	1980–2009	-3.3	-3.5 to -3.1									
	Cancer	1980–1986	0.2	-0.9 to 1.3	1986–2009	-1.5	-1.7 to -1.4						
Czech Republic	CVD	1986–1999	-2.1	-2.4 to -1.7	1999–2009	-4.0	-4.6 to -3.5						
	Cancer	1986–1991	0.3	-0.7 to 1.3	1991–2003	-0.9	-1.2 to -0.6	2003–2009	-2.5	-3.2 to -1.8			
France	CVD	1980–1994	-3.6	-3.8 to -3.3	1994–1999	-0.6	-2.7 to 1.4	1999–2008	-4.6	-5.2 to -3.9			
	Cancer	1980–2008	-0.6	-0.6 to -0.6									
Germany	CVD	1990–1992	-4.9	-8.1 to -1.6	1992–2002	-2.1	-2.4 to -1.8	2002–2006	-5.4	-7.1 to -3.6	2006–2010	-2.6	-3.8 to -1.4
	Cancer	1990–1992	0.4	-1.1 to 2.0	1992–2006	-1.6	-1.7 to -1.5	2006–2010	-0.6	-1.1 to -0.1			
Greece	CVD	1980–1987	1.2	0.3 to 2.2	1987–2003	-1.9	-2.2 to -1.6	2003–2009	-4.9	-6.0 to -3.8			
	Cancer	1980–2009	-0.5	-0.5 to -0.4									
Italy	CVD	1980–1992	-3.8	-4.1 to -3.4	1992–1999	-1.1	-2.2 to 0.0	1999–2008	-4.6	-5.2 to -4.0			
	Cancer	1980–1988	0.1	-0.2 to 0.5	1998–2008	-1.1	-1.2 to -1.0						
Japan	CVD	1980–1987	-5.0	-5.6 to -4.5	1987–1993	-3.1	-4.1 to -2.2	1993–1996	-6.6	-10.9 to -2.1	1996–2009	-3.2	-3.4 to -2.9
	Cancer	1980–1993	-1.0	-1.1 to 0.9	1993–1996	1.0	-0.9 to 3.0	1996–2009	-1.2	-1.3 to -1.1			
Netherlands	CVD	1980–1990	-2.4	-2.8 to -2.1	1990–1993	0.0	-4.7 to 5.0	1993–2001	-2.4	-3.1 to -1.8	2001–2010	-4.6	-5.1 to -4.1
	Cancer	1980–1989	0.3	-0.1 to 0.6	1989–2010	-0.4	-0.5 to -0.3						
Poland	CVD	1980–1982	-3.5	-9.3 to 2.6	1982–1985	4.0	-1.9 to 10.3	1985–1993	-0.8	-1.5 to 0.0	1993–2009	-3.6	-3.8 to -3.3
	Cancer	1980–1988	0.4	0.1 to 0.6	1988–2003	-0.1	-0.2 to 0.1	2003–2009	-0.8	-1.1 to -0.4			

(continued)

Table 2. Continued.

Country	Cause	Trend 1			Trend 2			Trend 3			Trend 4		
		Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI	Period	APC	95% CI
Portugal	CVD	1980–1991	−2.0	−2.5 to −1.6	1991–2003	−3.1	−3.5 to −2.6	2003–2009	−6.4	−9.9 to −2.7			
	Cancer	1980–1990	0.2	−0.2 to 0.5	1990–2009	−0.9	−1.0 to −0.7						
Romania	CVD	1980–1999	−0.3	−0.5 to 0.0	1999–2010	−3.5	−4.0 to −3.0						
	Cancer	1980–1990	−0.1	−0.3 to 0.2	1990–2001	1.0	0.8 to 1.3	2001–2010	−0.6	−0.9 to −0.3			
Russian Federation	CVD	1980–1990	−0.9	−2.1 to 0.2	1990–2003	1.6	0.8 to 2.5	2003–2009	−4.4	−6.6 to −2.2			
	Cancer	1980–1993	0.4	0.3 to 0.6	1993–2009	−0.6	−0.7 to −0.5						
South Africa	CVD	1993–1998	10.0	4.2 to 16.1	1998–2008	−0.5	−1.9 to 0.9						
	Cancer	1993–1999	3.2	1.7 to 4.7	1999–2008	−0.9	−1.6 to −0.3						
Spain	CVD	1980–2009	−3.5	−3.6 to −3.4									
	Cancer	1980–1994	−0.1	−0.3 to 0.0	1994–2009	−1.0	−1.2 to −0.9						
UK	CVD	1980–1993	−2.5	−2.6 to −2.3	1993–2002	−3.3	−3.7 to −2.9	2002–2009	−5.5	−6.0 to −4.9			
	Cancer	1980–1988	0.6	0.3 to 0.8	1988–2009	−1.3	−1.3 to −1.2						
Ukraine	CVD	1981–1991	−1.9	−2.9 to −0.8	1991–1995	6.4	0.1 to 13.1	1995–2009	−0.5	−1.0 to 0.1			
	Cancer	1981–1992	1.2	1.0 to 1.4	1992–1997	−1.3	−2.1 to −0.5	1997–2009	−0.7	−0.9 to −0.5			
USA	CVD	1980–1987	−2.1	−2.5 to −1.7	1987–1990	−3.6	−6.6 to −0.4	1990–2000	−1.3	−1.6 to −1.0	2000–2007	−4.3	−4.7 to −3.8
	Cancer	1980–1985	0.6	0.4 to 0.8	1985–1994	0.1	0.0 to 0.2	1994–2002	−1.2	−1.3 to −1.1	2002–2007	−1.6	−1.8 to −1.4

The analyses of aggregated data of high-income non-European countries and the EU refer to the periods with available data for all the countries (high-income non-European, 1980–2004; EU-15, 1990–2005; EU-27, 1992–2005); interpolation of missing years was performed in these groups. The maximum number of joinpoints allowed was set to three. CVD, cardiovascular diseases; EU-15, European Union 15; EU-27, European Union 27; HI, High-income; SAR, Special Administrative Region.

number of CVD deaths among individual countries ranged between -45.0% and -4.0% in men and between -41.6% and -5.5% in women (Table 3 and Appendix 6).

Regarding cancer mortality, there was an increase in the number of deaths in most settings, with relative variation ranging between -3.6% and 153.1% in men and between -4.3% and 163.5% in women.

Between 1980 and 2008 the absolute number of cancer deaths became higher than the number of CVD deaths in men from France, Hong Kong SAR, Japan, Netherlands, Slovenia, and Spain. Among women, the number of CVD deaths is still higher than for cancer in all countries analysed.

Discussion

In high-income countries, CVD mortality trends are characterized by steep declines over the last decades, while a downward trend in cancer mortality started more recently and was less pronounced. This resulted in the gradual convergence of the CVD and cancer mortality rates, and the latter are already higher in some countries. Among the BRICS, China and South Africa share a similar pattern of no meaningful variation in both CVD and cancer ASMR and an increase in the overall number of deaths by these causes. Brazil and Hong Kong SAR present trends similar to those of high-income countries, except for the still increasing number of CVD deaths.

The present study provides a comprehensive overview of the trends in major causes of death worldwide, but some limitations need to be discussed. Since we are analysing broad groups of causes of death, mostly in the more developed areas of the world, differences in the quality of coding between countries and over the years or the use of three different revisions of the International Classification of Diseases (ICD) are not expected to compromise the comparability of data across countries or over time.^{10,11} Still, there are issues of completeness of death certification and content validity that may vary, especially in BRICS and some of the middle-income countries included in our analyses. For example, the absence of sustained health monitoring after the collapse of the Soviet Union raises concerns regarding data quality in several Eastern European countries; however, analyses conducted in Russia showed that the exceedingly high CVD mortality was real and its key determinant was alcohol abuse.¹² In some countries, the mortality rates may be underestimated and the trends may not apply to the whole country because data on the number of deaths is available to less than 90% of the population, namely Albania (70.8%), Brazil (79.7%), Republic of Moldova (83.2%), Serbia (83.1%), South Africa (76.9%), and the Former Yugoslav Republic of

Macedonia (89.2%); however, this is not expected to meaningfully compromise the comparison of the rates over time. Such concerns are higher for China, since mortality data covers less than 10% of the entire population and are limited by the use of verbal autopsy methods in rural areas;¹³ nevertheless, these are the best available data for this country, and, as such, still useful, namely taking into account that these data are expected to represent the whole country population.¹⁴

Our results are in accordance with the 2004 update of WHO's *The global burden of disease*,¹ with CVD depicting the highest mortality burden in terms of the absolute number of deaths, particularly in women, while the relevance of cancer as a leading cause of death is directly related with socioeconomic status of countries.

Although distinct cardiovascular diseases and cancers share some important risk factors, the strength of the associations and lag-times are different; the geographical distribution and trends of these exposures are therefore expected to have a different impact on the mortality by CVD or cancer.

Smoking increases the risk of stroke and myocardial infarction by 2–4-fold, and the trends in CVD ASMR are closely associated with the variation in the patterns of smoking.^{15–17} However, the variation in the patterns of smoking had also a major contribution to the declines in cancer ASMR among men, and for the less favourable trends among women,¹⁸ since lung cancer is one of the most important causes of cancer death in most developed settings (Appendix 8). In contrast, although alcohol consumption is strongly associated with upper digestive and respiratory tract cancers,¹⁹ it has a smaller contribution to the overall cancer mortality than other risk factors.²⁰ Conversely, alcohol abuse is a major determinant of the CVD ASMR fluctuations, as already shown in Eastern European countries.¹²

The decline in stomach cancer mortality among high-income countries, largely explained by the reduction in the prevalence of *Helicobacter pylori* infection, and the access to a better diet that accompanied the general improvement in the populations' living conditions,²¹ had an important contribution to overall reduction in cancer mortality (Appendix 8). Colorectal, breast, and prostate are the cancer sites responsible for a larger number of deaths (Appendix 8) and the recent decline in their ASMR contributes to the overall reduction in cancer mortality. This probably reflects a more effective control of cancer through the increase in the proportion of the population covered by effective screening practices, especially among women,^{22,23} or the access to more effective management strategies.^{24,25}

The obesity epidemic^{26,27} may slow down, or even reverse, the observed downward trends in the mortality from colorectal and selected hormone-related cancers,

Table 3. Sex- and cause-specific number of deaths and respective absolute and relative variation

Country	Overall period	Cause	Men				Women			
			No. of deaths		Variation		No. of deaths		Variation	
			Initial	Final	Absolute (n)	Relative (%)	Initial	Final	Absolute (n)	Relative (%)
HI non-European	1980–2004	CVD	730,365	636,921	−93,444	−12.8	704,131	704,505	374	0.1
		Cancer	365,093	536,760	171,668	47.0	295,373	443,310	147,937	50.1
EU-15	1990–2005	CVD	744,232	627,931	−116,301	−15.6	893,238	777,397	−115,841	−13.0
		Cancer	505,589	537,106	31,517	6.2	404,965	419,792	14,827	3.7
EU-27	1992–2005	CVD	1,052,579	920,170	−132,409	−12.6	1,225,269	1,105,130	−120,139	−9.8
		Cancer	640,717	677,002	36,286	5.7	504,215	525,718	21,503	4.3
Australia	1980–2006	CVD	29,369	21,727	−7642	−26.0	27,000	23,881	−3119	−11.6
		Cancer	13,761	21,158	7397	53.7	10,230	16,383	6153	60.1
Belgium	1980–2005	CVD	23,945	15,791	−8154	−34.1	25,453	19,161	−6292	−24.7
		Cancer	15,468	14,907	−561	−3.6	11,222	11,122	−100	−0.9
Brazil	1980–2008	CVD	102,532	162,270	59,738	58.3	88,367	147,109	58,742	66.5
		Cancer	33,841	85,639	51,798	153.1	27,807	73,286	45,478	163.5
Canada	1980–2004	CVD	43,714	36,671	−7043	−16.1	36,504	37,203	700	1.9
		Cancer	22,690	34,802	12,112	53.4	17,962	31,262	13,300	74.0
China	1987–2000	CVD	108,101	140,128	32,027	29.6	104,157	124,346	20,190	19.4
		Cancer	71,952	93,085	21,134	29.4	44,272	56,366	12,094	27.3
Hong Kong SAR	1980–2009	CVD	3757	5578	1821	48.5	3641	5311	1671	45.9
		Cancer	4080	7600	3520	86.3	2529	4937	2409	95.3
Czech Republic	1986–2009	CVD	33,785	23,716	−10,070	−29.8	38,326	29,232	−9093	−23.7
		Cancer	15,489	15,337	−152	−1.0	12,096	12,200	104	0.9
France	1980–2008	CVD	93,130	68,224	−24,907	−26.7	108,376	77,572	−30,803	−28.4
		Cancer	75,519	88,971	13,452	17.8	50,534	61,227	10,694	21.2
Germany	1990–2010	CVD	188,392	149,419	−38,973	−20.7	263,610	205,874	−57,736	−21.9
		Cancer	104,974	117,082	12,108	11.5	104,436	99,985	−4451	−4.3
Greece	1980–2009	CVD	18,603	23,403	4800	25.8	20,036	25,866	5830	29.1
		Cancer	10,058	16,633	6575	65.4	6566	10,557	3991	60.8
Italy	1980–2008	CVD	124,112	97,485	−26,627	−21.5	134,505	125,839	−8666	−6.4
		Cancer	72,892	93,013	20,121	27.6	50,988	70,272	19,284	37.8
Japan	1980–2009	CVD	152,560	158,064	5504	3.6	151,626	172,665	21,039	13.9
		Cancer	96,380	205,154	108,775	112.9	69,718	136,029	66,311	95.1
Netherlands	1980–2010	CVD	27,714	18,454	−9260	−33.4	24,350	20,891	−3459	−14.2
		Cancer	18,441	22,531	4090	22.2	12,918	18,960	6042	46.8
Poland	1980–2009	CVD	81,092	81,975	883	1.1	82,171	92,119	9948	12.1
		Cancer	33,887	52,325	18,438	54.4	26,868	40,785	13,916	51.8
Portugal	1980–2009	CVD	19,290	15,043	−4247	−22.0	21,690	18,803	−2887	−13.3
		Cancer	7899	14,278	6379	80.8	6521	9752	3231	49.6
Romania	1980–2010	CVD	59,750	73,500	13,750	23.0	67,913	81,179	13,265	19.5
		Cancer	16,130	27,849	11,719	72.7	12,609	18,981	6372	50.5
Russian Federation	1980–2009	CVD	308,384	527,847	219,463	71.2	493,542	641,428	147,885	30.0
		Cancer	118,710	154,398	35,688	30.1	109,876	133,364	23,488	21.4
South Africa	1993–2008	CVD	19,945	37,314	17,369	87.1	20,386	45,374	24,988	122.6
		Cancer	12,455	17,052	4597	36.9	10,010	16,580	6570	65.6
Spain	1980–2009	CVD	62,413	55,851	−6562	−10.5	70,355	66,474	−3881	−5.5
		Cancer	35,175	62,824	27,649	78.6	24,486	38,020	13,533	55.3
UK	1980–2010	CVD	161,427	90,936	−70,490	−43.7	167,184	97,621	−69,563	−41.6
		Cancer	77,855	81,789	3934	5.1	69,049	74,715	5667	8.2
Ukraine	1981–2009	CVD	134,907	206,317	71,410	52.9	205,565	264,048	58,483	28.4
		Cancer	41,257	48,796	7539	18.3	36,911	39,140	2229	6.0

(continued)

Table 3. Continued.

Country	Overall period	Cause	Men				Women			
			No. of deaths		Variation		No. of deaths		Variation	
			Initial	Final	Absolute (n)	Relative (%)	Initial	Final	Absolute (n)	Relative (%)
USA	1980–2007	CVD	498,103	398,171	–99,932	–20.1	483,095	434,784	–48,312	–10.0
		Cancer	229,232	291,829	62,597	27.3	194,900	269,735	74,834	38.4

Data on the No. of deaths are the mean of the initial or the final 3 years, as applicable, or those available in these periods for each country. The analyses of aggregated data of high-income non-European countries and the EU refer to the periods with available data for all the countries (high-income non-European, 1980–2004; EU-15, 1990–2005; EU-27, 1992–2005); interpolation of missing years was performed in these groups. CVD, cardiovascular diseases; EU-15, European Union 15; EU-27, European Union 27; HI, High-income; SAR, Special Administrative Region.

as well as CVD. Specifically, the mortality for ischemic heart disease at younger adult ages already started to increase in some European countries, and this has been attributed mostly to the effect of increasing prevalence of obesity and diabetes.²⁸

The decline in CVD mortality observed among high-income countries has been explained with increased control of cholesterol levels and hypertension, which directly affect the incidence of CVD.^{15–17} Also, evidence-based pharmacological and interventional therapies, such as thrombolysis, percutaneous coronary angioplasty, statins, and angiotensin-converting enzyme inhibitors, led to the decline of ischemic heart disease case-fatality rates, contributing to explain approximately half of the decline in the disease-specific mortality.^{15–17} The efficacy of acute management and secondary prevention for stroke is less pronounced and the proportion of cases covered is in general smaller.²⁹ This could explain the steeper decline in ischemic heart disease than stroke mortality rates in most settings (Appendix 7), particularly among men, since for a long time women have consistently been less aggressively diagnosed and treated.^{30,31}

In conclusion, in a few high-income countries the ASMR for CVD are currently lower than those for cancer, and the consistent decreases in CVD mortality over the last decades have overcome the impact of the growth and ageing of populations in the overall number of deaths. On the other hand, stabilization in the absolute number of cancer deaths was observed only in some of the more affluent countries, reflecting more modest and less generalized declines in the cancer ASMR, as well as the reduction of the importance of CVD as a competing risk.

These findings show that a higher mortality of cancer than CVD is to be expected in the next decades, along with an increased burden over the health systems. This underlines the need to reinforce primary prevention, namely through the control of risk factors such as smoking or obesity, along with a rational use of early

diagnosis and management strategies proved to be effective for mortality reduction.

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Conflict of interest

The authors declare that there is no conflict of interest.

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