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ORIGINAL ARTICLE

Changing patterns of mortality in 25 European countries and their economic and political correlates, 1955–1989

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Abstract
Objectives We investigated trends in mortality in European countries by cause of death in the period 1955–1989, and studied the role of economic and political conditions.
Methods We extracted data on age-standardised mortality by country ($n = 25$), sex, cause of death ($n = 17$) and calendar year from an internationally harmonised dataset. We analysed changes in dispersion of mortality as well as changes in the association of mortality with average income and levels of democracy.
Results After 1960, dispersion in all-cause mortality in Europe as a whole increased due to diverging trends for many specific causes of death, particularly for cerebrovascular disease. This coincided with widening disparities in average income, and strengthening of the association between levels of democracy and mortality. Divergence in Central and Eastern Europe could largely be explained from stagnating trends in average income and an increasing mortality disadvantage related to its democratic deficit.
Conclusions Although this was a politically stable period, mortality patterns were highly dynamic, and prefigured the more dramatic mortality trends after 1990. Economic and political stagnation probably explains the diverging trends in Central and Eastern Europe.

Keywords Mortality · Causes of death · Economic conditions · Democracy · Europe

Introduction

Background

For most of Europe, the decades following World War II were a period of unprecedented progress in many areas of life (Black et al. 2000; Judt 2005). Rapid economic growth brought a degree of prosperity everywhere, systems of social security were introduced that reduced the risks of poverty, barriers to health care access were removed by the introduction of tax- or insurance-based national health systems, and new drugs and other treatment modes were developed that brought infectious and several other diseases under control.

Politically, however, Europe was divided between a Western, capitalist bloc, and an Eastern, communist bloc. Within the Western bloc most countries had liberal democracies, although until the mid-1970s Spain, Portugal and Greece were governed by military dictators. Within the Eastern bloc, and despite a few failed attempts at democratisation, political participation of the population was limited and countries were governed by autocratic rule (Black et al. 2000; Judt 2005).

During the 1940s and 1950s the socialist planning system enabled economies in the East to rapidly catch up with those in the West, but during the 1970s and 1980s both parts of Europe increasingly grew apart, not only in economic but also in other terms, due to a general stagnation in the East affecting all spheres of life (Maddison 2003). This would ultimately lead to the collapse of the Soviet Union, and the dissolution of the communist bloc around 1990.

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Mortality trends

Developments in population health in Europe were also remarkable. After many infectious diseases had been brought under control, before and immediately after World War II, other conditions came to the foreground, such as cardiovascular disease, cancer and injuries (Omran 1983). It took some time before ways of preventing or treating these "diseases of affluence" were developed, but after 1970 successes in cardiovascular disease prevention, cancer screening, and road traffic safety, and progress in the medical treatment of these conditions gradually started to bring down mortality from these causes (Olshansky and Ault 1986).

This is illustrated by Fig. 1, which shows that the cause-of-death structure of mortality, as reflected in the shares of specific conditions in all-cause mortality, gradually changed over time. Looking at the average values for Europe as a whole, the shares of "all other causes", pneumonia and influenza declined, whereas those of many other diseases increased. "All other causes" form a heterogeneous group composed of infectious diseases, perinatal and maternal causes, and other conditions which dominated mortality before World War II and continued their decline during the study period.

All-cause mortality in many countries has declined, but more uniformly so among women than among men (Fig. 2a). In Western Europe, male mortality tended to be stable until around 1970, and then started to decline rapidly. In Central and Eastern Europe, however, male mortality never declined much, and generally rose after around 1970. As a result, mortality levels in Western Europe, still very dissimilar in the 1950s, converged to low levels around 1990, while those in Central and Eastern Europe remained high and increasingly moved away from those in Western Europe (Leon 2011; Mackenbach 2013a; Vallin and Meslé 2004).

Mortality convergence in Western Europe is exemplified by the extreme cases of Finland and Portugal (Fig. 2b). Both countries had much faster mortality declines than Sweden, a country in which both male and female mortality levels have been among the lowest in Europe throughout this period. As a result, Finland and Portugal almost closed their mortality gap with Sweden, as did many other Western European countries. Mortality divergence in Central and Eastern Europe is equally universal. Hungary and Bulgaria are good illustrations, where male

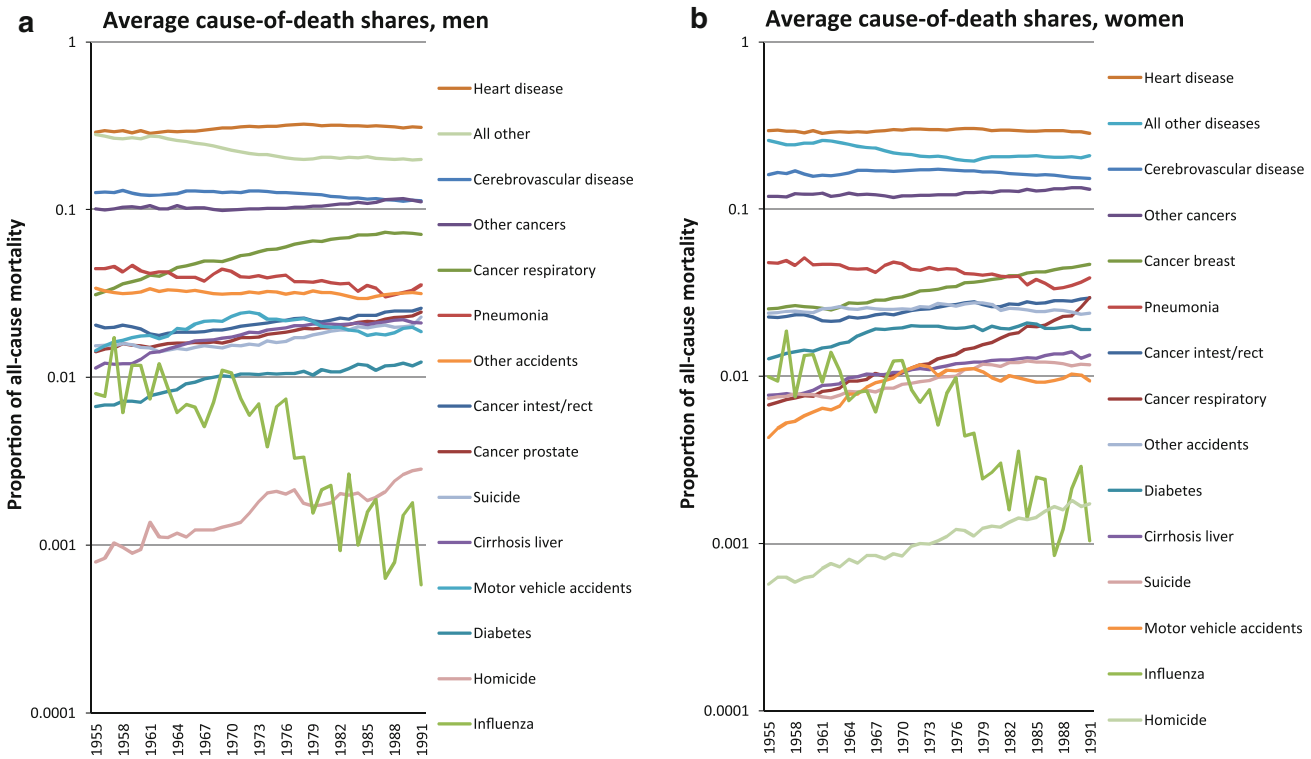

Fig. 1 Changes in cause-of-death shares, average for Europe as a whole, 1955–1991. **a** Men. **b** Women. A more detailed analysis reported in ESM Appendix Table A2 confirms the heterogeneity of mortality trends for specific causes of death. While some conditions follow the trend of all-cause mortality, others such as respiratory cancer, prostate cancer, breast cancer, diabetes, motor vehicle accidents, suicide and homicide do not, or not always, as indicated in ESM Appendix Table A2 by negative regression and correlation coefficients with all-cause mortality among either men or women or both (colour figure online)

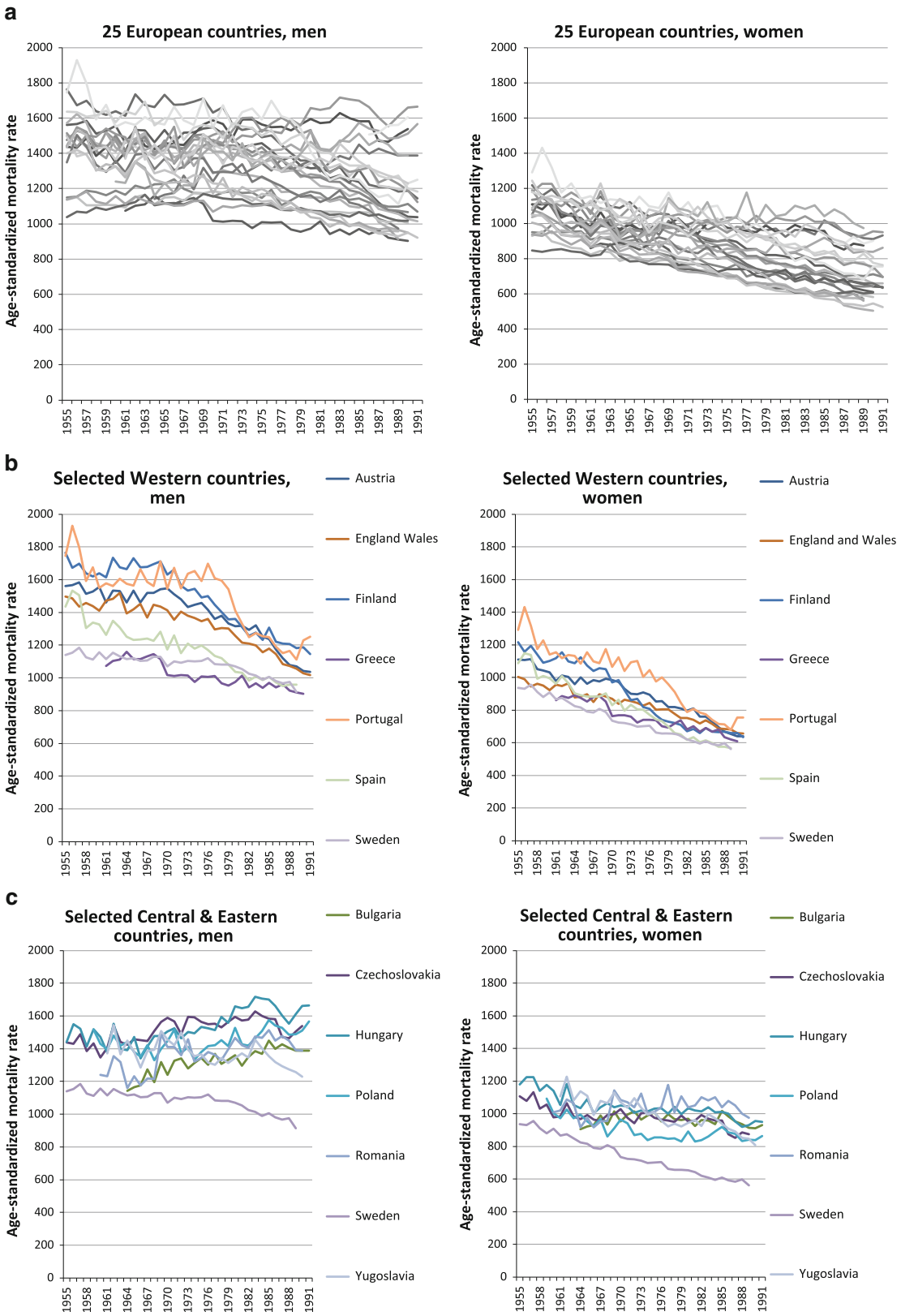

Fig. 2 Trends in age-standardised mortality from all causes, by country and sex, 1955–1991. **a** All countries. **b** Selected Western–European countries. **c** Selected Central and Eastern European countries (and Sweden) (colour figure online)

mortality rose and female mortality stabilised leading to a widening mortality gap with Sweden (Fig. 2c).

As a result of these disparate trends, within the scope of a few decades variation in mortality levels in Europe as a whole increased substantially. These pre-1990 trends can be seen as precursors of what happened after the system changes, when a further divergence took place, with marked mortality increases particularly in the former Soviet Union (Leon 2011; Mackenbach 2013a; Vallin and Meslé 2004; Zatonski 2008).

Study questions

While mortality developments after 1990 have been analysed extensively, those preceding the collapse of the Soviet Union have been less thoroughly investigated. For example, the role of specific causes of death in the widening gap in mortality between Western and Central and Eastern Europe after 1990 has been documented thoroughly (Shkolnikov et al. 1996a, b; Vallin and Meslé 2004; Zatonski 2008), but a systematic analysis of the contribution of specific conditions to convergence and divergence before 1990 is lacking.

Furthermore, it is unknown to which extent these developments have been driven by economic and political conditions. The role of economic conditions in determining mortality has been well established (Cutler et al. 2006; Mackenbach and Looman 2013; McKeown 1988; Preston 1975), and the divergence in economic conditions between European countries, therefore, is a possible explanation of diverging mortality trends. The same applies to political conditions: there is an growing body of literature about the positive effects of democracy on population health (Alvarez-Dardet and Franco-Giraldo 2006; Klomp and de Haan 2009; Mackenbach 2013b; Mackenbach et al. 2013; Muntaner et al. 2011), suggesting, for example, that democratisation in Spain, Portugal and Greece may have contributed to mortality convergence in Western Europe in the 1970s.

In this paper, we will analyse the background to the variations in national mortality trends within Europe in the period 1955–1989. The main study questions are:

- To which causes of death can patterns of convergence and divergence of all-cause mortality seen over this period be attributed?
- What has been the role of economic and political conditions in the patterns of convergence and divergence of mortality?

Methods

Age-standardised mortality data by cause of death for 25 middle- and large-sized European countries were extracted from the International Mortality Data Base of the National Center for Health Statistics of the Centers for Disease Control (http://www.cdc.gov/nchs/data/dvs/intmort95.pdf). These data were drawn from tapes originally supplied by the World Health Organization, and age-adjustment was performed by the direct method using the WHO "Old" European standard.

ICD codes are given in ESM appendix table A1. We did not use chronic obstructive pulmonary disease because it was available for a limited number of years and countries only. We created categories of "other cancers" and "all other causes" by subtraction from the next higher level of aggregation, and we then redistributed "signs, symptoms and ill-defined conditions" proportionally over all specific causes of death (excluding injuries). Since in preliminary analyses we noted a sudden increase in mortality from ischemic heart disease, and a simultaneous decrease in mortality from other heart disease in many countries in the late 1960s, during the introduction of ICD-8, we combined these two conditions in one group labelled "heart disease".

Data on average income (i.e., national income per head of population) were extracted from Maddison's dataset (http://www.ggdc.net/MADDISON/oriindex.htm). The national estimates of Gross Domestic Product per head of population in this dataset are based on extensive harmonisation efforts and on a conversion into 1990 International Geary-Khamis dollars (I$) using multilateral Purchasing Power Parities. A more detailed explanation of these data has been published elsewhere (Maddison 2003).

Levels of democracy were indicated by the Polity2 index as compiled by the world-wide and independent Polity IV project (http://www.systemicpeace.org/polity/polity4.htm). We extracted yearly data on this index from the Quality of Government dataset (Teorell et al. 2011) (http://www.qog.pol.gu.se/data/). The Polity2 index indicates a country's position on a continuous scale from 'strongly democratic' (+10) to 'strongly autocratic' (−10), and is a summary score designed to facilitate time-series analyses. It has become the standard measure of democracy in the literature (Wigley and Akkoyunlu-Wigley 2011).

In order to explore the role of economic and political conditions in mortality convergence and divergence, we regressed all-cause and cause-specific mortality rates on average income and levels of democracy using ordinary least squares linear regression, both without mutual control (univariate analyses) and with mutual control (multivariate analyses). We did this for 8 points in time: 1955, 1960, 1965, 1970, 1975, 1980, 1985 and 1989, which allowed us to study changes over time in the association between mortality and these two factors.

In order to evaluate the contribution of specific causes of death to convergence and divergence of all-cause mortality in Finland, Portugal, Hungary and Bulgaria we subtracted

Sweden's age-standardised all-cause and cause-specific mortality rates from the corresponding figures for these four countries. This first allowed us to quantify each country's gap with the benchmark country in all-cause mortality, and then to assess which causes of death contributed most to a widening or narrowing of this gap over time.

We also used the results of the univariate regression analyses mentioned above to calculate predicted all-cause mortality rates for each of the four countries for each of the 8 points in time. These predicted mortality rates were based on each country's average income and level of democracy at that point in time, and on the relationship between average income and level of democracy as observed at that point in time in the whole set of countries. We did the same for Sweden and then subtracted Sweden's predicted values from those for each of the four countries, in order to assess the extent to which each country's mortality convergence or divergence with Sweden was attributable to convergence or divergence of economic or political conditions.

Results

As was noted in the "Introduction", average all-cause mortality has declined, both among men and among women, but variation between countries has increased, both in absolute and relative terms (Table 1). Among men, the standard deviation (SD) increased from 195.2 to 212.3 deaths per 100,000 person-years, and the coefficient of variation (CV) increased from 13.6 to 18.1 %. Among women, the SD increased from 114.6 to 137.8 deaths per 100,000 person-years, and the CV from 10.1 to 19.2 %.

The rise of the SD for all-cause mortality is due to increasing dispersion for a range of causes of death, the most notable being cerebrovascular disease. Despite declining average mortality rates, the SD rose from 37.3 to 60.0 deaths per 100,000 person-years among men, and from 34.7 to 48.7 deaths per 100,000 person-years among women. The CV (not shown in Table 1) rose for most conditions, with a few exceptions only such as respiratory cancer among men for which the CV declined from 42.9 to 26.7 %, indicating mortality convergence in relative terms.

As shown in Table 1, average income also increased substantially, but so did disparities in average income, at least in absolute terms: the SD for average income rose from I$2,341 in 1955 to I$5,042 in 1989, mainly due to slower increases and even stagnation in Central and Eastern Europe. Levels of democracy also rose, partly as a result of democratisation in Spain, Portugal and Greece, partly as a result of the first steps towards democratisation in Central and Eastern Europe in the late 1980s (see ESM appendix figure A1).

Table 1 Summary statistics for cause-specific mortality and two covariates, Europe, 1955–1989

Men	1955		1989		Women	1955		1989	
	Average	SD	Average	SD		Average	SD	Average	SD
Cancer of colorectum	29.0	10.2	28.8	8.5	Cancer of colorectum	24.3	7.9	19.5	5.2
Cancer of respiratory organs	45.5	19.5	84.4	22.5	Cancer of respiratory organs	7.3	2.2	16.3	9.3
Cancer of prostate	19.8	4.4	25.4	8.5	Cancer of breast	26.8	6.6	30.7	7.4
Other cancers	143.3	21.0	133.5	18.4	Other cancers	128.3	18.6	93.2	10.5
Diabetes	9.5	3.4	13.8	5.2	Diabetes	13.6	6.5	13.7	6.2
Heart disease	415.9	104.8	361.9	87.0	Heart disease	319.6	67.9	210.4	59.7
Cerebrovascular disease	180.9	37.3	134.2	60.0	Cerebrovascular disease	174.1	34.7	112.9	48.7
Pneumonia	64.7	24.0	37.5	26.1	Pneumonia	52.1	18.6	25.3	21.1
Influenza	11.9	7.3	1.7	1.4	Influenza	11.0	6.9	1.5	1.4
Cirrhosis of liver	17.1	16.6	26.8	19.1	Cirrhosis of liver	8.4	7.5	10.3	6.9
Motor vehicle accidents	20.3	8.4	22.5	8.6	Motor vehicle accidents	4.6	2.0	7.2	1.7
Other accidents	48.8	13.4	38.4	18.3	Other accidents	25.6	6.2	17.2	6.8
Suicide	21.9	11.2	23.7	13.0	Suicide	7.9	4.5	8.0	4.6
Homicide	1.2	1.1	3.3	3.5	Homicide	0.6	0.4	1.4	1.1
All other	406.9	117.2	238.4	83.5	All other	280.6	77.1	149.3	58.1
All causes	1,436.6	195.2	1,174.4	212.3	All causes	1,084.9	114.6	717.0	137.8
National income (GDP)	4,815	2,341	12,861	5,042	National income (GDP)	4,815	2,341	12,861	5,042
Democracy	3.00	8.29	6.26	6.08	Democracy	3.00	8.29	6.26	6.08

Age-standardised mortality rates, in deaths per 100,000 person-years

Average average of age-standardised mortality rates, *SD* standard deviation of age-standardised mortality rates, *GDP* Gross Domestic Product

In 1955, higher average income went together with lower all-cause mortality among women only (although the association was only marginally statistically significant, $P = 0.06$), but levels of democracy were not related to all-cause mortality (Table 2). In 1989, however, both variables were independently associated with all-cause mortality, both among men and women. These associations with all-cause mortality are the net effect of complex relations with cause-specific mortality. In 1989, average income was positively associated with cancer of prostate, influenza, and motor vehicle accidents (women only), and negatively associated with cerebrovascular disease (women only), motor vehicle accidents (men only), and "all other causes". In that year, democracy was positively associated with motor vehicle accidents (women only), and negatively associated with heart disease and homicide (women only).

Figure 3 shows the evolution over time of the association of average income and levels of democracy with all-cause mortality. Democracy's association with all-cause mortality becomes more and more negative over time, particularly after 1970, regardless of whether we control for average income or not. In a multivariate analysis, the association becomes statistically significant ($P < 0.05$) in 1980 and remains so thereafter. For average income, however, the evolution is more ambiguous: after 1965, its association with all-cause mortality becomes more and more negative over time in a univariate analysis, but this effect disappears when we control for democracy. In a multivariate analysis, significance levels vary over time, but the association is statistically significant ($P < 0.05$) among men in 1989 and among women in all years since 1970. Results of cause-specific analyses are presented in ESM appendix figure A2.

Apparently, in Europe as a whole the growing dispersion of all-cause mortality reflects a combination of several phenomena: a growing dispersion of average income, and a strengthening of the association with democracy. We will now look at several exemplar countries in more detail. Convergence within Western Europe can only partly be explained by these two phenomena, as can be seen from the cases of Finland and Portugal. On the other hand, the divergence of mortality in Central and Eastern Europe can be explained quite well by these two phenomena, as can be seen from the cases of Hungary and Bulgaria (Fig. 4).

Finland started to close its mortality gap with Sweden in the late 1960s, but this was due to neither a narrowing gap in average income nor any democratisation (Fig. 4a). Finland's lower national income predicted a slightly higher mortality rate throughout the study period, while its levels

Table 2 Relation between cause-specific mortality and average income and democracy, by sex, Europe, 1955 and 1989

	1955			1989		
	Coefficient	*P* value	R^2	Coefficient	*P* value	R^2
Men						
Cancer of colorectum						
GDP	0.002	0.227	0.39	0.001	0.186	0.09
Democracy	0.382	0.298		−0.414	0.392	
Cancer of respiratory organs						
GDP	0.001	0.880	0.03	−0.001	0.526	0.07
Democracy	0.359	0.709		−0.244	0.843	
Cancer of prostate						
GDP	**0.001**	**0.032**	0.53	**0.001**	**0.001**	0.73
Democracy	0.098	0.549		0.176	0.508	
Other cancers						
GDP	−0.002	0.642	0.07	0.000	0.867	0.00
Democracy	0.939	0.352		0.185	0.866	
Diabetes						
GDP	0.000	0.636	0.02	0.000	0.981	0.00
Democracy	−0.031	0.863		0.059	0.829	
Heart disease						
GDP	−0.010	0.549	0.07	0.001	0.771	0.46
Democracy	4.520	0.322		**−10.437**	**0.009**	
Cerebrovascular disease						
GDP	−0.004	0.512	0.04	−0.005	0.061	0.62
Democracy	0.273	0.883		−4.186	0.070	
Pneumonia						
GDP	−0.005	0.074	0.64	0.000	0.710	0.04
Democracy	−1.481	0.069		−0.691	0.443	
Influenza						
GDP	−0.001	0.415	0.06	**0.000**	**0.003**	0.44
Democracy	0.335	0.377		−0.058	0.176	
Cirrhosis of liver						
GDP	−0.001	0.787	0.12	−0.001	0.223	0.30
Democracy	−0.626	0.442		−0.685	0.456	
Motor vehicle accidents						
GDP	0.002	0.244	0.38	**−0.001**	**0.007**	0.33
Democracy	0.370	0.310		0.813	0.055	
Other accidents						
GDP	0.000	0.910	0.00	−0.001	0.494	0.41
Democracy	0.027	0.969		−1.470	0.081	
Suicide						
GDP	0.002	0.258	0.09	0.001	0.289	0.11
Democracy	−0.498	0.352		−1.070	0.143	
Homicide						
GDP	0.000	0.408	0.15	0.000	0.732	0.24
Democracy	−0.018	0.726		−0.205	0.192	
All other						
GDP	−0.025	0.162	0.40	**−0.015**	**0.003**	0.49
Democracy	−4.187	0.398		3.255	0.361	

Table 2 continued

	1955			1989		
	Coefficient	*P* value	R^2	Coefficient	*P* value	R^2
All causes						
GDP	−0.041	0.225	0.17	**−0.020**	**0.034**	0.67
Democracy	0.462	0.960		**−14.971**	**0.049**	
Women						
Cancer of colorectum						
GDP	0.001	0.539	0.23	0.001	0.145	0.13
Democracy	0.294	0.349		−0.189	0.502	
Cancer of respiratory organs						
GDP	0.000	0.318	0.08	0.000	0.960	0.05
Democracy	0.047	0.640		0.259	0.542	
Cancer of breast						
GDP	**0.002**	**0.004**	0.71	0.001	0.185	0.33
Democracy	0.190	0.315		0.258	0.443	
Other cancers						
GDP	−0.002	0.627	0.02	0.000	0.955	0.01
Democracy	0.552	0.570		0.116	0.852	
Diabetes						
GDP	0.001	0.571	0.05	0.000	0.390	0.04
Democracy	0.008	0.982		0.153	0.642	
Heart disease						
GDP	−0.008	0.488	0.04	−0.001	0.616	0.70
Democracy	1.308	0.669		**−7.672**	**0.001**	
Cerebrovascular disease						
GDP	−0.004	0.464	0.04	**−0.005**	**0.035**	0.62
Democracy	0.657	0.696		−2.890	0.119	
Pneumonia						
GDP	**−0.004**	**0.045**	0.66	0.000	0.762	0.02
Democracy	−1.046	0.084		−0.394	0.552	
Influenza						
GDP	−0.001	0.662	0.04	**0.000**	**0.003**	0.51
Democracy	0.249	0.487		−0.025	0.435	
Cirrhosis of liver						
GDP	−0.001	0.558	0.21	−0.001	0.148	0.28
Democracy	−0.309	0.381		−0.113	0.739	
Motor vehicle accidents						
GDP	0.001	0.055	0.52	**0.000**	**0.001**	0.47
Democracy	0.063	0.396		**0.166**	**0.032**	
Other accidents						
GDP	0.001	0.529	0.11	0.000	0.783	0.13
Democracy	0.104	0.731		−0.474	0.212	
Suicide						
GDP	0.001	0.158	0.14	0.001	0.066	0.17
Democracy	−0.201	0.345		−0.412	0.104	
Homicide						
GDP	0.000	0.710	0.02	0.000	0.951	0.34
Democracy	−0.010	0.562		**−0.093**	**0.049**	
All other						
GDP	−0.019	0.096	0.47	**−0.010**	**0.002**	0.52
Democracy	−2.739	0..366		2.306	0.343	

Table 2 continued

	1955			1989		
	Coefficient	*P* value	R^2	Coefficient	*P* value	R^2
All causes						
GDP	−0.032	0.063	0.39	**−0.016**	**0.002**	0.80
Democracy	−0.834	0.856		**−9.004**	**0.021**	

Results of multivariate linear regression analyses. Slope = regression coefficient. Bold indicates *P* values <0.05. *GDP* Gross Domestic Product

of democracy have been as high as those of Sweden. Finland's remarkable achievement is due to a narrowing of the gap with Sweden for many different causes of death. Among men, the largest contribution was made by heart disease, whereas among women heart disease was as important as cerebrovascular disease.

Portugal's convergence with Sweden can also not be attributed to economic conditions: if anything, its growing gap in average income since 1965 predicted a widening of the mortality gap (Fig. 4b). However, democratisation predicted a narrowing of its mortality gap with Sweden after 1975, and thus might have played a role in this remarkable achievement. Although mortality from "all other causes" declined rapidly throughout the study period, this was at first compensated by rising mortality from cerebrovascular disease. Portugal only started closing its mortality gap with Sweden in the late 1970s, when a turning-point in the mortality trend for cerebrovascular disease occurred, both among men and women.

In the 1950s, Hungary already had a substantial mortality disadvantage as compared to Sweden, and this was partly explained by its lower average income (Fig. 4c). Around 1970 the gap started to widen, probably partly due to a widening gap in average income, partly due to a strengthening of the effect of democracy. Democratisation in the late 1980s predicted a sudden narrowing of the mortality gap with Sweden, but this was not observed. The growing gap in mortality with Sweden was due to rising or stagnating mortality from a range of causes of death, with again an important role for cerebrovascular disease, particularly among men.

Bulgaria's is again a different story (Fig. 4d). In the mid-1960s there was no great gap in mortality with Sweden, due to the fact that higher mortality from some causes (such as cerebrovascular disease) was compensated by lower mortality from heart disease. Since the latter advantage gradually eroded, and the disadvantage for other causes grew, a gap in total mortality arose. Both among men and among women most of Bulgaria's widening gap in total mortality is proportional to its growing economic

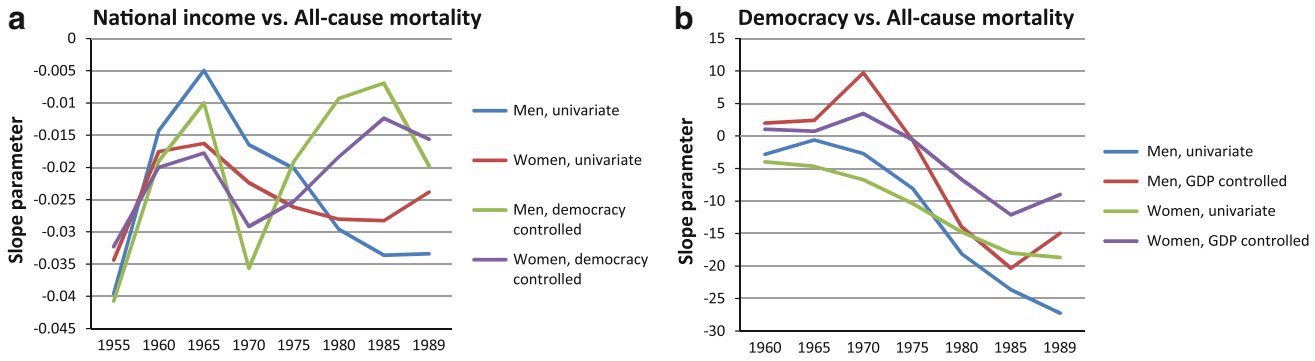

Fig. 3 Development over time of the relation between average income and all-cause mortality, and between levels of democracy and all-cause mortality, Europe, 1955–1989. **a** Average income. **b** Democracy (colour figure online)

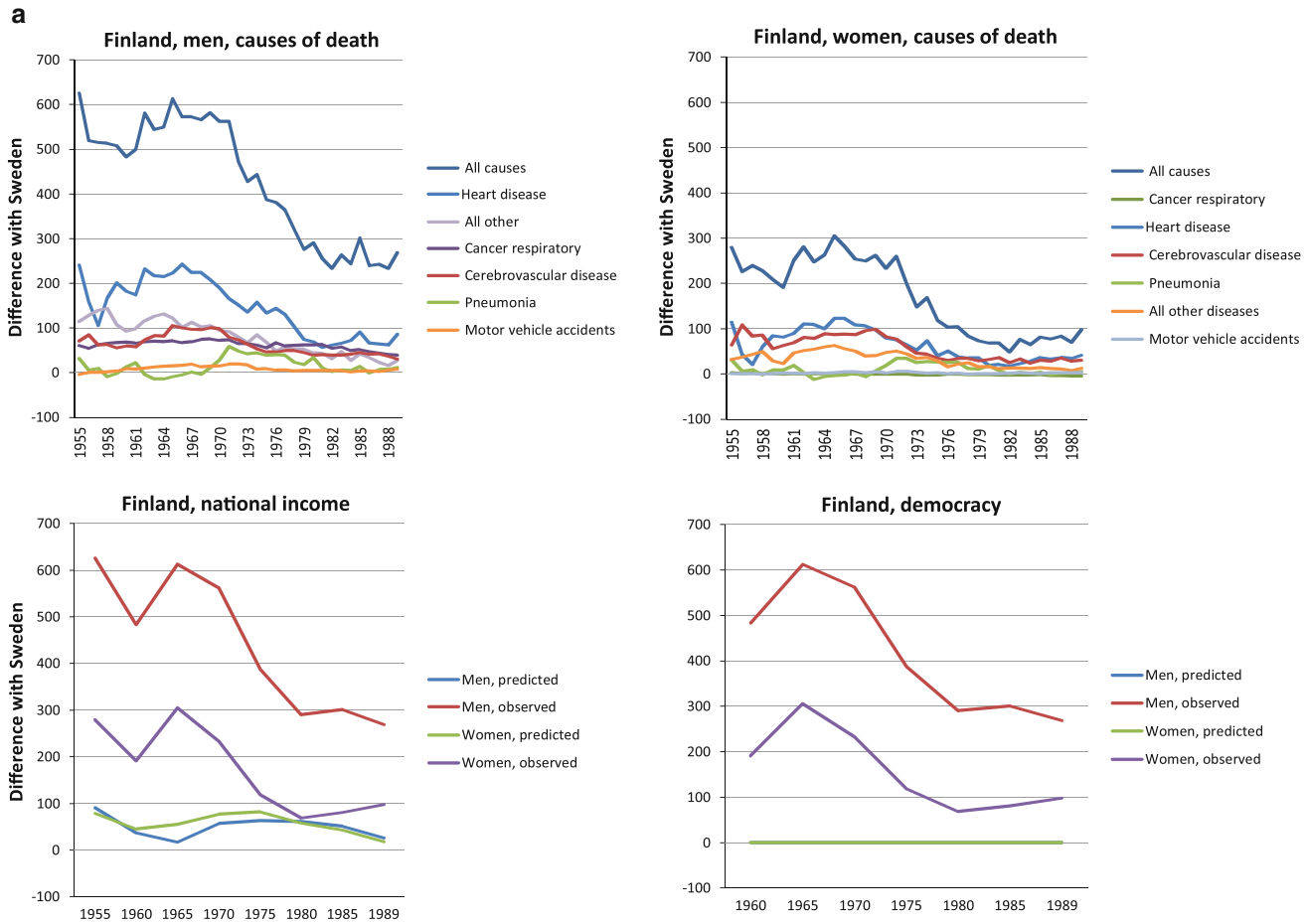

Fig. 4 Differences in mortality with Sweden, 1955–1989: role of different causes of death, average income and levels of democracy in Finland (**a**), Portugal (**b**), Hungary (**c**) and Bulgaria (**d**). All graphs present differences in age-standardised mortality rates (in deaths per 100,000 person-years) with Sweden. The *top graphs* present observed differences in mortality from all causes as well as from a selection of specific causes of death. The *bottom graphs* present observed and predicted differences in mortality from all causes. Predicted differences were calculated from the predicted values for the country and for Sweden, on the basis of univariate regression of all-cause mortality on average income (*bottom left hand graph*) and on levels of democracy (*bottom right hand graph*) (colour figure online)

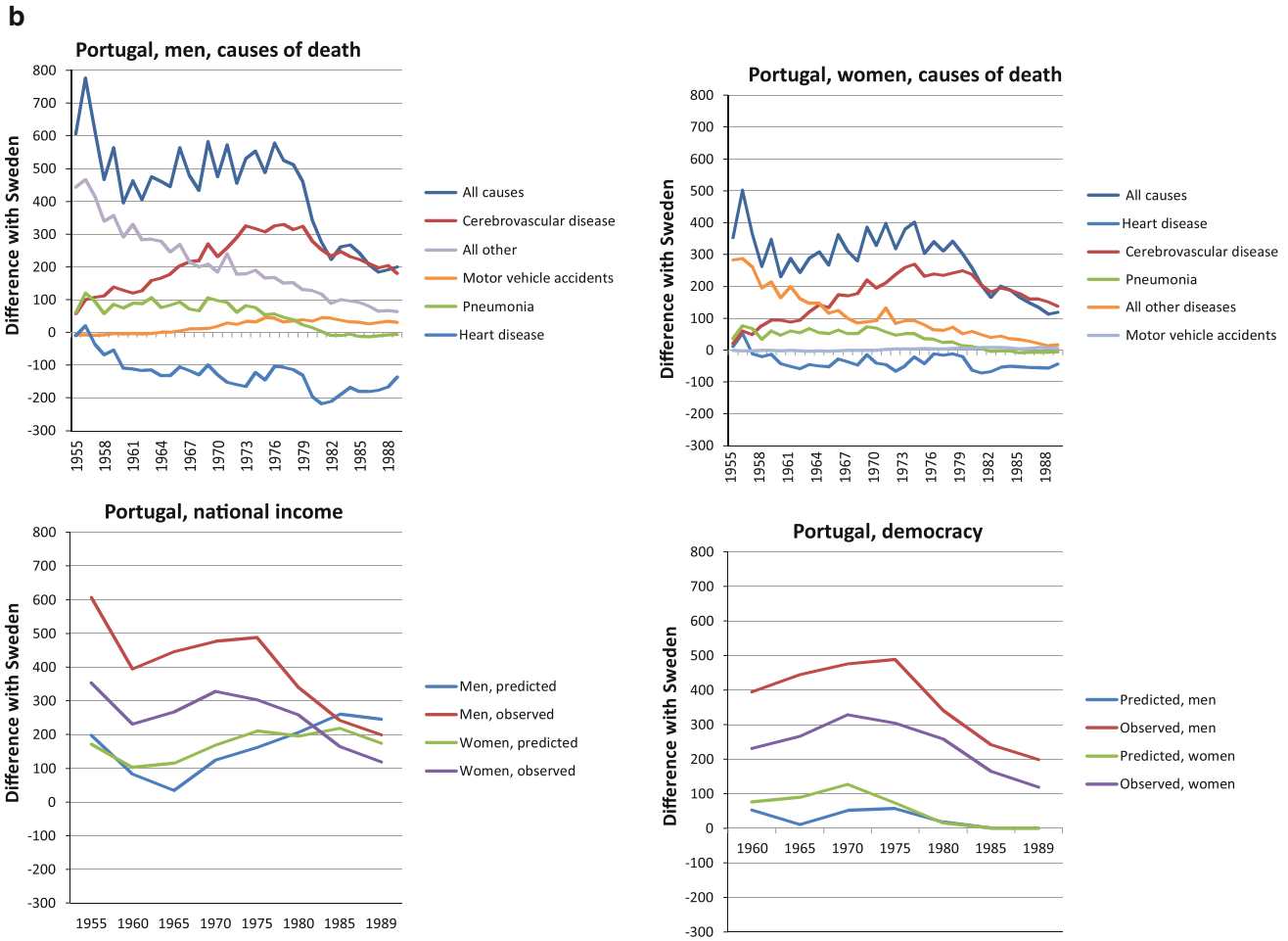

Fig. 4 continued

disadvantage, as well as its democratic deficit, as compared to Sweden.

Discussion

Limitations

We used an existing dataset with a limited number of causes of death, including a large group of "all other causes". Declining mortality due to these contributed importantly to convergence of all-cause mortality (Table 1; Fig. 4), but as details are lacking we cannot say with certainty which specific causes account for this decline. As stated in the introduction, however, these are infectious diseases, perinatal and maternal causes, and other conditions which dominated mortality before World War II and continued their decline during the study period (Omran 1983). This group should not be equated with "unknown" causes because the category of "signs, symptoms and ill-defined conditions" has been redistributed over all the "known" causes (including the "other" known causes; see the "Methods" section).

The accuracy and validity of cause-of-death classifications is far from perfect, and differences between countries, or changes over time, in certification or coding of causes of death could, therefore, have biased our results. For example, some of the rise of cancer and heart disease seen during the study period (Fig. 1) could be due to better recognition of these "modern" causes of death, and so could be the higher rates of mortality from some cancers in countries with higher average income in the 1950s (Table 2), or the shrinking advantage for heart disease mortality among Bulgarian men seen in the 1960s and 1970s (Fig. 4d). On the other hand, the association between mortality and income is far from uniform, and many of the changes and differences in cause-specific mortality seem too large to be attributable to simple registration artefacts.

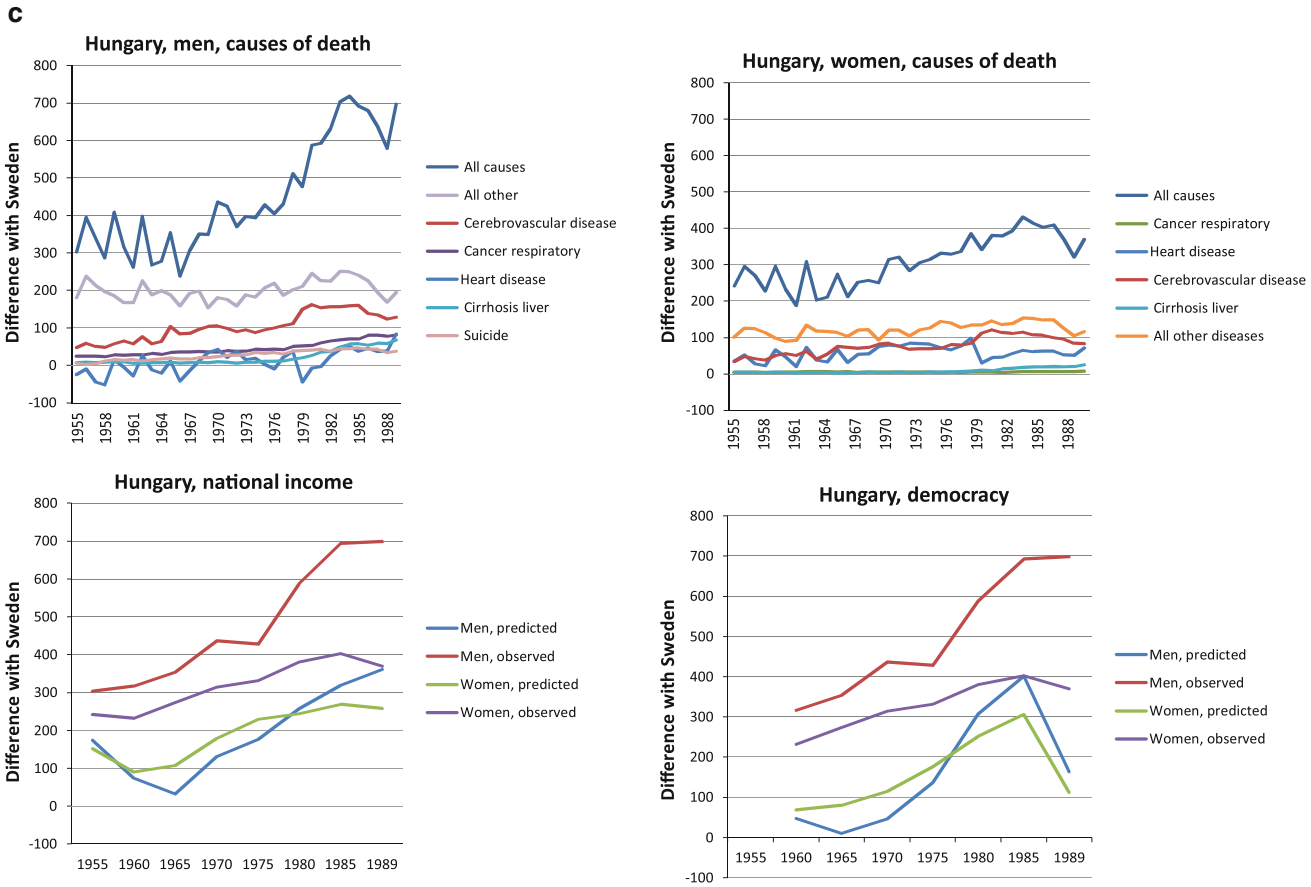

Fig. 4 continued

Our analysis of the role of average income in explaining mortality levels and trends (as in Table 2; Figs. 3, 4) implicitly assumes a causal effect of income on mortality. This is, however, contentious: these cross-sectional associations may be confounded by other factors (e.g., levels of education, Caldwell 1986), or by reverse effects of population health on economic performance (Acemoglu and Johnson 2006; Swift 2011). Longitudinal analyses often find much weaker associations between national income and mortality indicators (Bloom and Canning 2007). We, therefore, see these analyses as exploratory only, but they do clearly suggest the possibility that changing economic conditions have contributed to widening or narrowing of gaps in mortality.

The same applies to our results on levels of democracy. Levels of democracy are partly "endogenous", reflecting the collective preferences of populations, and the association between democracy and mortality may be partly due to other factors associated with these collective preferences, such as differences in value orientations (Inglehart and Welzel 2005), which also affect other collective and individual behaviours such as health-related lifestyles. We have, however, controlled for average income, which is known to be an important determinant of both democracy (Acemoglu et al. 2008; Lipset 1959) and health-related behaviours (Ezzati et al. 2005).

Interpretation

During the early years of this period, some countries still had to finish a classical transition from infectious diseases to chronic diseases and injuries (Omran 1983), whereas during the later years other countries already embarked upon a new transition in which chronic diseases retreated to higher ages and injuries declined as a cause of premature mortality (Olshansky and Ault 1986). At both ends of the study period, all-cause mortality was negatively associated with average income, but on the basis of very different cause-specific patterns: countries with lower incomes had higher mortality from "old" diseases in the early years and higher mortality from "new" diseases at the end.

Although these aggregate level relationships do not necessarily represent individual level relationships between economic conditions and mortality, the similarity between

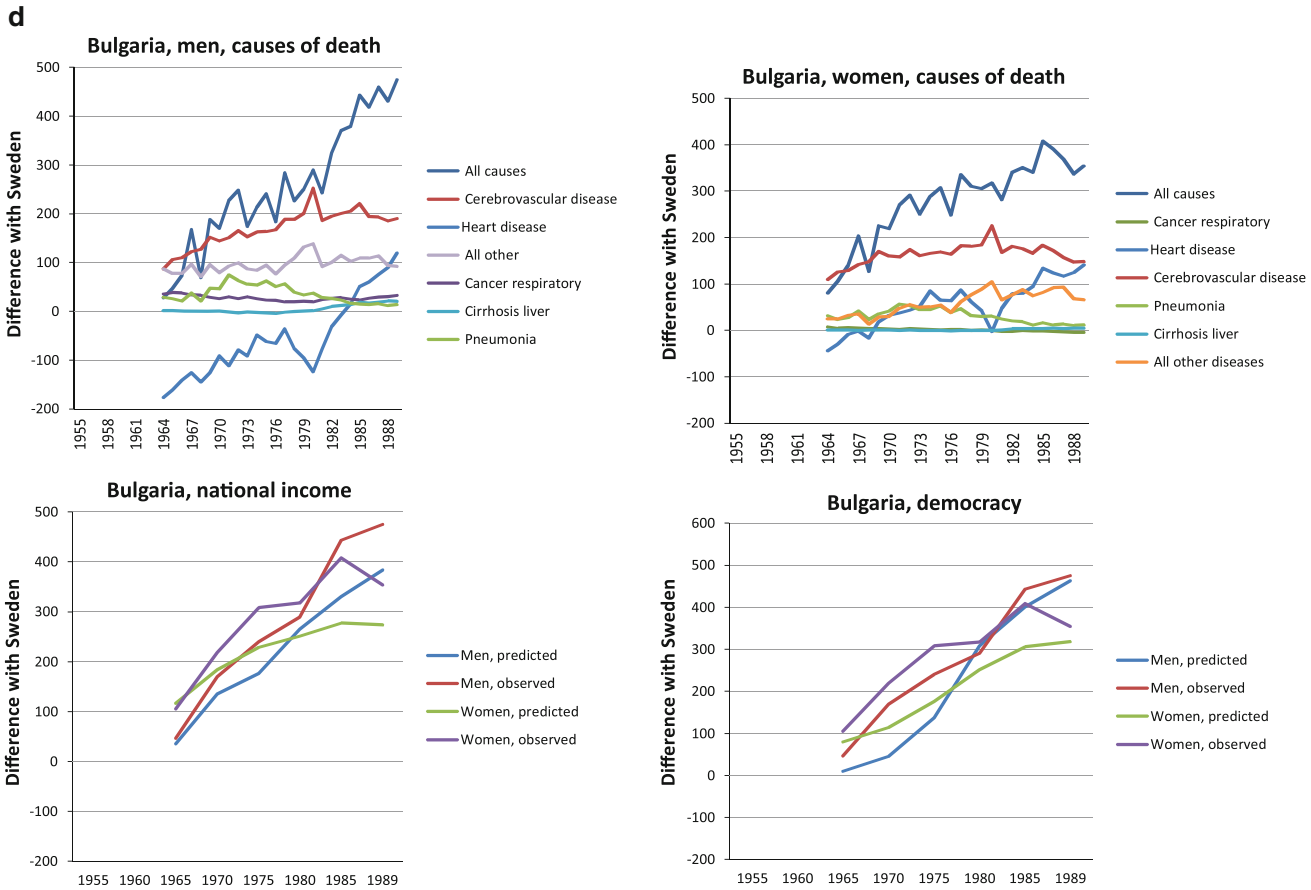

Fig. 4 continued

the two is remarkable. The available evidence suggests that inequalities in mortality between socioeconomic groups within countries (as defined on the basis of, e.g., individual occupational class) declined until the 1960s and then started to rise again (Mackenbach et al. 2003; Pamuk 1985; Strand et al. 2010). This rise has been attributed to a process of gradual diffusion of lifestyle change and/or uptake of effective therapies from higher to lower socioeconomic groups (Rogers 1962). A similar process of diffusion may be behind the patterns observed in our between-country comparisons.

Our results suggest that a widening gap in average income between European countries may have contributed to the widening gap in mortality, particularly between Western Europe on the one hand, and Central and Eastern Europe on the other hand. Economic stagnation in Central and Eastern Europe during the 1970s and 1980s led to a relative impoverishment of this part of the subcontinent (Maddison 2003), and may have negatively affected population health through excessive alcohol consumption (Leon et al. 2009), psychosocial factors (Marmot and Bobak 2000), inadequate health care (Nolte et al. 2004) or defective health policies (Mackenbach and McKee 2013).

Although this was a politically stable period, some important changes did occur, for example in Spain, Portugal and Greece, where military dictatorship was replaced by liberal democracy in the mid-1970s (Black et al. 2000). In our data, Portugal stands out as a country with clear discontinuities in its mortality trends (Fig. 4b). All-cause mortality decline in Portugal started in the late 1970s, following the "carnation revolution", and was due to a reversal of the mortality trend for cerebrovascular disease, as well as to favourable mortality trends for pneumonia and heart disease. It is tempting to speculate that democratisation, followed by modernisation of many institutions including the implementation of a national health service, has played a role in these spectacular developments (Barros et al. 2011; Mackenbach et al. 2013).

Although patterns and trends among men and women were qualitatively similar, at the end of the study period

associations between mortality and both average income and democracy tended to be stronger among men than among women (Table 2; Fig. 3). This helps to understand why between-country variations in mortality were larger among men than among women in 1989 (Table 1; Fig. 2). Men appear to be more vulnerable to economic stress, and to the negative consequences of non-democratic government, perhaps because of a tendency to respond with hazardous lifestyles (Mackenbach et al. 2013).

In Portugal, the decline of cerebrovascular disease explained a large part of its mortality convergence, but this is just a special case of the surprisingly important role that this disease has played in developments throughout Europe. One of its sub-forms, haemorrhagic stroke, is an "old" disease which has probably been in decline for most of the 20th century in many European countries (Mirzaei et al. 2012). This decline was due to a combination of changes in food consumption with concomitant reductions of salt intake and the introduction of early detection and treatment of hypertension (Joossens and Kesteloot 1991; Mirzaei et al. 2012).

Mortality from cerebrovascular disease has been rising during most of the study period in many Central and Eastern European countries (Fig. 4). In this region, stroke mortality only started to decline in the 1980s or even later. This is likely to reflect high levels of uncontrolled hypertension (Mark et al. 1991), a low priority placed on hypertension control by physicians (Mark et al. 1998), and delays in widespread prescribing of modern antihypertensive drugs (Roberts et al. 2010).

Ultimately, the divergence of mortality between Western and Central and Eastern Europe was due to different political conditions, as illustrated by our results on the role of democracy. It has been argued that democratic governments can be expected to make decisions in accordance with voters' interests, and thus to be more actively engaged in promoting the public good than authoritarian governments. This advantage may be strengthened by greater public accountability, greater effectiveness in getting things done that require the active participation of the public, greater inclination towards redistributive policies, and greater ability to recruit competent and honest people (Besley and Kudamatsu 2006; Klomp and de Haan 2009; Mackenbach et al. 2013; Wigley and Akkoyunlu-Wigley 2011).

Conclusions

Although this was a politically stable period, mortality patterns were highly dynamic, and prefigured the more dramatic mortality trends after 1990. While some Western European countries were able to close the gap with the most advanced countries, Central and Eastern European countries saw their mortality gap widen, probably as a result of economic and political stagnation. The central role of cerebrovascular disease in trends for all-cause mortality requires further investigation.

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